Status and Trends for the U.S. Forest Products Sector

A Technical Document Supporting the Forest Service 2010 RPA Assessment

Kenneth E. Skog, David B. McKeever, Peter J. Ince,
James L. Howard, Henry N. Spelter, and Albert T. Schuler

Abstract

Forest products sector products and income help sustain the social, economic, and ecological benefits of forestry in the United States. Solidwood products consumption increased with population between 1965 and 2008 and varied with housing starts. Lumber's share declined from 83% to 70%, and structural panels' share increased from 9% to 17%. Paper and paperboard consumption increased with gross domestic product until 1999, then stopped increasing partly due to a shift in advertising to electronic media and a shift from domestic manufacturing to imports of manufactured products. Roundwood needed to make products consumed, including imports, have remained remarkably stable at 1.75 m3 per capita although the portion from imports has varied. Per capita consumption declined during the recent recession. Net imports have varied with the U.S. dollar exchange rate. Net import share varied between 5% and 10% from 1965 to the early 1990s, increased to over 20% by 2004–2005 and declined with the recession to 12% in 2009. Structural panel and lumber production have increased with increasing housing starts but declined more than 40% in 2009 - associated with a 72% decline in housing starts through 2010. Paper and paperboard production increased faster than lumber production from 1965 to 1999, after which paperboard production leveled off and paper production declined. Prospects for solidwood, paper and paperboard production will be influenced by the economic recovery, particularly housing starts and intensity of wood use per unit of economic activity; by global demand and supply, and by the long-term value of the dollar. Consumption of wood for energy was stable from 1950 through the mid 1970s. Roundwood fuelwood and black liquor/residue use doubled by the mid 1980's then declined. Residential fuelwood use declined the most until about 1999 and has since been stable to increasing. Because most wood energy is linked to pulp or solidwood products production, the wood energy share of outputs has remained relatively constant. Wood energy consumption could move above the industry associated amounts with continuing change in the price of fossil fuel versus wood fuel, changes in wood energy technologies, or changes in regulations or incentives.

Keywords: Forest sector, housing, lumber, panels, paper, pulp, consumption, production, trade, wood requirements, wood energy

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Executive Summary

The forest products sector helps sustain the social, economic, and ecological benefits of forestry in the United States. Product revenues sustain economic benefits that include jobs and income. Ecological and social benefits can be supported by timber revenue to landowners that help keep land in forests and by forest treatments that can help maintain ecological functions. The degree to which the forest products sector helps sustain benefits is influenced by levels of demand and consumption of forest products and how technology, markets, and demand for timber translates into harvest of different species and sizes of trees in different regions.

Our overall objective in this report is to explain how, over the last 40 to 50 years, a range of forces driving solid wood and paper product consumption and trade and use of wood for energy have resulted in certain trends in the use of wood and wood fiber resources in the United States. We also discuss the possibility of continuation or change in trends, particularly in response to the recession beginning in 2008 or changing use of wood for energy.

Solid Wood Products Consumption

In the United States, consumption in weight of products increased roughly in line with population between 1965 and 2008 with variation that roughly corresponds to variation in U.S. housing starts. However, the composition of consumption has changed with lumber's share declining from 83% to 70%, while structural panels' share increased from 9% to 17% and nonstructural panels' share increased from 8% to 13%.

The harvest needed to provide for total U.S. consumption, including harvest to make products imported to the United States, has remained surprisingly stable over much of the last 50 years at about 1.7 m^3 per capita. However, per capita consumption declined in 2006 through 2010, when a collapse in housing demand followed by economic recession greatly reduced housing construction. This relatively stable relationship in periods of economic growth and even modest recessions suggests that in a general way, wood and paper products fulfill fundamental needs per capita and have remained competitive with alternate means of meeting those needs. Even though consumption per capita has been stable, the portion of consumption from net imports has varied.

Consumption of solid wood products is influenced by its intensity of use per unit of economic activity, such as square meter of housing or dollar spent for nonresidential construction, building repair and remodeling, or manufacturing. For each category, the intensity of wood use has been decreasing. For example, lumber use per square meter of new single family housing decreased 18% between 1999 and 2009.

Paper and Paperboard Consumption

Consumption in weight of products increased in line with gross domestic product (GDP) until 1999, after which consumption stopped increasing partially because of the shift in advertising from print to electronic media and because of more imports of manufactured products instead of domestic production.

Roundwood requirements to make solid wood and paper and paperboard products consumed in the United States, including imports, have remained remarkably stable at about 1.3 and 0.45 m^3 per capita for softwoods and hardwoods, respectively (1.75 m^3 total).

Contribution of Net Imports to Domestic Consumption

Net imports (and resultant effect on domestic production) have varied in part with the U.S. dollar exchange rate with foreign currencies. The net import share in roundwood equivalents varied mostly between 5% and 10% from 1965 to the early 1990s, then increased to over 20% by 2004–2005 and then declined with the recession to 12% in 2009.

With total consumption (in roundwood equivalents) increasing at the pace of population and net imports varying with exchange rate, U.S. harvest increased from 333 to 445 million cubic meters ($\times 10^6$ m^3) between 1965 and 1989, remained relatively stable to 2005, then declined to 307 × 10^6 m^3 in 2009. This total trend holds for softwood harvest, whereas hardwood harvest peaked in about 1995 with a steady decline since then. The increase in net imports since the 1990s allowed for stable to declining U.S. harvest.

Because of consumption and trade drivers, lumber production increased with increasing housing starts, despite increasing net lumber imports, from 72 to 96 × 10^6 m^3 between 1965 and 2005 and declined more than 40% to 56 × 10^6 m^3 in 2009. Structural panel production increased steadily until about 1999, remained steady at about 25 × 10^6 m^3 until 2005, *then declined by almost 40%* to 16 × 10^6 m^3 in 2009. Through 2007, oriented strandboard (OSB) production increased steadily, overtaking declining softwood plywood production in 2005. The declines after 2005 are associated with a 72% decline in housing starts through 2010 and because of the recession beginning in December 2007. There is a question going forward about whether housing starts will return to a level given by the several year averages prior to the recession. The amount and size of housing will likely be lower with more restrictive lending practices.

Paper and paperboard production increased even faster than lumber production from 1965 to 1999, after which paperboard production leveled off and paper production declined sharply.

Going forward, the prospects for solid wood, paper and paperboard production, and required U.S. roundwood harvest will be influenced not only by the degree of economic recovery, particularly housing starts and intensity of wood use per unit of economic activity, but also by global demand and global sources of supply and by the value of the dollar relative to other currencies. Recently, the dollar exchange rate has been at a level that corresponds to net imports at 5% of consumption in the early 1990s (compared with 20% in 2008). To the extent that exchange rate is a driver of competitive advantage, this could mean import share could decrease and U.S. production, and U.S. timber harvest would cover a greater fraction of consumption needs as wood and paper product consumption increases with recovery from the recession.

Although consumption is not likely to soon return to its previous high consumption level of 555 × 10^6 m^3 (roundwood equivalent) in 2005, such a consumption level could increase U.S. harvest above the 2005 level of 438 × 10^6 m^3 to above 520 × 10^6 m^3. This higher harvest level would be about 20% above the 2005 level if the low dollar exchange rate continues, and the effect of a low dollar exchange rate on net imports is similar to the effect it had in the early 1990s.

In the longer run, if historical consumption trends resume after recovery from the recession, then structural panel consumption could increase faster than population growth, lumber and paperboard consumption could increase in line with population growth, and paper consumption would not keep pace with population growth.

Total consumption of wood feedstocks for energy was relatively stable between 1950 and the mid 1970s just above 150 × 10^6 m^3 wood equivalent. These consumption numbers include roundwood, mill residue, and black liquor from pulping. From the mid 1970s to the mid 1980s, roundwood fuelwood and black liquor/residue use both roughly doubled, then both declined. Residential fuelwood use declined the most until about 1999 and has since been stable to increasing with increasing fuel oil and natural gas prices.

Wood energy (including wood or wood residue energy used in production of forest products) can be viewed as the largest single use of wood and wood fiber, which includes roundwood, residues, black liquor, and recovered paper. The share of wood used for energy was about 46% in 1965, declined to 34% in the late 1980s, and increased to 48% in 2009. The share had been relatively stable around 44% since the late 1990s through 2008.

The pulp and paper industry could also be viewed as the largest single consumer of wood and wood residues if we include wood residues used for energy and recycled and residue fiber used for pulp. Most wood energy is used by pulp and paper mills or solid wood products mills with a smaller fraction used for residential heating. Because most wood energy is linked to pulp or solid wood products production, the wood energy share of outputs has remained relatively constant. In the future, if significant structural changes occur, such as a change in the relationship between the price of fossil fuel and wood fuel, changes in wood energy technologies, or changes in regulations or incentives, then wood energy consumption would move above the amounts closely associated with production of wood and paper products.

Introduction

The forest products sector helps sustain social, economic, and ecological benefits of forestry in the United States. Economic benefits are sustained by product sales revenues that support jobs and income from forest industries. Ecological and social benefits can be supported by timber revenue to forest landowners that help keep land in forests and by forest treatments that can help maintain forest ecological functions. The degree to which the forest products sector helps sustain benefits is influenced by levels of demand and consumption of forest products and how technology, markets, and supply of forest timber and biomass translate this demand into harvest of different species and sizes of trees in different regions.

The objective of this paper is to explain how, over the last 40 to 50 years, a range of forces driving solid wood and paper product consumption and trade and use of wood for energy have resulted in certain trends in the use of wood and wood fiber resources in the United States. These wood and wood fiber resources include harvest of roundwood from forests, imports of roundwood in the form of logs and chips, use of recovered paper, and use of wood residues generated from processing roundwood into primary products such as lumber. To attain this objective we describe the following:

1. General trends in U.S. consumption of solid wood and paper products
2. General trends in trade and U.S. production of products
3. Detailed trends in consumption of solid wood products, trade in solid wood products, and U.S. production and product price
4. Detailed trends in consumption, trade, production, and prices for pulp, paper, and paperboard and for resulting pulpwood harvest, including use for oriented strandboard
5. Detailed trends in consumption of wood for energy by end use and prospective use of more wood for electric power or biofuels
6. Detailed trends in total U.S. output (production) of solid wood, paper products, and wood for energy and inputs of wood and wood fiber sources to make those outputs

The relative abundance or scarcity of timber and biomass supply and the efficiency of conversion processes to meet demand for products can be judged in part by trends in prices for lumber, panels, paper and paperboard, and by prices for sawlogs, pulpwood, and biomass. If prices are decreasing, this suggests that supply and technology are more than sufficient to meet demand needs. If prices are increasing, then the product may be viewed as becoming more economically scarce. Price increases may be due in part to increasing production costs (e.g., if energy prices are increasing). Increasing volumes and prices of harvested wood can help keep value of forest land somewhat higher and result in fewer acres of forest where the value for alternate uses is higher.

Drivers of Consumption of Wood and Paper Products

Consumption of solid wood and paper products in the United States is driven in large part (but not exclusively) by consumer and business needs for shelter, infrastructure, shipping, and communications. Proxies for growth or change in these needs include (but are not limited to) population, gross domestic product, housing starts, nonresidential construction expenditures, industrial production, and paper media advertising.

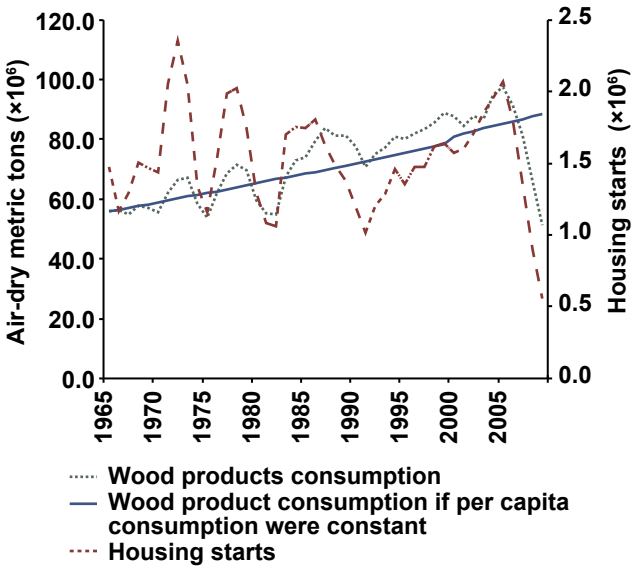

Figure 1. Solid wood products consumption if per capita consumption were constant at the 1965 level and annual housing starts, 1965–2009.

Four high-level aggregates of wood and paper products consumption to consider in looking at the influence of drivers are 1) solid wood products, 2) paper and paperboard, 3) weight of total wood and paper products, and 4) roundwood required to make wood and paper products. Roundwood required to make products is termed roundwood equivalent. For consumption the roundwood harvest is needed to make wood and paper products, including imported products. Within these consumption aggregates, the consumption of individual products is sensitive to progressively more specific drivers.

Solid wood products consumption in air-dry metric tons has grown at about the same rate as population over the last 50 years. Metric tons are used so wood consumption may be compared with paper consumption, which is reported in metric tons. Much of the variation in consumption is associated with variation in housing starts (Fig. 1), which have an influence on wood use based on house size and wood use per m^2 of floor space. House sizes have been increasing while wood use per m^2 has been decreasing. Wood use per unit has increased 56% between 1962 and 2009 for single family units and 15% for multifamily units (Table 1). Wood products consumption varies sharply with housing starts over time and has deceased sharply with the decreasing housing starts during the recession. This indicates that population growth is not a sufficient condition to create increasing growth in consumption. Housing starts and drivers of housing starts have a major influence on consumption levels and growth. Drivers of housing starts include jobs, wage levels, and home financing costs. In the post World War II era, a growing economy and a benign environment promoting a rising middle class eased the way for Americans to break off into smaller and more numerous

Table 1—Production of and timber products used in new housing by product and type of unit, selected years 1962–2009

Year and type of unit	Units produced ($\times 10^3$)	Floor area per unit (m^2)	Lumber[a] Total use ($\times 10^3$ m^3)	Lumber[a] Per m^2 (m^3)	Lumber[a] Per unit (m^3)	Structural panels[b] Total use ($\times 10^3$ m^3)	Structural panels[b] Per m^2 (m^3)	Structural panels[b] Per unit (m^3)	Nonstructural panels[c] Total use ($\times 10^3$ m^3)	Nonstructural panels[c] Per m^2 (m^3)	Nonstructural panels[c] Per unit (m^3)	Total, all wood products Total use ($\times 10^3$ m^3)	Total, all wood products Per m^2 (m^3)	Total, all wood products Per unit (m^3)
1962														
Single family	991	125	20,585	0.166	20.8	2,598	0.021	2.6	1,582	0.013	1.6	24,766	0.200	25.0
Multi-family	472	90	4,816	0.113	10.2	795	0.019	1.7	529	0.012	1.1	6,139	0.144	13.0
Mobile homes	118	57	328	0.049	2.8	89	0.013	0.8	129	0.019	1.1	547	0.082	4.6
Total	1,581	—	25,729	—	—	3,482	—	—	2,241	—	—	31,452	—	—
1970														
Single family	813	139	17,742	0.157	21.8	3,590	0.032	4.4	3,255	0.029	4.0	24,587	0.217	30.2
Multi-family	621	92	6,419	0.112	10.3	1,260	0.022	2.0	680	0.012	1.1	8,358	0.146	13.5
Mobile homes	401	68	1,395	0.051	3.5	408	0.015	1.0	754	0.028	1.9	2,557	0.094	6.4
Total	1,835	—	25,556	—	—	5,257	—	—	4,690	—	—	35,502	—	—
1976														
Single family	1,162	158	28,877	0.157	24.8	6,566	0.036	5.6	5,224	0.028	4.5	40,667	0.222	35.0
Multi-family	375	87	3,533	0.108	9.4	871	0.027	2.3	311	0.009	0.8	4,714	0.144	12.6
Mobile homes	246	90	1,201	0.054	4.9	267	0.012	1.1	820	0.037	3.3	2,287	0.104	9.3
Total	1,784	—	33,610	—	—	7,704	—	—	6,354	—	—	47,668	—	—
1986														
Single family	1,179	170	31,721	0.159	26.9	8,668	0.043	7.3	5,352	0.027	4.5	45,741	0.229	38.8
Multi-family	626	85	5,569	0.105	8.9	1,387	0.026	2.2	471	0.009	0.8	7,428	0.140	11.9
Mobile homes	244	103	1,996	0.079	8.2	351	0.014	1.4	822	0.033	3.4	3,169	0.126	13.0
Total	2,050	—	39,286	—	—	10,407	—	—	6,645	—	—	56,338	—	—
1996														
Single family	1,161	197	31,532	0.138	27.2	11,908	0.052	10.3	2,369	0.010	2.0	45,808	0.200	39.5
Multi-family	316	99	2,909	0.093	9.2	994	0.032	3.1	378	0.012	1.2	4,281	0.136	13.5
Mobile homes	363	129	3,757	0.080	10.3	1,620	0.035	4.5	670	0.014	1.8	6,047	0.129	16.6
Total	1,840	—	38,198	—	—	14,521	—	—	3,417	—	—	56,136	—	—
1998														
Single family	1,271	203	35,513	0.137	27.9	13,901	0.054	10.9	2,802	0.011	2.2	52,216	0.202	41.1
Multi-family	346	99	3,312	0.097	9.6	1,217	0.036	3.5	401	0.012	1.2	4,930	0.144	14.3
Mobile homes	373	135	4,064	0.081	10.9	1,441	0.029	3.9	805	0.016	2.2	6,310	0.125	16.9
Total	1,990	—	42,889	—	—	16,559	—	—	4,008	—	—	63,456	—	—
2005														
Single family	1,716	226	47,680	0.123	27.8	17,032	0.044	9.9	5,828	0.015	3.4	70,540	0.182	41.1
Multi-family	352	116	3,826	0.094	10.9	1,154	0.028	3.3	668	0.016	1.9	5,648	0.139	16.0
Mobile homes	147	148	2,599	0.119	17.7	958	0.044	6.5	424	0.020	2.9	3,982	0.183	27.1
Total	2,215	—	54,105	—	—	19,144	—	—	6,920	—	—	80,170	—	—
2009														
Single family	445	226	11,375	0.113	25.5	4,452	0.044	10.0	1,375	0.014	3.1	17,201	0.171	38.6
Multi-family	109	114	1,117	0.090	10.2	334	0.027	3.1	180	0.014	1.6	1,631	0.131	14.9
Mobile homes	50	142	724	0.102	14.5	298	0.042	6.0	118	0.017	2.4	1,140	0.161	22.9
Total	604	—	13,216	—	—	5,084	—	—	1,672	—	—	19,972	—	—

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products.
[b]Includes softwood plywood and OSB.
[c]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board. Sources: McKeever 2009, USDOC Bureau of the Census 2010.

households. Following the excesses leading up to the recent recession, a strict lending environment for financing home purchases has now become an impediment to household formation. Thus, with restrictions on the ability to get long-term loans with minimal down payments, individuals have to wait longer before they can break off to form separate, independent households, dampening the effect of rising population and changing the mix of demand from single-family units to less expensive apartments.

A key question going forward is how quickly and to what degree incomes and loan conditions will improve, and given those changes, to what degree individuals will be more cautious in buying new housing. It is unlikely that loan terms will return to previous generous levels, and individuals may remain more cautious in investments. This could mean housing starts and house sizes may be lower than recent levels, and solid wood consumption may not return to the former high level per capita.

Wood use for repair and alteration of housing will continue to increase relative to wood use for new construction. This is because the average age of housing stock, now about 35 years, is increasing.

Paper and paperboard products consumption, in metric tons, grew at a steady pace with increasing GDP for many years up until about 1999, when consumption declined and has continued to decline (Fig. 2). The two trends were not directly proportionate, as the average rate of growth in GDP was higher than the average growth rate for paper and paperboard consumption, but clearly both trends were growing in tandem up until 1999. The divergence between GDP growth and U.S. consumption is a clear reflection of structural changes that have occurred in paper and paperboard demands, primarily a result of higher imports of manufactured goods and slower growth in U.S. industrial production and shifts in advertising expenditures from print media to electronic media.

We next asked if there is a relationship between total consumption of solid wood and paper products and U.S. population growth. To answer this, we used two measures of total consumption of solid wood and paper. The first is total weight of products consumed per capita. The second is cubic volume of roundwood required to make the products consumed. In each case, consumption includes net imports. The weight of products measured includes virgin wood fiber (including mill residues), and recycled fiber content in paper, and the weight of wood (including mill residue) that ends up in solid wood products. The second measure differs from the first in that it excludes recycled fiber content in paper and includes mill residues used for energy.

Using the second measure of total consumption, roundwood equivalent, we note that roundwood required to make solid wood and paper was roughly constant per capita for the 40 years from 1965 through 2005, but then declined

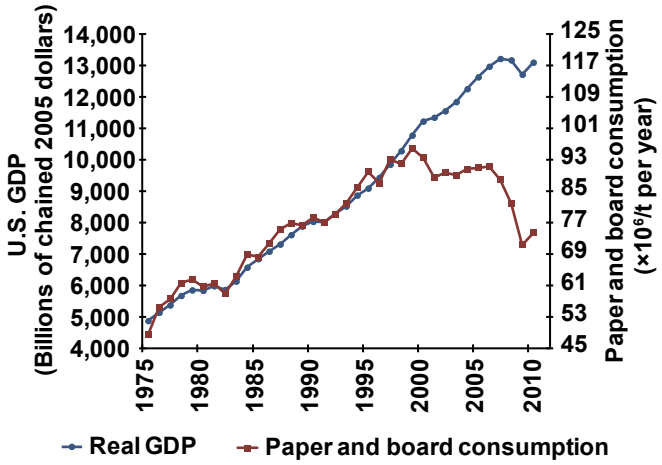

Figure 2. Trends in U.S. real gross domestic product (GDP) and U.S. paper and paperboard consumption, 1975–2008.

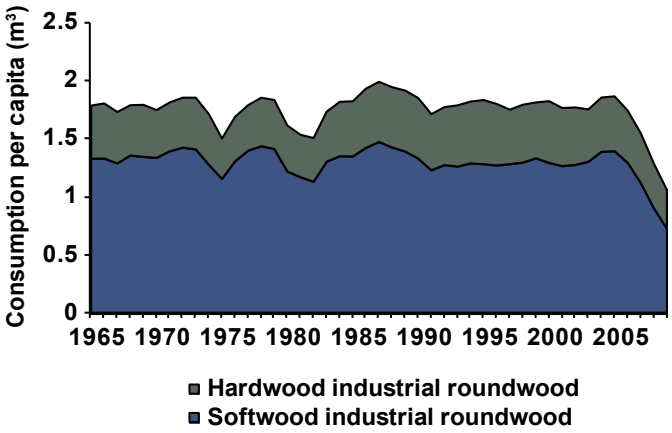

Figure 3. Solid wood and paper products consumption per capita in terms of roundwood required for production, including imports (Howard, in production).

significantly during the recent recession and collapse in housing construction since 2005 (Fig. 3). This means the harvest needed to provide for total U.S. consumption, including harvest to make imports, has remained stable over much of the last 50 years at about 1.7 m^3 per capita. However, per capita consumption declined in 2006 through 2010, when a collapse in housing demand followed by economic recession greatly reduced housing construction. This relatively stable relationship in periods of economic growth and even modest recessions suggests that wood and paper products, in a general way, fulfill fundamental needs per capita that have remained competitive with alternate means of meeting those needs. Figure 3 shows that this stability applies to consumption of hardwood and softwood separately as well. This seeming stability began in the 1940s during the Second World War. This overall stability masks considerable change in per capita consumption of individual solid wood and paper products.

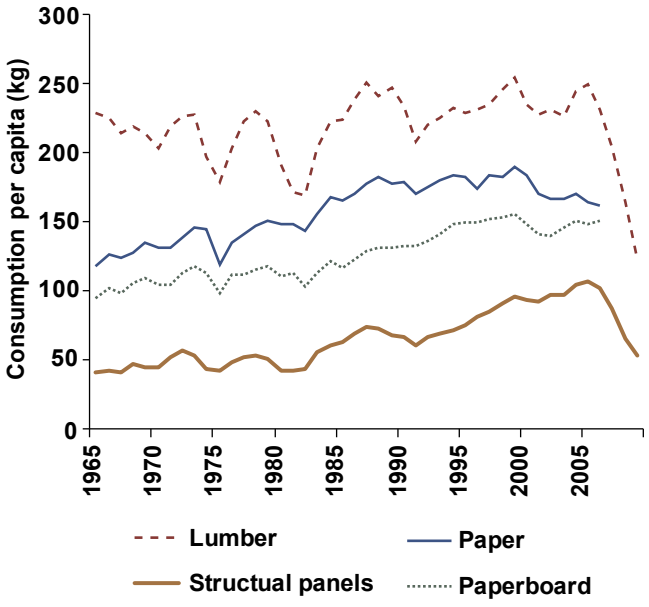

Figure 4. Primary solid wood and paper products consumption per capita.

Using the first measure of total consumption, the weight of separate products, we note that consumption of major solid wood and paper products per capita had certain general trends up to the collapse in housing demand that began in 2006 (Fig. 4). Lumber consumption per capita had been relatively stable although quite variable depending on the level of construction. Structural panels' consumption per capita was steadily increasing since the early 1980s. Paperboard consumption was increasing but leveled off in the 1990s and after. Paper consumption per capita was increasing until the mid 1980s, then was stable until about 2000 and has since declined. If historical consumption trends resume after recovery from the recession beginning in 2007, then structural panel consumption would increase faster than population growth, lumber and paperboard consumption would increase in line with population growth, and paper consumption would not keep pace with population growth.

Note that even though weight of consumption per capita for three of the four primary product categories was increasing or level, the overall roundwood required per capita has remained relatively stable. This is possible because a greater fraction of roundwood harvested makes it into solid wood products, paper, or composite panels. Also, more recovered paper is being used to make each ton of paper and paperboard. For paper and paperboard production in the United States, about 37% of the feedstock in 2009 was recovered paper rather than virgin wood, up from 25% in 1965, and recovered paper is not included in Figure 3.

Drivers of Production of Wood and Paper Products

U.S. production of solid wood and paper products is driven by overall demand for consumption and by competitiveness

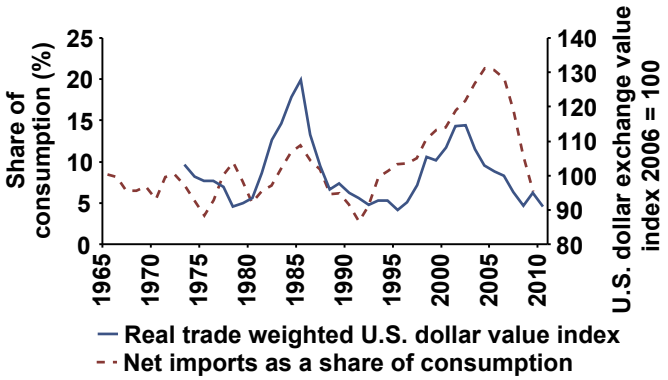

Figure 5. Wood and paper products net imports as a share of consumption in roundwood equivalents, 1965–2009.

of solid wood and paper products in import and export markets. Competitiveness of U.S. primary forest products is determined by cost factors in the United States compared with cost factors for foreign producers and by tariffs, non tariff trade barriers, and the exchange rate for the U.S. dollar. Cost factors in various countries include cost of wood feedstock (logs, chips) and nonwood feedstock (e.g., recovered paper, nonwood fiber pulp), capital and operating costs per unit of output (which includes the kind and level of conversion technologies). Most solid wood and paper products are commodity products that can be produced to set standards from a wide range of wood species around the world. Some solid wood products such as various species of hardwood lumber and veneer are specialty products in the sense that appearance features are unique, so trade in products with special features is also influenced by the domestic or foreign location of wood feedstock and its popularity for applications in various countries.

The average U.S. dollar exchange value relative to foreign currencies has a notable influence on overall net imports of solid wood and paper products. Figure 5 shows that increases in the amount of foreign currency (or products) that can be obtained per U.S. dollar are associated with an increase in net imports share of consumption of wood and paper products as measured using the ratio of roundwood equivalent for those products.

Figures 6 and 7 show that variation in net import share of consumption differs by wood or paper product and variation in share of consumption is greatest for softwood lumber and oriented strandboard. Softwood lumber and OSB are the two products with the highest share of consumption coming from net imports, about 35% until the recent collapse in housing demand and housing construction.

The level of U.S. production that is competitive in meeting U.S. consumption needs had been declining between 1991 and 2004 (Fig. 8). Competitiveness varies notably by product. Hardwood lumber and paperboard production are at levels that exceed U.S. consumption needs by 5% to 10% (Figs. 6, 7). Softwood plywood was competitive in providing for consumption plus up to 5% more (relative to

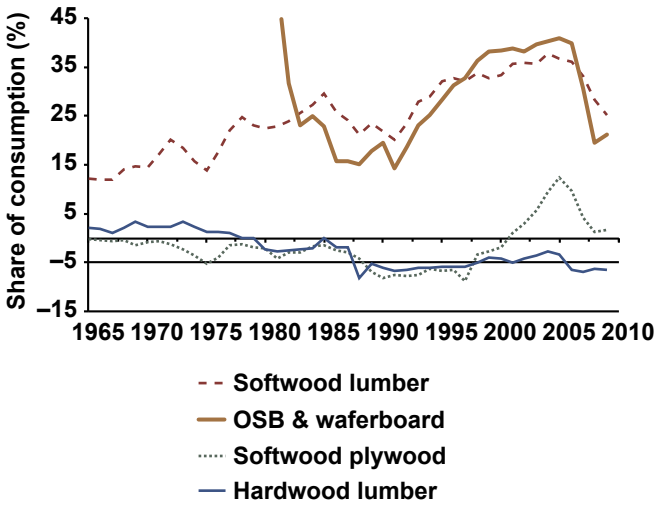

Figure 6. Net imports as a share of consumption, 1965–2009 (product volume ratio).

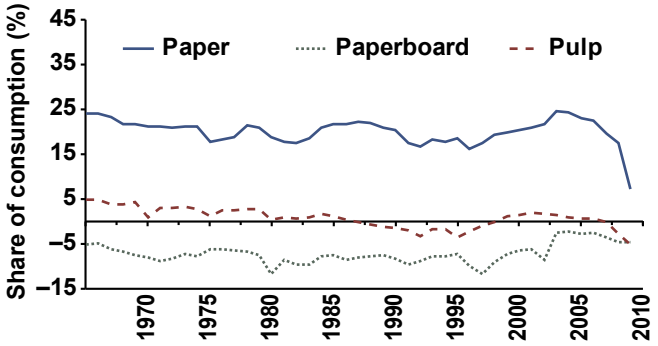

Figure 7. Net imports as a share of consumption 1965–2009 (product weight ratio).

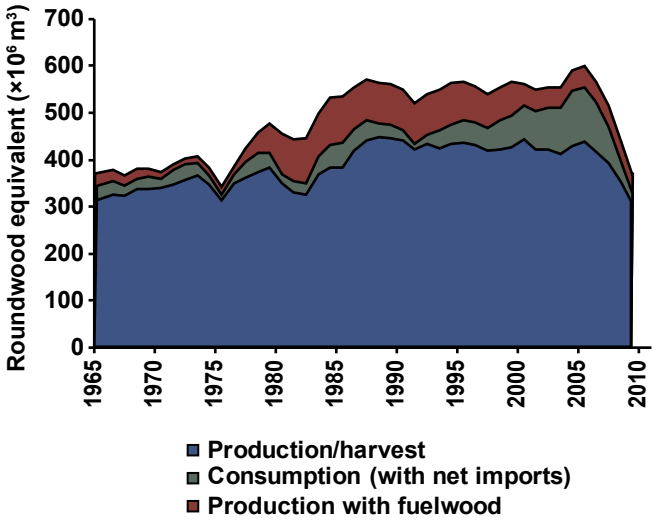

Figure 8. Solid wood and paper products production and net imports plus fuelwood consumption 1965–2009 (roundwood equivalent).

consumption) until the late 1990s. Softwood lumber and OSB production have been competitive only in providing a portion of consumption needs and that share has been decreasing until recently when it has increased. Production in the United States fell short of softwood lumber consumption by 12% 2004. It fell short by over 35% by 2004, but during the recession the deficit fell to 25% by 2009. Oriented strandboard production in the United States has had a similar pattern of covering consumption since the mid 1980s. Paper production coverage in the United States was 25% to 35% short of consumption between 1965 and 2004 but was only 7% short in 2009.

One factor that has decreased import share of consumption is that most imports of softwood lumber, OSB, and paper have been from Canada, and the Canadian dollar has gotten stronger in recent years. The recession decreased the need for imports and the increasingly strong Canadian dollar supported that decrease. The share of softwood lumber imports from Canada had been 95% or more from 1965 to 2004, declined to 85% in 2004 and increased somewhat during the recession to 94% in 2009. The share of paper imports from Canada had been 69% in 2006 but declined to 34% in 2009.

The net effect of increasing wood and paper product consumption and increasing competitiveness of U.S. production to meet consumption needs resulted in overall wood and paper production in roundwood equivalents increasing at about the pace of population between 1965 and 1991. From 1991 to 2005, net imports increased from less than 5% of consumption to more than 20% of consumption (Fig. 5). The result has been declining U.S. timber harvest since a high of 466×10^6 m^3 in 1986 to 395 in 2008, before the recession, and 307 in 2009, which includes the effect of the recession.

The dollar exchange rate has shifted to a weaker dollar, now at an index level that corresponds to a level of net imports of 5% of consumption in the early 1990s (versus 20% in 2008) (Fig. 5). This plus rapidly expanding demands for wood products in Asia that are shifting global trade flows from the United States to Asia could mean U.S. production and timber harvest would cover a greater fraction of consumption needs as wood and paper product consumption increases with recovery from the recession. Even with a recovery to the previous high consumption level of 554×10^6 m^3 in 2008, U.S. harvest may increase above the 2008 level of 395×10^6 m^3 to above 500×10^6 m^3 or more than 25% above the 2008 level if the low dollar exchange rate continues and the effect of a low dollar exchange rate on net imports is similar to the effect it had in the early 1990s.

Solid Wood Products Consumption, Trade, Production, and Prices

Solid wood products are used extensively to meet needs in construction, manufacturing, and shipping segments of the U.S. economy.

- Nearly all new single-family houses and low-rise multifamily residential structures are wood framed and sheathed.

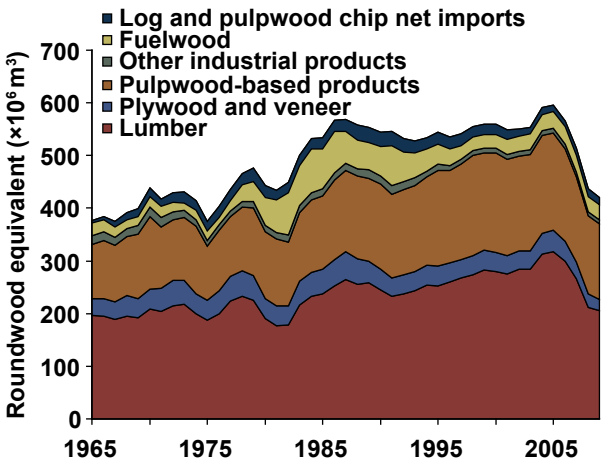

Figure 9. Roundwood used to produce fuelwood and products for U.S. consumption (including net imports, by type, 2005–2009).

- Large amounts of solid wood products are used in new nonresidential buildings and in the upkeep and improvement of existing structures.
- Solid wood is used extensively in various manufactured products, particularly furniture, and nearly all manufactured products are shipped on wooden pallets.
- Solid wood also provides a renewable energy source for industrial, commercial, and residential applications.

Roundwood equivalent is defined as the volume of logs or other round products required to produce given quantities of lumber, plywood, wood pulp, paper, or other similar products (Haynes 1990). In 2009, an estimated 406 million cubic meters ($\times 10^6$ m^3), roundwood equivalent, of timber was used for fuelwood and to make products used in the United States (including net imports). This is 32% less than the 599×10^6 m^3 used in 2005, the highest level on record (Fig. 9). For 2009, 89% of roundwood equivalent of consumption was industrial roundwood used to make lumber, panels, paper, other industrial products, and 11% was for fuelwood (Fig. 9). The portion of roundwood that is not fuelwood is termed industrial roundwood. Lumber, panels, and other industrial products used about 63% of the industrial roundwood. Pulpwood products used about 37%. Production of solid wood products generate residues that are about 10% to 15% of total industrial roundwood used. A portion of this residue is used to make paper or panel products and a portion is used for energy. Wood material in the form of black liquor remaining after pulping wood for paper is also used for energy. More details on the portions used for energy are noted in the energy section below.

This section presents estimates of solid wood products consumed in the United States since 1950 in major end-use markets. Solid wood products include the following:

- Lumber (softwood and hardwood)
- Structural panels (softwood plywood, and oriented strandboard (OSB))
- Nonstructural panels (combined hardwood plywood, particleboard, medium-density fiberboard (MDF), hardboard, and insulation board)
- Engineered wood products, (wood I-joists, glued-laminated (glulam) timbers, and structural composite lumber (SCL) consisting of laminated veneer lumber (LVL), parallel strand lumber (PSL), and oriented strand lumber (OSL)). Estimated amounts are included with softwood lumber consumption and production.

Solid wood products consumption by end use is determined by demand in major end-use markets including construction, manufacturing, packaging and shipping, and other uses. "Other industrial wood products" are evaluated separately and include cooperage logs, poles and piling, fence posts, round mine timbers, box bolts, excelsior bolts, chemical wood, shingle bolts, and other miscellaneous items.

Estimates of solid wood products consumption are based on findings from a limited number of public and private research reports that were conducted at irregular intervals over the past 60 years (For a partial listing of these studies, see McKeever 2009.) Information on wood products use from these reports was related to more readily available, annual time series economic data to generate end-use factors, the amount of a specific wood product used in a specific year in a specific application per unit of the economic variable. The amount of specific wood products (e.g., lumber) used in a given end us (e.g., single-family housing) across a range of years has been estimated by multiplying wood-use factors (wood use per unit of end-use activity) times year by year estimates of the end use activity. End-use activities include square feet of single-family housing, and dollar value of nonresidential construction. End-use factors have been developed by special studies for selected years.

Consumption in Construction: Overview

In 2009, 60% of solid wood products were consumed in 1) new housing units; 2) housing repair and remodeling; 3) nonresidential buildings; 4) nonresidential nonbuilding structures including highways, dams, and other structures; and 5) nonresidential alterations and renovations (Fig. 10). These used about 59% of all lumber, 76% of all structural panels, and 41% of all nonstructural panels consumed. Changes in wood use in construction over the last several decades include 1) substitution of nonwood for wood building products (e.g., vinyl for wood siding); 2) substitution of new wood products for existing wood and nonwood products (e.g., OSB for softwood plywood and structural panels for lumber), 3) changes in architectural characteristics of buildings and in building codes that favor one type of building product over another; and 4) changes in the ways structures are built. These and other changes caused a decline in the share of solid wood products that are used

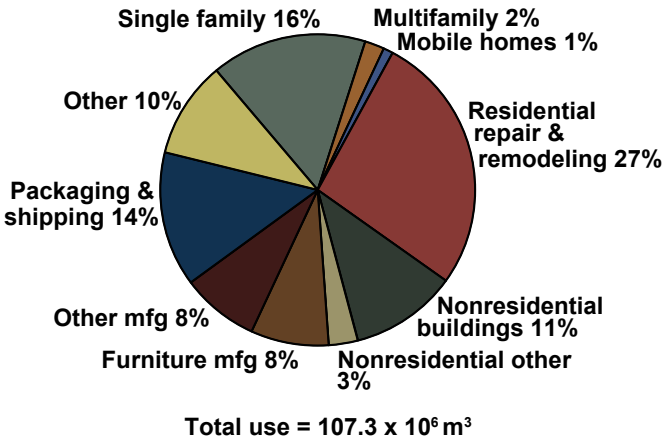

Figure 10. Solid wood products consumption by end-use market, 2009.

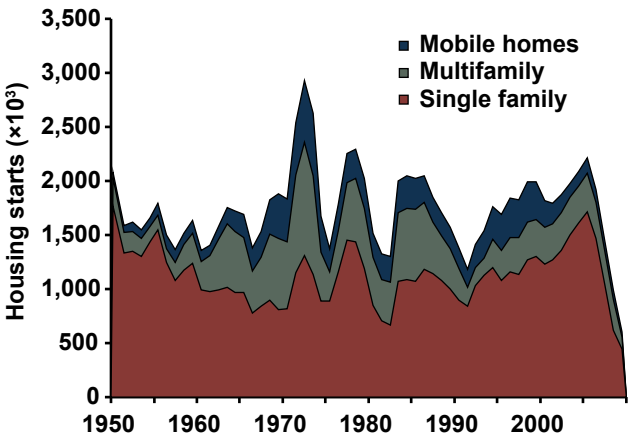

Figure 11. Housing starts in the United States by type, 1950–2009.

in construction rather than other end uses from record high levels achieved in the mid-1980s. In 1976, new housing and nonresidential construction accounted for 51% of all timber products used in the United States. In 2009, this was down to 33% (Tables 1–6).

The current economic downturn, which began in 2007–2008, continues to negatively affect residential construction, which is at its lowest levels in 60 years. Despite these changes, construction remains the principal market for lumber and panel products. Reported consumption includes onsite waste and loss: 10% for lumber, 5% for structural and nonstructural panels, and 2% for engineered wood products.

Consumption in New Residential Construction

New housing construction has historically been the largest single market in the United States for solid wood products using about one-third of the lumber, one-half of the structural panels, and about one-fifth of the nonstructural panels. Because of declines in housing starts, in 2009, housing used just 18% of lumber, 27% of structural panels, and 12% of nonstructural panels. Overall housing construction used about 19% of total solid wood products consumption (Fig. 10). Amounts of solid wood products consumed in new residential construction depend on the number and type of units built, their average size, and wood products use per unit.

The composition of solid wood products used in new residential construction has also changed over time. In 1962, lumber made up 82% of the timber used in new housing. Structural panels (11%) and nonstructural panels (7%) made up the remainder (Table 1). By 2009, lumber's share decreased to 66%. Structural panels more than doubled to 25%, while nonstructural panels decreased to 8%.

New Housing Unit Production

In 2009, 604,000 new housing units were produced in the United States (Fig. 11). This is only 27% of the number of units produced in 2005 and 21% of the record high

Table 2—Expenditures and timber products used in residential repair and remodeling, selected years 1962–2009

	Expenditures		Lumber[a]			Structural panels[b]			Nonstructural panels[c]			Total, all wood products		
Year	($\times 10^9$ current $)	($\times 10^9$ 2005 $)[d]	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)
1962	11.0	57.8	7,800	0.708	0.135	1,478	0.134	0.026	1,239	0.112	0.021	10,517	0.954	0.182
1970	14.8	60.7	9,009	0.610	0.148	2,078	0.141	0.034	1,465	0.099	0.024	12,552	0.850	0.207
1976	29.0	81.8	11,445	0.394	0.140	2,872	0.099	0.035	1,938	0.067	0.024	16,255	0.560	0.199
1986	94.3	149.9	29,179	0.309	0.195	6,208	0.066	0.041	3,762	0.040	0.025	39,148	0.415	0.261
1996	131.4	158.1	29,662	0.226	0.188	6,440	0.049	0.041	2,818	0.021	0.018	38,920	0.296	0.246
1998	133.7	156.3	27,300	0.204	0.175	6,206	0.046	0.040	2,399	0.018	0.015	35,905	0.269	0.230
2005	215.0	215.0	35,805	0.167	0.167	8,362	0.039	0.039	3,953	0.018	0.018	48,119	0.224	0.224
2009	142.9	130.1	21,173	0.148	0.163	5,329	0.037	0.041	2,499	0.017	0.019	29,002	0.203	0.223

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products.
[b]Includes softwood plywood and OSB.
[c]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board.
[d]Based on table 1.1.9. Implicit Price Deflators for Gross Domestic Product from the Bureau of Economic Analysis (2010). Sources: McKeever 2009, USDC BC 2010, USDOC Bureau of Economic Analysis 2010.

Table 3—Expenditures and timber products used in nonresidential construction, selected years 1962–2009

	Expenditures		Lumber[a]			Structural panels[b]			Nonstructural panels[c]			Total, all wood products		
Year and type	($\times 10^9$ current $)	($\times 10^9$ 2005 $)[d]	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)
Buildings														
1962	19.0	164.9	4,057	0.214	0.025	1,018	0.054	0.006	707	0.037	0.004	5,781	0.305	0.035
1970	39.4	255.7	4,259	0.108	0.017	1,053	0.027	0.004	974	0.025	0.004	6,286	0.160	0.025
1976	53.0	206.8	3,867	0.073	0.019	960	0.018	0.005	955	0.018	0.005	5,782	0.109	0.028
1986	150.5	320.7	6,465	0.043	0.020	2,151	0.014	0.007	1,261	0.008	0.004	9,877	0.066	0.031
1996	216.0	347.6	7,093	0.033	0.020	1,851	0.009	0.005	1,005	0.005	0.003	9,949	0.046	0.029
1998	263.1	390.0	8,095	0.031	0.021	2,110	0.008	0.005	1,099	0.004	0.003	11,304	0.043	0.029
2005	311.8	311.8	6,607	0.021	0.021	2,668	0.009	0.009	1,466	0.005	0.005	10,741	0.034	0.034
2009	432.3	351.5	7,549	0.017	0.021	3,160	0.007	0.009	1,573	0.004	0.004	12,281	0.028	0.035
Other construction														
1962	16.4	142.5	4,130	0.252	0.029	443	0.027	0.003	81	0.005	0.001	4,653	0.284	0.033
1970	29.5	191.4	4,958	0.168	0.026	623	0.021	0.003	79	0.003	0.000	5,659	0.192	0.030
1976	49.6	193.3	5,024	0.101	0.026	730	0.015	0.004	104	0.002	0.001	5,858	0.118	0.030
1986	89.3	190.2	4,193	0.047	0.022	575	0.006	0.003	75	0.001	0.000	4,844	0.054	0.025
1996	111.4	179.2	2,815	0.025	0.016	315	0.003	0.002	40	0.000	0.000	3,170	0.028	0.018
1998	128.9	191.0	2,885	0.022	0.015	365	0.003	0.002	38	0.000	0.000	3,288	0.026	0.017
2005	173.4	173.4	2,910	0.017	0.017	402	0.002	0.002	53	0.000	0.000	3,365	0.019	0.019
2009	245.2	199.4	2,245	0.009	0.011	421	0.002	0.002	62	0.000	0.000	2,727	0.011	0.014
Total nonresidential														
1962	35.3	307.5	8,187	0.232	0.027	1,460	0.041	0.005	788	0.022	0.003	10,435	0.295	0.034
1970	68.9	447.1	9,217	0.134	0.021	1,675	0.024	0.004	1,053	0.015	0.002	11,945	0.173	0.027
1976	102.6	400.1	8,891	0.087	0.022	1,690	0.016	0.004	1,058	0.010	0.003	11,640	0.113	0.029
1986	239.7	510.9	10,658	0.044	0.021	2,726	0.011	0.005	1,336	0.006	0.003	14,720	0.061	0.029
1996	327.4	526.8	9,908	0.030	0.019	2,166	0.007	0.004	1,045	0.003	0.002	13,119	0.040	0.025
1998	392.0	581.0	10,980	0.028	0.019	2,475	0.006	0.004	1,138	0.003	0.002	14,592	0.037	0.025
2005	485.2	485.2	9,517	0.020	0.020	3,070	0.006	0.006	1,519	0.003	0.003	14,106	0.029	0.029
2009	677.5	550.9	9,794	0.014	0.018	3,581	0.005	0.006	1,634	0.002	0.003	15,009	0.022	0.027

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products.
[b]Includes softwood plywood and OSB.
[c]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board.
[d]Based on table 1.1.9. Implicit Price Deflators for Gross Domestic Product from the Bureau of Economic Analysis. Sources: McKeever 2009, USDOC BC 2010, USDOC BEA 2010.

Table 4—Shipments and timber products used in manufacturing, selected years 1962–2009

	Shipments		Lumber[a]			Structural panels[b]			Nonstructural panels[c]			Total, all wood products		
Year and type	($\times 10^9$ current $)	($\times 10^9$ 2005 $)[d]	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)
Furniture														
1962	5.5	29.1	6,599	1.190	0.227	331	0.060	0.011	1,095	0.197	0.038	8,025	1.447	0.276
1970	9.1	37.3	6,820	0.751	0.183	395	0.044	0.011	2,343	0.258	0.063	9,559	1.053	0.256
1976	14.2	40.1	5,302	0.372	0.132	373	0.026	0.009	2,109	0.148	0.053	7,784	0.547	0.194
1986	33.1	52.6	7,531	0.228	0.143	523	0.016	0.010	4,100	0.124	0.078	12,154	0.367	0.231
1996	55.7	67.0	10,544	0.189	0.157	1,195	0.021	0.018	6,939	0.125	0.104	18,678	0.335	0.279
1998	57.4	67.1	11,243	0.196	0.168	1,599	0.028	0.024	7,641	0.133	0.114	20,484	0.357	0.305
2005	60.9	60.9	6,305	0.104	0.104	734	0.012	0.012	4,865	0.080	0.080	11,904	0.195	0.195
2009	55.0	50.1	4,233	0.077	0.084	502	0.009	0.010	3,352	0.061	0.067	8,087	0.147	0.161
Other manufacturing														
1962	386.7	2,028.9	3,182	0.008	0.002	315	0.001	0.000	304	0.001	0.000	3,801	0.010	0.002
1970	611.8	2,516.1	3,019	0.005	0.001	413	0.001	0.000	425	0.001	0.000	3,857	0.006	0.002
1976	1,145.5	3,227.8	4,683	0.004	0.001	628	0.001	0.000	1,947	0.002	0.001	7,258	0.006	0.002
1986	2,169.1	3,446.4	5,321	0.002	0.002	1,033	0.000	0.000	1,909	0.001	0.001	8,262	0.004	0.002
1996	3,553.2	4,276.4	6,488	0.002	0.002	1,499	0.000	0.000	1,825	0.001	0.000	9,812	0.003	0.002
1998	3,751.2	4,386.9	6,837	0.002	0.002	1,590	0.000	0.000	2,028	0.001	0.000	10,455	0.003	0.002
2005	4,569.1	4,569.1	5,803	0.001	0.001	1,456	0.000	0.000	2,965	0.001	0.001	10,224	0.002	0.002
2009	5,345.0	4,869.3	4,149	0.001	0.001	1,601	0.000	0.000	3,157	0.001	0.001	8,907	0.002	0.002
Total														
1962	392.3	2,058.0	9,781	0.025	0.005	646	0.002	0.000	1,398	0.004	0.001	11,826	0.030	0.006
1970	620.9	2,553.4	9,839	0.016	0.004	808	0.001	0.000	2,768	0.004	0.001	13,416	0.022	0.005
1976	1,159.7	3,267.9	9,984	0.009	0.003	1,002	0.001	0.000	4,056	0.003	0.001	15,042	0.013	0.005
1986	2,202.2	3,499.0	12,851	0.006	0.004	1,556	0.001	0.000	6,008	0.003	0.002	20,416	0.009	0.006
1996	3,608.9	4,343.5	17,032	0.005	0.004	2,695	0.001	0.001	8,763	0.002	0.002	28,490	0.008	0.007
1998	3,808.6	4,454.0	18,080	0.005	0.004	3,189	0.001	0.001	9,669	0.003	0.002	30,938	0.008	0.007
2005	4,630.0	4,630.0	12,108	0.003	0.003	2,190	0.000	0.000	7,831	0.002	0.002	22,128	0.005	0.005
2009	5,400.0	4,919.4	8,382	0.002	0.002	2,103	0.000	0.000	6,509	0.001	0.001	16,994	0.003	0.003

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products.
[b]Includes softwood plywood and OSB 3/8-in. basis.
[c]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board 3/8-in. basis.
[d]Based on table 1.1.9. Implicit Price Deflators for Gross Domestic Product from the Bureau of Economic Analysis. Sources: McKeever 2009, USDOC BC 2010, USDOC BEA 2010.

Table 5—Shipments and timber products used for packaging and shipping, selected years 1962–2009

	Shipments		Lumber[a]			Structural panels[b]			Nonstructural panels[c]			Total, all wood products		
Year and type	($\times 10^9$ current $)	($\times 10^9$ 2005 $)[d]	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)	Total use ($\times 10^3$ m^3)	Per 10^3 current $ (m^3)	Per 10^3 2005 $ (m^3)
1962	0.6	3.1	9,626	16.128	3.074	186	0.311	0.059	199	0.334	0.064	10,011	16.773	2.685
1970	0.7	2.8	12,075	17.650	4.292	255	0.373	0.091	279	0.407	0.099	12,609	18.431	3.605
1976	1.0	2.8	12,436	12.629	4.482	230	0.234	0.083	173	0.175	0.062	12,839	13.038	3.415
1986	1.8	2.9	12,958	7.104	4.471	350	0.192	0.121	133	0.073	0.046	13,441	7.368	2.846
1996	3.9	4.7	14,116	3.648	3.031	457	0.118	0.098	97	0.025	0.021	14,671	3.791	1.721
1998	4.5	5.3	15,823	3.488	2.983	529	0.117	0.100	111	0.024	0.021	16,463	3.629	1.673
2005	5.7	5.7	14,750	2.587	2.587	851	0.149	0.149	150	0.026	0.026	15,751	2.763	1.381
2009	6.5	5.9	14,175	2.181	2.394	959	0.148	0.162	216	0.033	0.036	15,350	2.362	1.236

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products.
[b]Includes softwood plywood and OSB.
[d]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board.
[d]Based on table 1.1.9. Implicit Price Deflators for Gross Domestic Product from the Bureau of Economic Analysis. Sources: McKeever 2009, USDOC BC 2010, USDOC BEA 2010.

Table 6—Timber products used for other purposes, selected years 1962–2009

Year and type	Lumber[a] ($\times 10^3$ m^3)	Structural panels[b] ($\times 10^3$ m^3)	Nonstructural panels[c] ($\times 10^3$ m^3)	Total, all wood products ($\times 10^3$ m^3)
1962	13,403	1,163	1,210	15,776
1970	12,259	2,518	1,606	16,383
1976	8,044	2,269	1,571	11,884
1986	8,682	1,534	940	11,156
1996	14,604	1,677	2,383	18,664
1998	15,260	1,848	2,732	19,841
2005	26,813	3,288	3,424	33,525
2009	7,875	1,454	1,630	10,958

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products.
[b]Includes softwood plywood and OSB.
[c]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board. Sources: Tables 1, 2, 3, 4, and 5 (in this report).

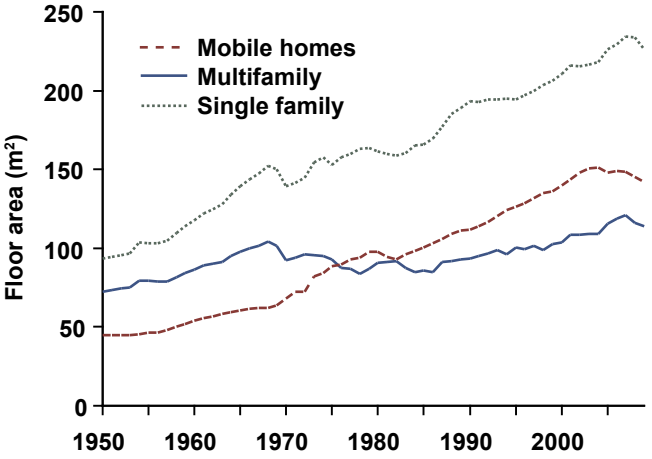

Figure 12. Average floor area of new housing units in the United States by type, 1950–2009.

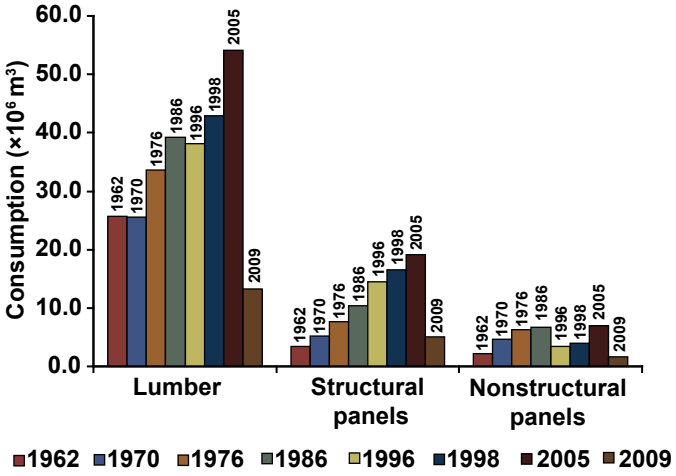

Figure 13. Solid wood products used for new residential construction in the United States by product, selected years, 1962–2009.

production in 1972. Of these 604,000 new units, 445,000 were single-family houses, 109,000 multifamily units, and 50,000 mobile homes. Housing production changes year to year depending on economic growth, interest rates, household formations, housing vacancy and replacement rates, and conversion of existing structures to alternative uses. In 2010, there was very little growth in U.S. housing starts, which remain depressed at levels below the lowest levels of the previous 60 years (Fig. 3), with prognosis of gradual recovery in the years ahead. Solid wood products consumption is also affected by the types of units produced. Single-family houses are larger and require more solid wood products than multifamily and mobile homes.

Solid wood Products Use Per Housing Unit

In 2009, the average single-family house used nearly 38.6 m^3 of wood products (Table 1). Included are 25.5 m^3 of lumber, 10.0 m^3 of structural panels, and nearly 3.1 m^3 of nonstructural panels. Amounts per house are down somewhat from 2005 but still reflect long-term averages. Multifamily units used, on average, about 38% of the wood as single-family houses. The average mobile home, because of its larger average size than multifamily units, used nearly 60% of the wood as new houses.

The average size of a housing unit directly affects the amount of solid wood products required to build it. New single-family houses averaged 226 m^2 of floor area in both 2005 and 2009, up from 203 m^2 in 1998 (Table 1). With few exceptions, the long-term trend in single-family houses has been toward increasing average size (Fig. 12). Growth in average size, in part a reflection of steadily rising real disposable personal income, contributed to the increases in the use of all wood products per house over the past 60 years.

Multifamily housing average sizes have varied over the years. Since 1995, average size has been above 100 m^2. In 2009, the average size measured nearly 114 m^2. The average mobile home in 2009 had 142 m^2 of floor area, more than 20% greater than the average multifamily unit. Mobile homes have shown the most dramatic and steady increases in size of all housing types since 1950. The growth is expected to continue. Much of the increase in size is attributable to changes in the types of units being produced. Single-wide units gave way to double-wide units and multisectional units. As size increased, more conventional construction practices were used, resulting in greater amounts of wood use.

In 2009, the average new single family house required 0.17 m^3 of wood per m^2 of floor area to build. Multifamily units averaged 0.13 m^3, and mobile homes 0.16 m^3. Although annual variations in use are common, in general combined wood products use per square meter of floor area in single- and multifamily units has fallen over the past two decades, while mobile home use has increased (Table 1).

Structural and architectural characteristics of new housing units can greatly affect both total amounts of solid wood products required to build the unit, as well as amounts needed per unit of floor area. These include foundation type, number of stories, exterior wall covering, presence and size of garages, and presence of porches and decks. Changes in the frequency in which these characteristics appear over time help explain some of the variation in solid wood products use per m^2 of floor area.

Total Solid wood Products Use in New Housing

The 445,000 single-family houses, 109,000 multifamily units, and 50,000 mobile homes produced in 2009 required 20.0×10^6 m^3 of solid wood products to build (Table 1, Fig. 13) This consisted of 13.2×10^6 m^3 of lumber, 5.1×10^6 m^3 of structural panels, and 1.7×10^6 m^3 of nonstructural panels. These volumes include actual amounts of each wood product used along with allowances for onsite

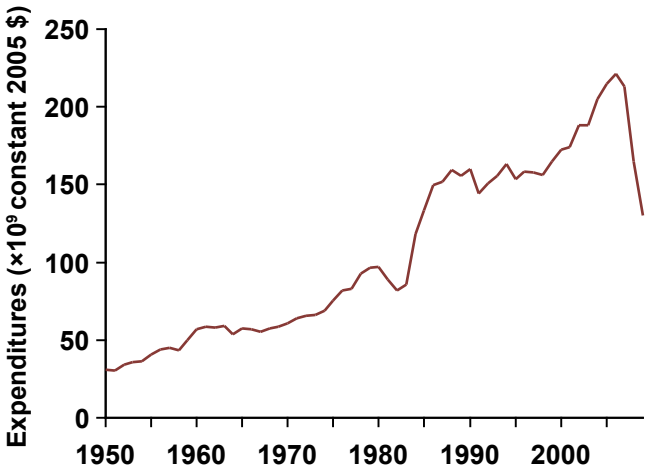

Figure 14. Residential repair and remodeling in the United States, 1950–2009.

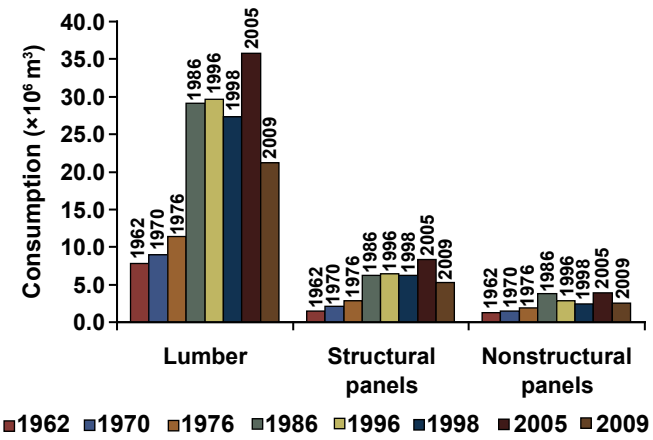

Figure 15. Solid wood products used for residential repair and remodeling in the United States by product, selected years, 1962–2009.

waste. Also included are amounts of engineered lumber included with softwood lumber. These amounts are considerably below consumption just 4 years prior in 2005 due primarily to nearly a 75% drop in new housing unit production in 2009.

Engineered lumber currently accounts for about 11% of total softwood/engineered lumber in new single-family construction and about 15% in new multifamily construction.

Consumption in Residential Repair and Remodeling

Repair and remodeling, also referred to as upkeep and improvements, to residential units in the existing housing stock are an important market for solid wood products. Included are many and varied activities and projects, some of which require substantial amounts of solid wood products, some of which do not. Overall, about 27% of all solid wood products were used for residential repair and remodeling in 2009 (Fig. 10), or about 28% of all lumber, 29% of all structural panels, and 18% of all nonstructural panels consumed in the United States. This market has become and remains important, as the Nation's housing stock has grown larger, its average age has increased, and homeowner incomes have risen.

Residential Repair and Remodeling Expenditures

Annual activity in the residential repair and remodeling market is measured in terms of dollars of expenditure and was previously tracked by the USDOC Bureau of the Census. This tracking was discontinued after 2007. Estimates for 2008 and 2009 were made based on recent trends and relationships to other types of construction. Expenditures, when converted to constant (2005) dollars, totaled more than $\$130 \times 10^9$ in 2009 (Table 2). This was $\$85 \times 10^9$ below 2005 expenditures, and the lowest level of expenditure in the past 25 years (Fig. 14). Solid wood products consumption is not only affected by total expenditures but also by the types of expenditures in a given year. Three major repair and remodeling activity types exist: maintenance and repairs, additions and alterations, and major replacements. Maintenance and repairs expenditures are for upkeep of the residential property rather than additional investment in the property. Addition and alteration expenditures are for enlargements or improvements to or within the residential structure or the property. Major replacements are construction improvements to the property and are closely related to maintenance and repair. The scope of the project defines its classification. Of these three expenditure types, additions and alterations are the most wood intensive and important in determining overall levels of solid wood products consumption.

Solid wood Products Use Per $1,000 of Residential Repair and Remodeling Expenditures

Solid wood products use per $1,000 of constant dollar expenditure measures the relative amounts of each timber product used per unit of repair and remodeling activity. Use per $1,000 of constant (2005) expenditures in 2009 was estimated to be 0.220 m^3 to 0.163 m^3 of lumber, 0.041 m^3 of structural panels, and 0.017 m^3 of nonstructural panels (Table 2). Little change in use factors occurred between 2005 and 2009. This is because use factors are not dependent on the absolute dollars of expenditures but on the types of projects undertaken, and in a good economy many more homeowners will purchase a new home rather than upgrade their existing home.

Total Solid wood Products Use in Residential Repair and Remodeling

The repair and remodeling of residential structures and properties consumed an estimated 29.0×10^6 m^3 of solid wood products in 2009 (Table 2). This translates into 21.2×10^6 m^3 of lumber (including engineered wood products), 5.3×10^6 m^3 of structural panels, and 2.5×10^6 m^3 of nonstructural panels (Table 2, Fig. 15). Total use in 2009,

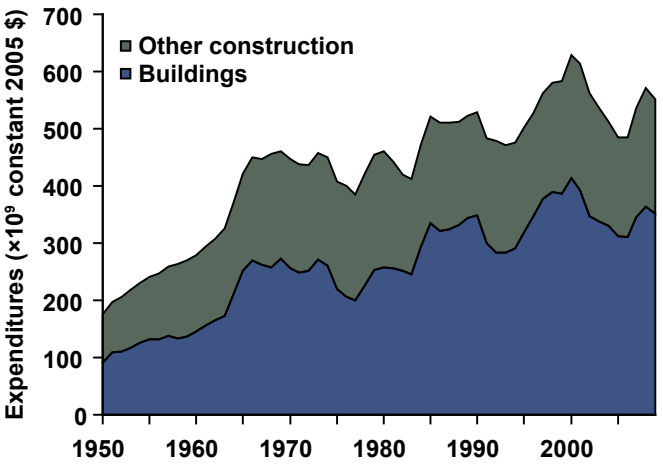

Figure 16. Nonresidential construction in the United States by type, 1950–2009.

29×10^6 m^3, was only about 60% of that in 2005, but considerably higher than in the 1960s and 1970s when repair and remodeling had not yet become a major wood products market (Table 7). Engineered lumber in residential repair and remodeling has not yet achieved the levels seen in new residential construction. Currently only about 2% of the softwood/engineered lumber consumed is engineered lumber.

Consumption in Nonresidential Construction

Nonresidential construction is a diverse mixture of new buildings and other structures, alterations and renovations to existing structures, and construction that does not include a building or structure at all. Two types of new nonresidential construction are considered here: (1) nonresidential buildings (includes stores, restaurants, office buildings, warehouses, hotels and motels, factories, schools, religious buildings, hospitals, and nonresidential farm buildings) and (2) all other types of nonresidential construction (typically does not include a building, such as streets and highways, water and sewer systems, dams, military, conservation and development projects, railroad construction, and other similar types of nonbuilding construction).

The construction of nonresidential buildings and other nonresidential structures in the United States in 2009 used about 13% of all the lumber, 19% of all the structural panels, and 12% of all the nonstructural panels consumed domestically, equivalent to 14% of all solid wood products (Fig. 10). Consumption is dependent on the numbers, types, and sizes of buildings and other structures built, and the amounts and types of building products used in their construction. Because of the diversity inherent in nonresidential construction, activity in this sector is measured in the total annual value of construction put in place.

Value of Nonresidential Construction

Total value for all nonresidential construction in the United States in 2009, measured in constant 2005 dollars, was just over $\$550 \times 10^9$ (Table 3, Fig. 16). This is about $\$65 \times 10^9$ greater than in 2005 but below levels achieved in the 1990s. Nonresidential construction was a bright spot in an otherwise lackluster construction market in 2009. It tended to be somewhat insulated from the current economic downturn because (1) nearly all nonresidential construction projects require longer planning and construction times than residential construction projects, and (2) Federal stimulus money to help alleviate the current economic crisis was targeted at public works nonresidential construction. The value of buildings constructed in 2009 totaled $\$352 \times 10^9$ (64% of total expenditures), and although not a record high level was very respectable. Other nonresidential construction totaled nearly $\$200 \times 10^9$.

Solid wood Products Use Per $1,000 of Nonresidential Construction Value

In 2009, solid wood products use per $1,000 of constant (2005) expenditures was estimated to be 0.027 m^3 to 0.018 m^3 of lumber, 0.006 m^3 of structural panels, and 0.003 m^3 of nonstructural panels (Table 3). As might be expected, use per $1,000 for buildings was greater than that for other construction, nearly 2 times greater for lumber, and more than 4 times greater for structural panels. In general, the use of lumber, structural panels, and nonstructural panels per $1,000 of constant construction value has been steady or rising in the 1990s and 2000s for buildings, and steady or falling for other construction. Recent efforts to promote the use of solid wood products in low-rise nonresidential buildings may be having an impact. In the past, restrictive codes and other building regulations were instrumental in limiting wood use in some types of buildings and locations. Building codes are continually being revised and changed. The recently adopted International Building Code (IBC) is a new, improved, state-of-the-art national building code, which may expand the role of wood in some nonresidential buildings.

Total Solid wood Products Use in New Nonresidential Construction

The construction of nonresidential buildings, their alterations and renovations, and other nonresidential construction required an estimated 15.0×10^6 m^3 of solid wood products in 2009 (Tables 3, 7, Fig. 17). This volume consisted of 9.8×10^6 m^3 of lumber, 3.6×10^6 m^3 of structural panels, and 1.6×10^6 m^3 of nonstructural panels. Engineered lumber is included with lumber. All estimates include allowances for onsite loss and waste.

In general, nonresidential buildings and their alterations and renovations have maintained or increased their use of solid wood products over the past 20 years (Table 3). Lumber (including engineered lumber) usage has tended to be more subject to annual variations than structural panels and nonstructural panels. Other nonresidential construction is losing lumber and nonstructural panel share. Structural panel share seems to be rebounding from losses experienced in the 1990s. Currently, engineered lumber accounts for about

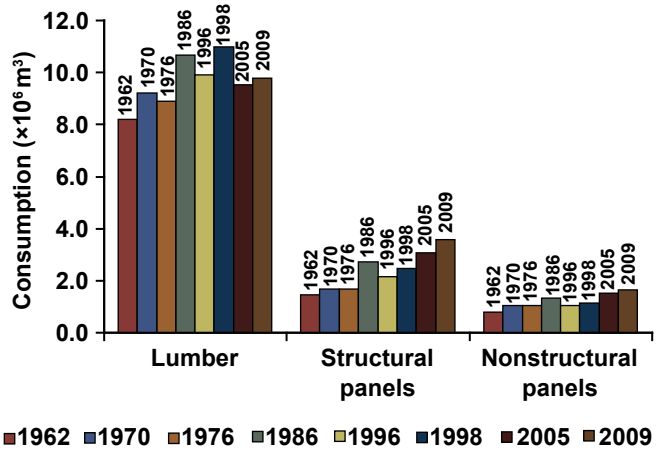

Figure 17. Solid wood products used for nonresidential construction in the United States by product, selected years 1962–2009.

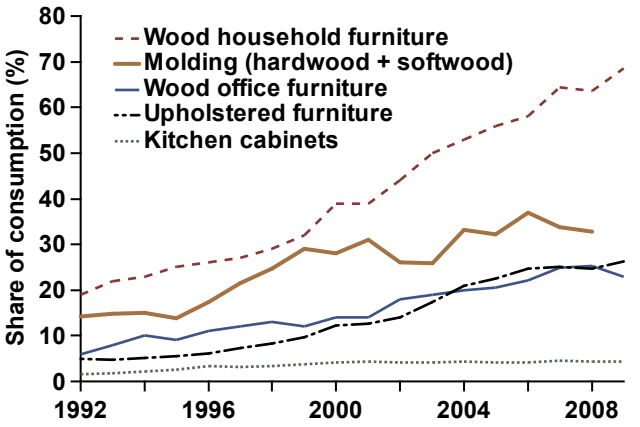

Figure 18. Furniture imports as a fraction of U.S. domestic furniture consumption, 1992–2008.

Notes: Shares based on dollar value. Shares may be conservative because some imported components and finished furniture is included in domestic shipments.

Source: U.S. Census, Annual Survey of Manufacturers (2010); International Trade Administration (2010).

15% of the total lumber/engineered lumber consumed.

Consumption in Manufacturing

A number of manufacturing industries make products entirely from wood, and some use combinations of wood and nonwood materials. In addition, many use wood jigs, models, patterns, flasks, and other wood products during production. In recent years, many manufacturing activities have been relocated offshore to take advantage of labor and material cost savings. This has been especially true for furniture and fixtures manufacturing. See the following section on trends in furniture production and trade. Trends in solid wood products consumption reflect this offshore relocation, as outsourcing of furniture production resulted in declining U.S. consumption of hardwood lumber in furniture manufacturing. Production and consumption of hardwood lumber and saw logs in the United States has in fact dramatically declined through a combination of circumstances, including off-shoring of manufacturing, declines in housing demand, and the recent recession. In 2009, U.S. hardwood lumber production was about 50% less than recent peak levels in the late 1990s (USDOC BOC 2010, Current Industrial Reports). The last time that U.S. hardwood lumber production declined similarly by over 50% was during the Great Depression of the 1930s.

Manufactured goods were divided into two major groups: (1) household, commercial, and institutional furniture and (2) other products. Other products include all NAICS industries coded 31, 32, or 33 but exclude furniture and furniture and related products manufacturing (NAICS 337) and wood products manufacturing (321). Although the "Other products" group accounts for more than 96% of the all industry shipments, solid wood products consumption for individual manufactured products is relatively small; therefore, they were combined.

Substantial amounts of solid wood products are used to produce pallets, containers, prefabricated wooden buildings, structural wood members, mobile homes, millwork and cabinets, flooring, and other wood products (NAICS 321), as well as custom architectural woodwork and millwork (NAICS 337212). To avoid double counting, these solid wood products were included in the report sections dealing with packaging and shipping and residential and nonresidential construction and are not included in manufacturing.

Overall, manufacturers used about 11% of all lumber, 11% of all structural panels, and 46% of all nonstructural panels consumed in the United States in 2009. This is equivalent to 16% of all solid wood products consumed (Fig. 10). These percentages are somewhat misleading because although they seem to be in line with historic trends, they reflect the lesser decline in manufacturing in 2009 compared with the much more dramatic declines in construction. The U.S. Department of Commerce, Bureau of the Census measures activity in all major manufacturing industries annually. Annual value of industry shipments was used here to estimate solid wood products consumption.

Trends in U.S. Furniture Production, Consumption and Trade

Over the past 10 to 30 years, the U.S. furniture industry has declined substantially in competitiveness relative to foreign producers, particularly the wood household furniture industry (NAICS 337122). Figure 18 shows a progressive loss of market share to imports by various furniture sectors, with one exception, kitchen cabinets (USDOC BOC 2010, USITC 2010). Cabinet makers invested in their production capacity, focused on changing designs for customers, produced higher value-added products and thus improved competitiveness with imported products. The rest of the wood furniture industry did not maintain its competiveness. The wood molding and millwork industry lost domestic

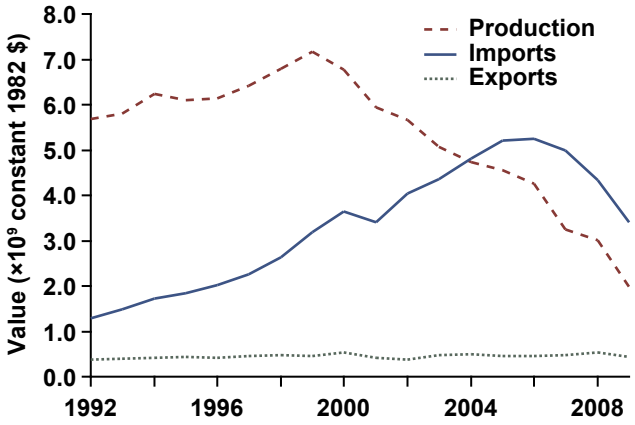

Figure 19. Wood household furniture production imports and exports, 1992–2008. Source: U.S. Census, Annual Survey of Manufacturers (2010); International Trade Administration (2010).

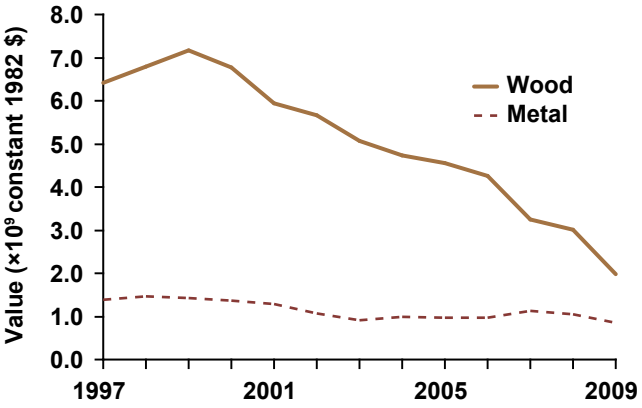

Figure 20. Wood and metal household furniture production in the United States, 1997–2008.

market share in the 1980s, a decade before furniture, for both similar and different reasons. The spotted owl crisis dramatically increased ponderosa pine prices, the raw material for much of the molding/millwork production, and that opened the door to cheaper imports, mostly from South America.

Looking more closely at wood household furniture, Figure 19 shows trends of decreasing production and increasing imports to meet consumption needs. These trends began in accelerating in 1999. Production declines continued despite the dramatic boom in housing starts during the period 2000 through 2005. Rising imports have been slowed by the recent housing collapse, and it is generally expected that imports will tend to resume their capture of market share once housing returns to normal. However, this gain in share will be limited if the U.S. dollar exchange rate remains low. There are several drivers of these changes, but the key one is globalization. Once the import tariffs were reduced and finally removed, U.S. borders were opened up to free trade, and that exposed the domestic furniture industry to tough price competition primarily from Asia. Initially, it was Taiwan, then mainland China, and now we're seeing increasing imports from Vietnam and other places as furniture production moves to countries with still lower production costs. Other causes of our market share loss include a lack of investment in domestic plants by American manufacturers. This is especially relevant as most furniture in America is marketed as a commodity, and that means low price points. So, when U.S. industry was no longer protected by tariffs, manufacturers were vulnerable to lower priced furniture from overseas. Labor is the main ingredient to cheaper foreign imports with Chinese labor costs about one tenth of U.S. labor costs.

Not all furniture suffered with increased global competition. The domestic metal household furniture industry production has not decreased as much as wood furniture production has (Fig. 20). There are several reasons for this: (1) it is a much smaller market than wood household furniture, so offshore manufacturers were not as interested, (2) metal household furniture manufactures have maintained plant efficiency, and (3) they have modified furniture designs to meet customers' needs.

What factors could lead to increased wood furniture production in the United States? Stronger domestic and world growth will help. However, a key ingredient will be modifying designs for customers and investing in plant capacity to keep costs competitive. An additional important factor would be to produce types of furniture with more value added – specialty markets - as opposed to commodity furniture because it is most difficult to compete with low-cost imported commodity furniture because of high U.S. labor costs and labor intensity of production. In addition, furniture production may come back to the U.S. as manufacturing costs increase in China and other exporting countries.

Manufactured Product Shipments

Shipments of all manufactured products, measured in constant (2005) dollars totaled $4,919 × 10^9 in 2009, up from $4,630 in 2005 (Table 4, Fig. 21). Although not a record high level of expenditures, it is one of the highest in recent years. Overall growth in manufacturing shipments has been fairly steady, averaging about 2.2% per year since 1950.

In 2009, furniture and fixture shipments totaled 50 × 10^9 constant 2005 dollars compared with $61 × 10^9 in 2005 (Table 4). Shipments peaked in 1999 and 2000 at nearly $69 × 10^9, and have steadily fallen ever since (Fig. 18). Shipments of other manufactured products totaled $4,869 × 10^9 in 2009, and continues on its long-term increasing trend.

Solid wood Products Use Per $1,000 of Manufacturing Shipments

The use of lumber and structural and nonstructural panels per $1,000 of constant (2005) industry shipments has decreased considerably over the years, particularly in furniture

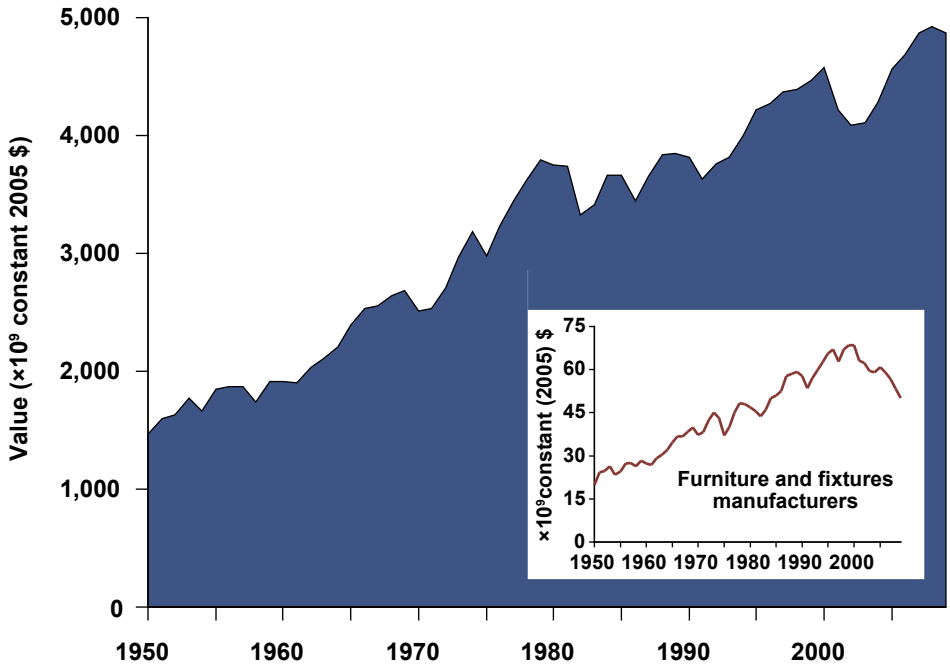

Figure 21. Manufacturing industry shipments in the United States excluding furniture and fixtures; insert shows shipments for furniture and fixtures, 1950–2009.

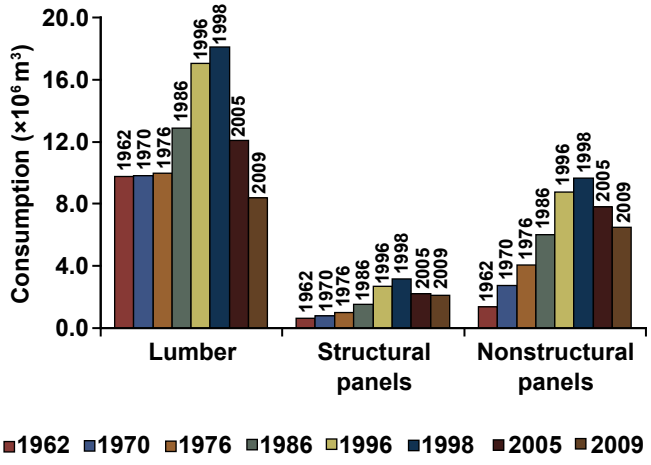

Figure 22. Solid wood products used for manufacturing in the United States by product, selected years, 1962–2009.

and fixtures manufacturing (Table 4). In 2009, furniture and fixtures manufacturing required an average of 0.161 m^3 of solid wood products per $1,000 (2005) of industry shipments. This is 16% less than in 2005, and about half the 1998 amount. For other manufacturing, solid wood products use per $1,000 of industry shipments, much smaller than that for furniture and fixtures, which average between 0.001 and 0.002 m^3 per $1,000. Trends in solid wood products consumption per $1,000 of shipments reflect the numerous and diverse changes in materials and technologies used to manufacture products. These trends also reflect changes in consumer preferences for specific products and the materials from which they are made. Lower cost materials such as nonstructural panels, plastics, and metal have eroded many of traditional lumber markets. Trends also reflect, to some extent, the mix of manufactured products consumed annually.

Total Solid wood Products Use in Manufacturing

Solid wood products consumption in manufacturing totaled 17.0 × 10^6 m^3 in 2009, consisting of 8.4 × 10^6 m^3 of lumber, 2.1 × 10^6 m^3 of structural panels and 6.1 × 10^6 m^3 of nonstructural panels (Tables 4, 7). Consumption in 2009 was down in each product category from 2005 levels, and from record high 1998 levels (Fig. 22). Much of the decline was due to falling furniture and fixture real dollar shipments, and declining solid wood products use per constant dollar of shipments.

Furniture and fixtures are an important component of solid wood products consumption in manufacturing. In 2009, industry furniture and fixture shipments accounted for just 1% of all industry shipments but 47% of combined solid wood products consumption. Lumber and nonstructural panels accounted for about one-half and structural panels about one-fourth of consumption.

Consumption in Packaging and Shipping

Substantial amounts of solid wood products are used annually in the U.S. to produce pallets, boxes, crates, hampers, baskets, and other wooden containers; and for the dunnage, blocking, and bracing required in the transportation, handling, and storage of industrial, agricultural, and military products. Although these are technically manufactured

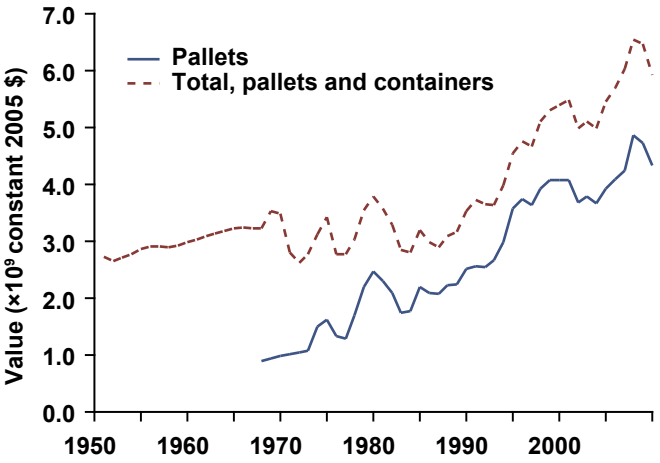

Figure 23. Value of wooden pallet and container shipments in the United States, 1960–2009.

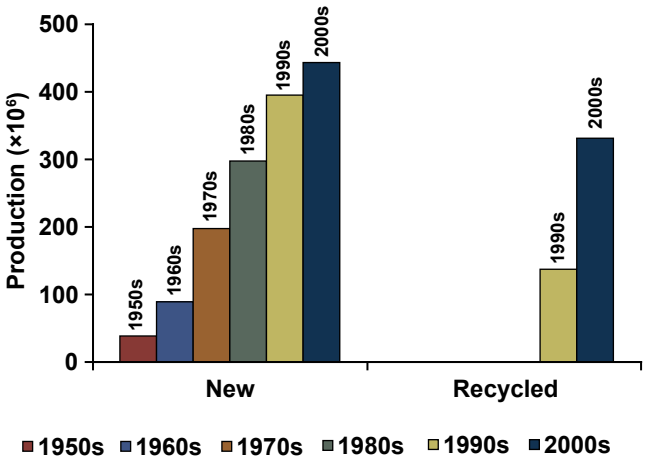

Figure 24. Decade average wooden pallet production, by type, selected years, 1962–2009.

products, they are evaluated separately because they constitute a sizeable market for solid wood products, particularly lower grade hardwood lumber. In 2009, about 14% of all solid wood products consumed were for packaging and shipping. Lumber was by far the most used product accounting for 19% of all lumber consumed. Structural panels and nonstructural panels accounted for 5% and 2%, respectively, of their total consumption. As with manufacturing, these levels of consumption reflect the lesser decline in pallet and container use in 2009 compared with the much more dramatic declines in construction. Additionally, hardwood lumber declines in furniture and other manufacturing were somewhat offset by more stable packaging and shipping markets.

Wooden Pallet and Container Shipments

Shipments of wooden pallets and containers, measured in constant 2005 dollars totaled $5.9 × 10^9$ in 2009, up from $5.7 in 2005 (Table 5). Although not a record high level of shipments, it is one of the highest in recent years (Fig. 23). Overall growth in shipments has been fairly steady, averaging about 1.2% per year since 1950.

In 2009, wooden pallet shipments totaled $4.3 × 10^9$ (2005 dollars), 73% of total shipments. Shipments of wooden containers have fluctuated little over its long-term 40-year average of about $1.3 × 10^9$.

Solid wood Products Use Per $1,000 of Shipments

The use of lumber and structural and nonstructural panels per $1,000 of constant (2005) wooden pallet and container shipments has changed over the years. In 2009, an estimated 1.2 m^3 was used per $1,000 (2005) of product shipments (Table 5). This is down substantially from use per $1,000 in the 1970s and 1980s when the use of wooden pallets was growing rapidly. Since then, use per $1,000 of shipments has fallen because of improvements in materials handling technologies, substitution of nonwood for wood products in both pallets and containers, and a decline in the need for wooden dunnage, blocking, and bracing as containerized and bulk shipments of manufactured and agriculture goods and increased use of palletized transportation systems have emerged.

Wooden Pallet Production

The wooden pallet industry is the mainstay of the packaging and shipping market. Overall pallet production continues its 60-year long upward trend. Since the development of the recycled pallet in the mid-1990s, new wooden pallets now account for about 58% of all pallets produced (Fig. 24). The principal reason for the rapid increase in the use of recycled pallets is that many states and municipalities ban the landfilling of used pallets. Others recover landfilled pallets for reuse or conversion into products with little or no value. The recovery of pallet material at landfills for repairing and remanufacturing pallets could be the next major recovery-reuse step. Trends in reduced new material use, increased recovery and repair, and decreased landfilling continue.

Total Solid Wood Products Consumption for Packaging and Shipping

An estimated $15 × 10^6$ m^3 of solid wood products were used for packaging and shipping in 2009 (Table 5, 7, Fig. 25). This consists of $14.2 × 10^6$ m^3 of lumber, $1.0 × 10^6$ m^3 of structural panels, and $0.2 × 10^6$ m^3 of nonstructural panels. Not included in these totals are the amounts of reused and reclaimed lumber used to repair and produce recycled pallets. In 2009, wooden pallets accounted for an estimated 90% of all solid wood products used, wooden containers 8%, and dunnage, blocking, and bracing, 2%. Additionally, as much as $11.0 × 10^6$ m^3 of solid wood products were reused for pallet repair and recycling in 2009.

Consumption in Other Uses

In addition to the major end uses discussed above, an estimated $11 × 10^6$ m^3 of solid wood products were used in 2009 for other purposes (Tables 6, 7, Fig. 26). This consists

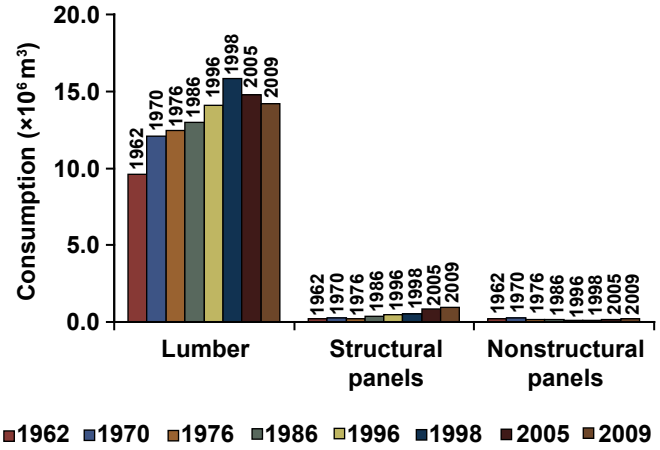

Figure 25. Solid wood products used for packaging and shipping in the United States by product, selected years, 1962–2009.

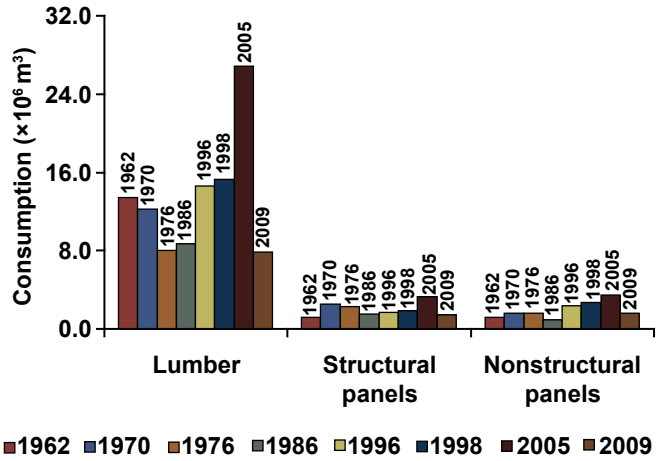

Figure 26. Solid wood products used for other purposes in the United States by product, selected years, 1962–2009.

of 7.9 × 10^6 m^3 of lumber, 1.5 × 10^6 m^3 of structural panels, and 1.6 × 10^6 m^3 of nonstructural panels. Other uses include, but are not limited to, roof supports and other construction in mines; made-at-home or do-it-yourself projects such as furniture, boats, and picnic tables; made-on-the-job products such as advertising and display structures; and various other activities not captured elsewhere in this report. Also included are millwork, cabinets, finished flooring, and other nonstructural uses in nonresidential construction. Volumes in the "other uses" category were estimated by subtracting volumes of solid wood products consumed in the specific end uses such as construction, manufacturing, and shipping, discussed above from estimated total consumption of each solid wood product. Estimates for the other uses category may be too high or low, depending on the accuracy of the estimates of total consumption (obtained from statistics on total production and net imports) and consumption in specific uses. Consumption estimates for specific uses are based on limited studies conducted at irregular intervals over the years. As these studies age, relationships between solid wood products consumption and major drivers change. These changes affect end-use specific solid wood product consumption estimates, which may or may not be reflected until studies are updated.

Consumption Summary

Solid wood products (excludes "other industrial wood products") are vital to the strength and well being of the U.S. economy. The current economic downturn and resulting impact on construction markets has put consumption in 2009 at levels not seen for nearly 30 years (Table 7). New residential construction was the hardest hit of all end-use markets. In 2009, an estimated 107 × 10^6 m^3 of solid wood products were consumed compared with 214 × 10^6 m^3 just 4 years prior. Construction is by far the greatest consumer of wood products (Fig. 27), accounting for 60% or more of total consumption in recent years. Typically, new residential construction accounts for about one-half of all solid wood products used for construction. However, in 2009, just about one-fourth of all solid wood products used for construction were for new residential construction. The robustness of the residential repair and remodeling market and the nonresidential construction market helped construction maintain its market share. Information on consumption in specific end-use markets provides important insights into the strength of the market and how factors affecting the market impact consumption. Tables 8, 9, and 10 summarize consumption of lumber, structural panels, and nonstructural panels, respectively.

Summary

Consumption, imports, exports, and production are shown separately for lumber, structural panels, and nonstructural panels in Tables 8–10, and in combination as total solid wood products in Table 11. Consumption of "other industrial wood products" is shown separately in Table 15. Total wood products consumption, including solid wood and "other industrial wood products," increased 116% between 1962 and 2005 to 223 × 10^6 m^3 in 2005 and decreased during the recession by 52% to 115 × 10^6 m^3 in 2009. With an increase in net imports as a share of consumption from 10% in 1962 to 33% in 2005 total production increased 61% but only 16 percentage points of the increase occurred since 1986 (Fig. 28, Tables 11, 15).

Eighty percent of wood products consumption is in lumber and structural panel products with virtually all of the increase in net imports coming from softwood lumber and oriented strandboard (Figs. 29, 30). The other 20% of consumption is in nonstructural panels and miscellaneous industrial solid wood products.

The consumption of structural panels rapidly shifted from softwood plywood to OSB in the 1990s, with OSB

Table 7—Timber products consumption in the United States, by per capita and end use, specified years 1962–2009

				End use						
				Construction						
Year	Population ($\times 10^6$)	Per capita (m^3)	Total ($\times 10^3$ m^3)	New housing ($\times 10^3$ m^3)	Residential repair and remodeling ($\times 10^3$ m^3)	Nonresidential construction ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Manufacturing ($\times 10^3$ m^3)	Shipping ($\times 10^3$ m^3)	All other ($\times 10^3$ m^3)
1962	187	483	90,017	31,452	10,517	10,435	52,403	11,826	10,011	15,776
1970	205	499	102,407	35,502	12,552	11,945	59,999	13,416	12,609	16,383
1976	218	529	115,328	47,668	16,255	11,640	75,563	15,042	12,839	11,884
1986	241	645	155,219	56,338	39,148	14,720	110,207	20,416	13,441	11,156
1996	266	640	170,000	56,136	38,920	13,119	108,176	28,490	14,671	18,664
1998	270	670	181,196	63,456	35,905	14,592	113,954	30,938	16,463	19,841
2005	297	721	213,799	80,170	48,119	14,106	142,395	22,128	15,751	33,525
2009	307	349	107,285	19,972	29,002	15,009	63,983	16,994	15,350	10,958

Sources: Howard, in preparation, Appendix tables 1, 2, 3, 4, 5, and 6.

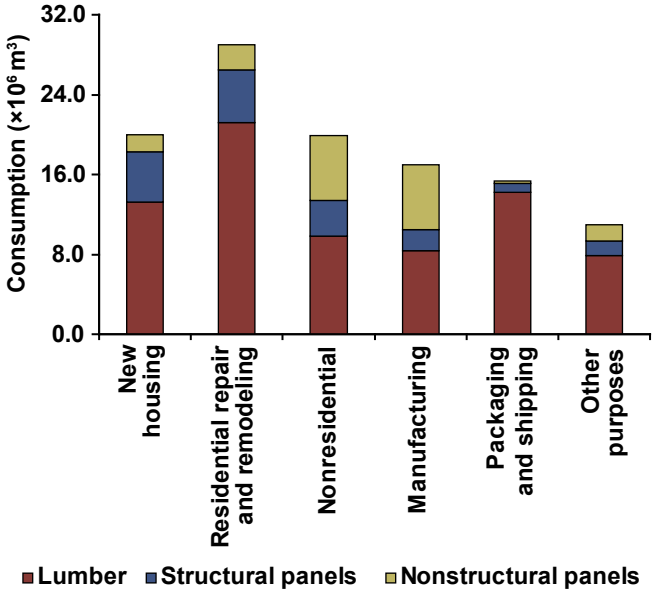

Figure 27. Solid wood products consumption in the United States by end use and product, 2009.

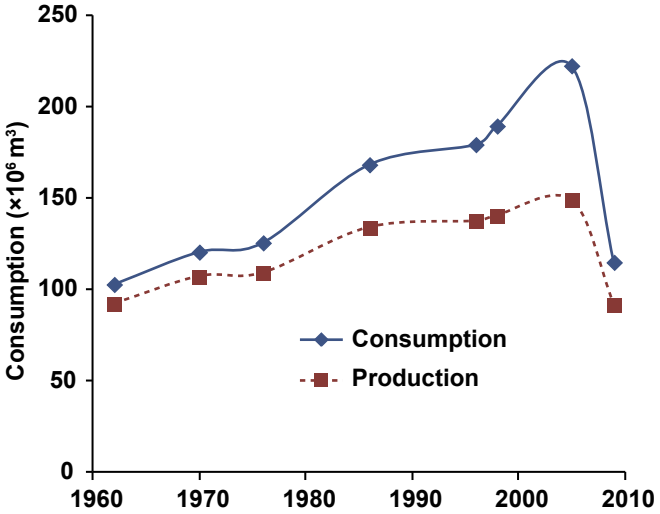

Figure 28. Total solid wood products consumption and production for the United States, 1962–2009 (× 10^6 m^3).

consumption exceeding softwood plywood consumption in 1998 and thereafter with much of the shift coming from sharply increasing imports since the mid 1990s. Since 2005, OSB consumption has decreased more than 50% by 2009 with much of the decrease in imports (Fig. 30).

The consumption of nonstructural panels has been on the order of one-half or more of the structural panel consumption in recent years. Nonstandard panel consumption decreased about 40% between 2005 and 2009. About half of the decrease was because of decreased inputs (Table 14). There was an upward shift in real (deflated) prices for softwood lumber, hardwood lumber, and even softwood plywood (despite deceases in consumption) on the order of 40% between the 1980s and the 1990s (Fig. 31) fueled by increases in construction. With price levels in the 1980s that were similar to prices in the 1960s and consumption levels on the order of 60% higher in the 1980s than the 1960s, it appears that there may not have been overall increasing economic scarcity of wood products over this period even with increasing consumption. However, there is uncertainty in this hypothesis as prices in the 1970s were considerably volatile. Increases in economic scarcity (increases in real prices for products) can be kept in check by increases in resource availability and maintaining or decreasing costs for manufacturing.

Going forward, if the dollar exchange rate remains low (Fig. 5), then as consumption of wood products increases with an economic recovery it is likely that the net import

Table 8—Lumber consumption in the United States by per capita use, softwoods and hardwoods, and end use, specified years 1962–2009

						End use						
						Construction						
				Species group								
				Softwoods ($\times 10^3$ m^3)	Hardwoods ($\times 10^3$ m^3)	New housing ($\times 10^3$ m^3)	Residential repair and remodeling ($\times 10^3$ m^3)	Nonresidential construction ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Manufacturing ($\times 10^3$ m^3)	Shipping ($\times 10^3$ m^3)	All other ($\times 10^3$ m^3)
1962	187	400	74,526	54,926	19,600	25,729	7,800	8,187	41,716	9,781	9,626	13,403
1970	205	380	77,955	57,804	20,151	25,556	9,009	9,217	43,782	9,839	12,075	12,259
1976	218	387	84,410	65,471	18,939	33,610	11,445	8,891	53,946	9,984	12,436	8,044
1986	241	472	113,615	89,305	24,310	39,286	29,179	10,658	79,123	12,851	12,958	8,682
1996	266	465	123,520	95,731	27,789	38,198	29,662	9,908	77,768	17,032	14,116	14,604
1998	270	482	130,333	101,500	28,834	42,889	27,300	10,980	81,169	18,080	15,823	15,260
2005	297	516	153,098	127,652	25,446	54,105	35,805	9,517	99,427	12,108	14,750	26,813
2009	307	243	74,615	59,111	15,504	13,216	21,173	9,794	44,183	8,382	14,175	7,875
Softwood lumber (%)												
1962	—	—	—	—	—	91	96	65	87	30	36	91
1970	—	—	—	—	—	93	96	65	88	38	38	90
1976	—	—	—	—	—	95	97	62	90	50	41	86
1986	—	—	—	—	—	96	95	67	92	44	29	83
1996	—	—	—	—	—	95	95	34	72	92	28	56
1998	—	—	—	—	—	96	96	74	93	41	34	89
2005	—	—	—	—	—	95	94	70	93	49	43	87
2009	—	—	—	—	—	96	98	78	93	63	43	85

[a]Includes hardwood and softwood dimension and boards and the lumber equivalent of engineered wood products. Sources: Howard, in preparation, tables 1, 2, 3, 4, 5, and 6.

Table 9—Structural panel consumption in the United States by per capita use, softwood plywood and OSB, and end use, specified years 1962–2009

						End use						
						Construction						
				Panel type								
				Softwood plywood ($\times 10^3$ m^3)	OSB ($\times 10^3$ m^3)	New housing ($\times 10^3$ m^3)	Residential repair and remodeling ($\times 10^3$ m^3)	Nonresidential construction ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Manufacturing ($\times 10^3$ m^3)	Shipping ($\times 10^3$ m^3)	All other ($\times 10^3$ m^3)
1962	187	45	8,415	8,415	0	3,482	1,478	1,460	6,420	646	186	1,163
1970	205	61	12,592	12,592	0	5,257	2,078	1,675	9,010	808	255	2,518
1976	218	72	15,767	15,696	71	7,704	2,872	1,690	12,266	1,002	230	2,269
1986	241	95	22,780	19,087	3,693	10,407	6,208	2,726	19,340	1,556	350	1,534
1996	266	105	27,957	15,946	12,011	14,521	6,440	2,166	23,128	2,695	457	1,677
1998	270	114	30,807	15,214	15,593	16,559	6,206	2,475	25,240	3,189	529	1,848
2005	297	124	36,904	14,461	22,443	19,144	8,362	3,070	30,576	2,190	851	3,288
2009	307	60	18,510	7,736	10,774	5,084	5,329	3,581	13,994	2,103	959	1,454
Softwood lumber (%)												
1962	—	—	—	—	—	100	100	100	100	100	100	100
1970	—	—	—	—	—	100	100	100	100	100	100	100
1976	—	—	—	—	—	100	100	99	99	100	100	100
1986	—	—	—	—	—	75	95	94	84	98	99	62
1996	—	—	—	—	—	43	70	65	53	94	97	48
1998	—	—	—	—	—	34	63	60	43	94	96	41
2005	—	—	—	—	—	23	58	56	36	91	70	27
2009	—	—	—	—	—	18	55	33	36	94	62	10

[a]Includes softwood plywood and OSB. Sources: Howard, in preparation, tables 1, 2, 3, 4, 5, and 6.

Table 10—Nonstructural panel consumption in the United States by per capita and end use, specified years 1962–2009

				End use						
				Construction						
Year	Population ($\times 10^6$)	Per capita (m^3)	Total[a] ($\times 10^3$ m^3)	New housing ($\times 10^3$ m^3)	Residential repair and remodeling ($\times 10^3$ m^3)	Nonresi-dential construc-tion ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Manufac-turing ($\times 10^3$ m^3)	Shipping ($\times 10^3$ m^3)	All other ($\times 10^3$ m^3)
1962	187	38	7,075	2,241	1,239	788	4,268	1,398	199	1,210
1970	205	58	11,860	4,690	1,465	1,053	7,207	2,768	279	1,606
1976	218	69	15,150	6,354	1,938	1,058	9,351	4,056	173	1,571
1986	241	78	18,825	6,645	3,762	1,336	11,743	6,008	133	940
1996	266	70	18,523	3,417	2,818	1,045	7,280	8,763	97	2,383
1998	270	74	20,056	4,008	2,399	1,138	7,544	9,669	111	2,732
2005	297	80	23,797	6,920	3,953	1,519	12,392	7,831	150	3,424
2009	307	46	14,160	1,672	2,499	1,634	5,806	6,509	216	1,630

[a]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board. Sources: Howard, in preparation, tables 1, 2, 3, 4, 5, and 6.

Table 11—Solidwood products production, foreign trade, and apparent domestic consumption in the United States, specified years 1962–2009

		Imports			Exports			Net imports			
			As a percentage of			As a percentage of			As a percentage of		
Year	Produc-tion ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Produc-tion	Consump-tion	Total ($\times 10^3$ m^3)	Produc-tion	Consump-tion	Total ($\times 10^3$ m^3)	Produc-tion	Consump-tion	Consump-tion ($\times 10^3$ m^3)
1962	79,381	12,501	16	14	1,865	2	2	10,636	13	12	90,017
1970	89,091	16,504	19	16	3,187	4	3	13,317	15	13	102,407
1976	98,815	21,861	22	19	5,348	5	5	16,513	17	14	115,328
1986	120,887	40,988	34	26	6,656	6	4	34,332	28	22	155,219
1996	128,102	51,051	40	30	9,152	7	5	41,898	33	25	170,000
1998	132,144	55,862	42	31	6,810	5	4	49,053	37	27	181,196
2005	140,266	80,701	58	38	7,168	5	3	73,533	52	34	213,799
2009	84,257	29,024	34	27	5,996	7	6	23,028	27	21	107,285

Source: Howard, in preparation.

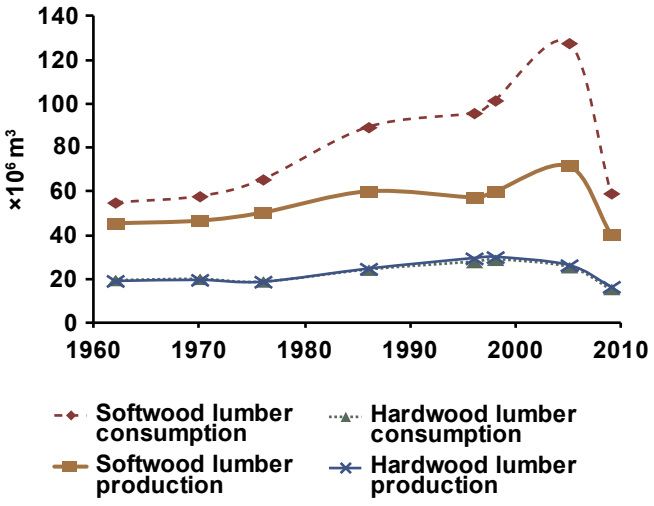

Figure 29. Softwood and hardwood lumber consumption and production for selected years 1962–2009 (× 10^6 m^3).

share of consumption will remain below 33% level for all wood products seen in 2005. When the dollar exchange rate was last at current levels (early 1990s) the net import share of consumption was 20% to 23%, which corresponds to the 2009 net import share of 20%. For example, to return to a 2005 production level of 149 × 10^6 m^3 would require a consumption level of 190 × 10^6 m^3 or 15% less than the consumption level in 2005.

Pulp, Paper, and Paperboard Consumption, Trade, Production, and Prices

Drivers of Pulp, Paper, and Paperboard Consumption and Trade

Paper and paperboard consumption in the United States peaked in line with peaking of industrial production in about 1999 and declined as industrial production declined through 2000–2001 (Fig. 32) (U.S. Federal Reserve 2008a).

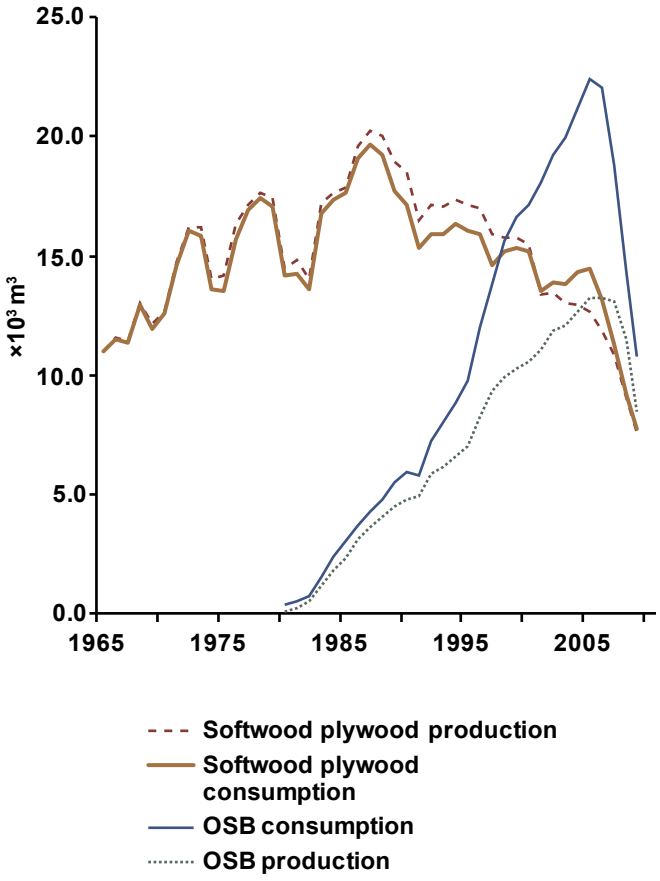

Figure 30. Softwood plywood and oriented strandboard consumption and production, 1965–2009.

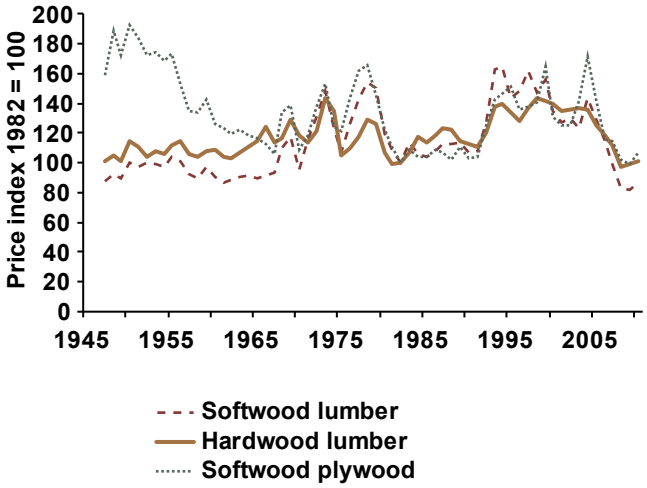

Figure 31. Deflated prices for softwood and hardwood lumber and softwood plywood, 1947–2010 (1982 = 100).

The recession of 2000–2001 followed the Asian financial crisis of the late 1990s and coincided with a period when the exchange value of the U.S. dollar was increasing, which increased consumer goods imports and decreased U.S.

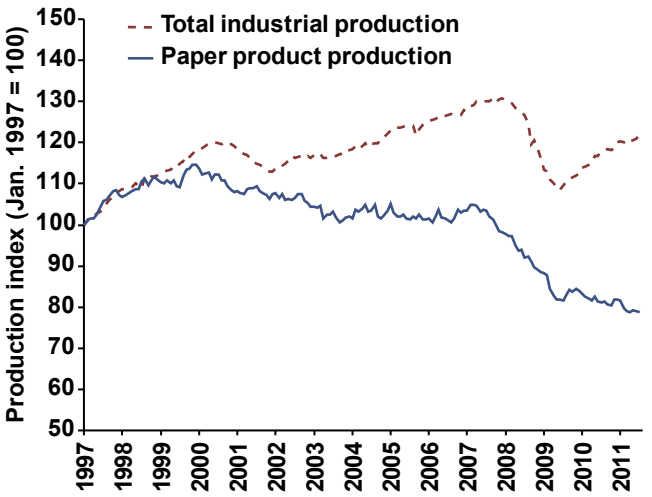

Figure 32. Monthly trends in total U.S. industrial production index (U.S. Federal Reserve 2008a) and U.S. paper product production index, 1997–2009.

manufacturing. The largest U.S. demands for paper and paperboard are for packaging and print advertising, both historically linked to industrial production, so U.S. demands for paper and paperboard generally declined as growth in manufacturing of consumer goods shifted overseas and as growth in advertising expenditures shifted from print media to digital media in recent years.

Growth in U.S. industrial production resumed after the 2001 downturn, but average growth from 2001 to 2008 was *less than half* the average growth rate for industrial production in the latter half of the 20th century (U.S. Federal Reserve 2008a). The decline of growth in U.S. industrial output reflects expansion of manufactured goods imports, which have soared to record levels over the past decade.

After 2001, U.S. demands for newsprint and printing papers were also negatively affected as growth in advertising expenditures shifted from print media to electronic media. Slower growth in print advertising and other structural changes in paper and paperboard use resulted in a gradual divergence over the past decade between the industrial production trend and production of paper and paperboard.

The recession of 2008 resulted in further steep declines in U.S. industrial production and in production of paper and paperboard (Fig. 32), but this time the downturn was due to sharp declines in retail sales and consumer spending, which were influenced by a credit crisis and rising unemployment. Retail sales in the United States, for example, dropped by 12.4% in just six months from June to December of 2008 (U.S. Census Bureau), by far the largest and most rapid decline in decades.

In contrast to declining domestic production for paper and paperboard, the U.S. net imports of pulp, paper, and paperboard increased for a period in the past decade but then

Table 12—Lumber[a] production, foreign trade, and apparent domestic consumption in the United States, by softwood and hardwood, specified years 1962–2009

		Imports			Exports			Net imports			
			As a percentage of			As a percentage of			As a percentage of		
Year	Production ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Production	Consumption	Total ($\times 10^3$ m^3)	Production	Consumption	Total ($\times 10^3$ m^3)	Production	Consumption	Consumption ($\times 10^3$ m^3)
Softwood lumber[a]											
1962	45,592	10,818	24	20	1,483	3	3	9,334	20	17	54,926
1970	46,801	13,635	29	24	2,633	6	5	11,003	24	19	57,804
1976	50,478	18,782	37	29	3,789	8	6	14,993	30	23	65,471
1986	60,182	33,602	56	38	4,479	7	5	29,123	48	33	89,305
1996	57,423	42,530	74	44	4,221	7	4	38,308	67	40	95,731
1998	60,066	44,098	73	43	2,665	4	3	41,433	69	41	101,500
2005	71,651	58,118	81	46	2,117	3	2	56,001	78	44	127,652
2009	40,533	20,898	52	35	2,320	6	4	18,578	46	31	59,111
Hardwood lumber											
1962	19,180	730	4	4	309	2	2	420	2	2	19,600
1970	19,658	795	4	4	302	2	1	493	3	2	20,151
1976	18,826	680	4	4	568	3	3	113	1	1	18,939
1986	24,726	819	3	3	1,234	5	5	–416	–2	–2	24,310
1996	29,472	889	3	3	2,572	9	9	–1,682	–6	–6	27,789
1998	30,040	1,295	4	4	2,502	8	9	–1,207	–4	–4	28,834
2005	26,333	2,537	10	10	3,424	13	13	–887	–3	–3	25,446
2009	16,494	900	5	6	1,890	11	12	–990	–6	–6	15,504
Total											
1962	64,772	11,547	18	15	1,793	3	2	9,754	15	13	74,526
1970	66,459	14,430	22	19	2,934	4	4	11,496	17	15	77,955
1976	69,304	19,462	28	23	4,357	6	5	15,106	22	18	84,410
1986	84,907	34,421	41	30	5,714	7	5	28,707	34	25	113,615
1996	86,894	43,419	50	35	6,793	8	5	36,626	42	30	123,520
1998	90,107	45,393	50	35	5,167	6	4	40,227	45	31	130,333
2005	97,984	60,655	62	40	5,541	6	4	55,114	56	36	153,098
2009	57,027	21,798	38	29	4,210	7	6	17,588	31	24	74,615

[a]Includes laminated veneer lumber beginning in 1986. Source: Howard, in preparation.

narrowed as the trade-weighted value of the U.S. dollar peaked (in 2002) and then declined (Fig. 33). Net imports of pulp, paper, and paperboard peaked at about 8 million metric tons in 2002–2003.

Rising imports and weaker domestic demands led to industry downsizing and consolidation. For example, according to industry sources, 98 U.S. paper mills closed between 1998 and 2003 (American Forest & Paper Association 2005). Consolidation resulted in job losses, but the industry achieved higher average labor and capital productivity. Higher productivity and a weaker dollar improved the competitiveness of U.S. producers, and by 2008 the net imports were very small (American Forest & Paper Association 2008), and positive net exports were achieved in 2010 (Fig. 33).

As shown in Figure 33, the trade-weighted dollar exchange rate increased in early 2009, as the value of foreign currencies declined amid the global economic recession. A higher dollar could adversely affect the U.S. pulp, paper, and paperboard trade balance in the long run, but by 2009–2010, the United States was a net exporter of paper and paperboard for the first time in decades as the dollar remained weak in 2010 (Fig. 33).

Relationship to GDP Growth

Over the long run (as noted in Fig. 2), up until 1999 U.S. paper and paperboard consumption has increased fairly consistently as GDP has increased. The two trends have different growth rates. The average rate of growth in GDP was higher than the average growth rate for paper and paperboard consumption, but both trends were growing in tandem up until 1999, at which point the trends diverged sharply. This divergence is due to structural changes that have occurred in demands for paper and paperboard, primarily a result of higher imports of manufactured goods and slower growth in U.S. industrial production and shifts in advertising expenditures from print media to electronic media.

By 2008, the divergence from GDP suggests that consumption was 30 million metric tons lower than may have been attained if the relationship between consumption and GDP growth had continued.

Paper and paperboard production in the United States also tracked well with increasing GDP up to the late 1990s, but not more recently (Fig. 34). The projected gap in production growth compared with GDP growth is not quite as great as

Table 13—Structural panel production, foreign trade, and apparent domestic consumption in the United States, by softwood plywood and OSB, specified years 1962–2009

		Imports			Exports			Net imports			
			As a percentage of			As a percentage of			As a percentage of		
Year	Production ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Production	Consumption	Total ($\times 10^3$ m^3)	Production	Consumption	Total ($\times 10^3$ m^3)	Production	Consumption	Consumption ($\times 10^3$ m^3)
Softwood plywood											
1962	8,419	12	0	0	15	0	0	–4	0	0	8,415
1970	12,691	2	0	0	101	1	1	–99	–1	–1	12,592
1976	16,319	11	0	0	634	4	4	–623	–4	–4	15,696
1986	19,574	56	0	0	544	3	3	–488	–2	–3	19,087
1996	16,975	75	0	0	1,105	7	7	–1,029	–6	–6	15,946
1998	15,732	158	1	1	676	4	4	–518	–3	–3	15,214
2005	12,682	2,143	17	15	364	3	3	1,779	14	12	14,461
2009	7,618	545	7	7	427	6	6	118	2	2	7,736
OSB											
1962	0	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0	0
1976	71	0	0	0	0	0	0	0	0	0	71
1986	3,109	584	19	16	0	0	0	584	19	16	3,693
1996	8,243	3,907	47	33	139	2	1	3,768	46	31	12,011
1998	9,936	5,745	58	37	89	1	1	5,657	57	36	15,593
2005	13,262	9,331	70	42	150	1	1	9,182	69	41	22,443
2009	8,494	2,439	29	23	159	2	1	2,280	27	21	10,774
Total											
1962	8,419	12	0	0	15	0	0	–4	0	0	8,415
1970	12,691	2	0	0	101	1	1	–99	–1	–1	12,592
1976	16,390	11	0	0	634	4	4	–623	–4	–4	15,767
1986	22,683	640	3	3	544	2	2	96	0	0	22,780
1996	25,218	3,982	16	14	1,243	5	4	2,739	11	10	27,957
1998	25,668	5,904	23	19	765	3	2	5,139	20	17	30,807
2005	25,944	11,474	44	31	514	2	1	10,960	42	30	36,904
2009	16,112	2,984	19	16	587	4	3	2,397	15	13	18,510

Source: Howard, in preparation.

Table 14—Nonstructural production[a], foreign trade, and apparent domestic consumption in the United States, specified years 1962–2009

		Imports			Exports			Net imports			
			As a percentage of			As a percentage of			As a percentage of		
Year	Production ($\times 10^3$ m^3)	Total ($\times 10^3$ m^3)	Production	Consumption	Total ($\times 10^3$ m^3)	Production	Consumption	Total ($\times 10^3$ m^3)	Production	Consumption	Consumption ($\times 10^3$ m^3)
1962	6,190	942	15	13	57	1	1	885	14	13	7,075
1970	9,940	2,072	21	17	152	2	1	1,920	19	16	11,860
1976	13,120	2,388	18	16	358	3	2	2,030	15	13	15,150
1986	13,296	5,927	45	31	398	3	2	5,528	42	29	18,825
1996	15,990	3,650	23	20	1,116	7	6	2,534	16	14	18,523
1998	16,370	4,565	28	23	878	5	4	3,687	23	18	20,056
2005	16,338	8,572	52	36	1,114	7	5	7,458	46	31	23,797
2009	11,117	4,242	38	30	1,199	11	8	3,043	27	21	14,160

[a]Includes hardwood plywood, particleboard, MDF, hardboard, and insulation board. Source: Howard, in preparation.

Table 15—Miscellaneous industrial timber products[a] production and consumption, specified years 1962–2009

Year	Total ($\times 10^3$ m^3)[b]	Softwood ($\times 10^3$ m^3)[b]	Hardwood ($\times 10^3$ m^3)[b]
1962	13,167	6,796	6,371
1970	18,463	9,992	8,471
1976	10,619	6,796	3,823
1986	13,451	7,263	6,187
1996	9,684	5,133	4,552
1998	8,637	4,577	4,059
2005	9,005	4,773	4,232
2009	7,985	4,191	3,794

[a]Includes cooperage logs, poles and piling, fence posts, hewn ties, round mine timbers, box bolts, excelsior bolts, chemical wood, shingle bolts, and miscellaneous items.
[b]Roundwood equivalent. Source: Howard, in preparation.

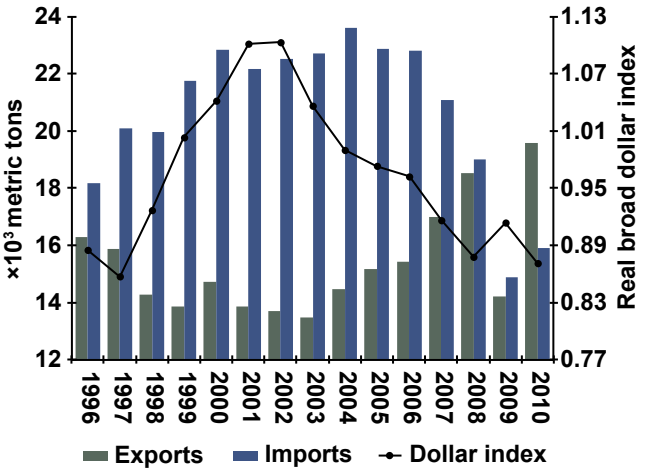

Figure 33. U.S. exports and imports of all pulp, paper, and paperboard products (American Forest & Paper Association 2007, 2008) and real broad trade-weighted dollar index (U.S. Federal Reserve 2008b), 1996–2008.

for consumption because paper and paperboard exports have expanded and imports have decreased in recent years. However, there is an apparent loss of well over 25 million metric tons of growth in U.S. production over the past decade relative to the historical GDP relationship.

Whether looking at U.S. paper and paperboard consumption (Fig. 2) or production (Fig. 34), it is obvious that there was a structural change in growth trends relative to overall economic growth or GDP, and the onset of the structural change was coincident with the Asian financial crisis of the late 1990s, the subsequent rise in value of the U.S. dollar, and consequent downturn in industrial production and recession of 2000–2001. The 2000–2001 recession marked a point when growth in U.S. industrial production changed significantly. From 1950 to 2000, growth in industrial production was +3.8% per year, but since 2000 it has been negligible (0.1% per year). Average consumption and production growth rates prior to 1999 were well above 2% per year, but growth on average has been negligible from 2001 to 2008. The annual rate of growth in production from 2001 to 2008 was just under 0% per year, much less than the average rate of 2.4% from 1970 to 1999. Furthermore, U.S. paper and board production dropped steeply in 2009 coincident with the global financial crisis, followed by a solid rebound in 2010. However, U.S. production in 2010 was still below the 2008 level, although the U.S. paper and paperboard trade balance improved as the United States became a net exporter.

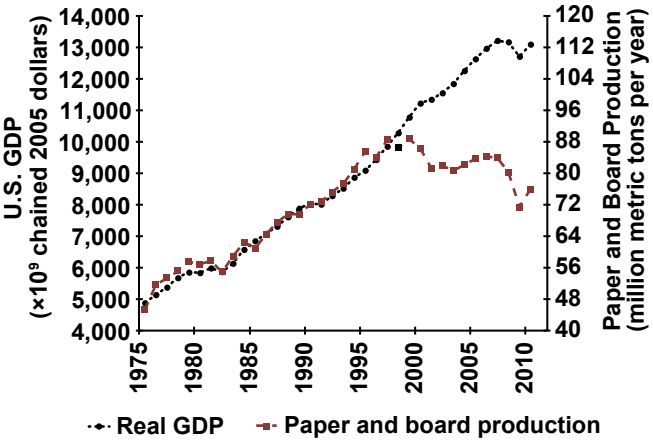

Figure 34. Divergence since 1999 between trends in U.S. real GDP (USDOC Bureau of Economic Analysis 2010) and U.S. paper and paperboard production (American Forest & Paper Association 2007, 2008).

Wood Pulp Production

The trends in paper and paperboard consumption since the late 1990s, along with earlier increases in paper recycling, had a major impact on the historic trend in U.S. wood pulp production. For most of the 20th century, U.S. wood pulp production was increasing, but production peaked in the mid-1990s (Fig. 35). Growth in wood pulp production was slowed by increasing use of recovered paper during the late 1980s to 1990s.

Since the late 1990s, the utilization rate of recovered fiber in U.S. paper and paperboard remained about level (American Forest & Paper Association 2007). Since then increases in paper recovered for recycling have mostly been exported (mainly to China). Thus, since the late 1990s, changes in U.S. wood pulp production have been determined primarily by changes in U.S. paper and paperboard production. Therefore, U.S. wood pulp output has been almost level (slightly declining) since 2001, although there has been some increase in net exports (Fig. 35). With nearly level wood pulp production since 2001, pulpwood consumption at U.S. wood pulp mills has also been nearly level (slightly declining) during the last decade since 2001.

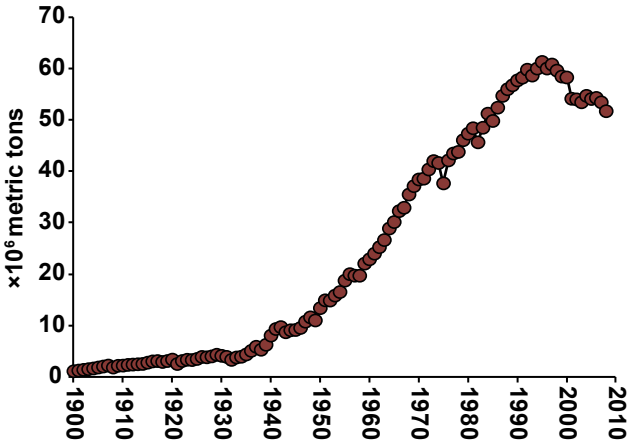

Figure 35. Annual U.S. wood pulp production, 1900–2008 (USDOC Bureau of Economic Analysis 2010; Howard, in production; and American Forest & Paper Association 2007).

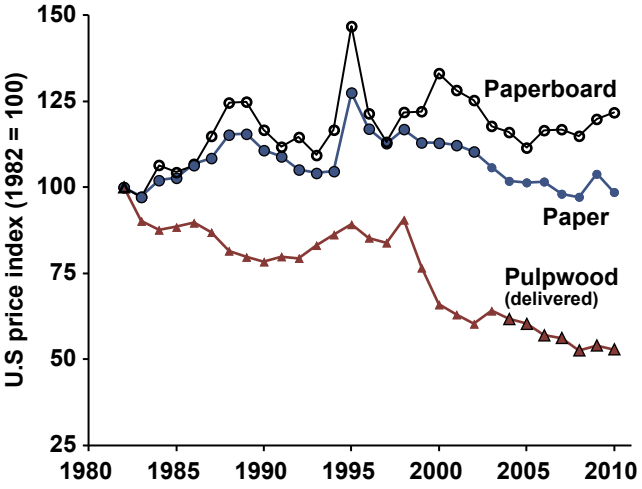

Figure 36. U.S. real price indexes for paper, paperboard, and pulpwood, 1982–2008 (BLS producer price indexes, (U.S. Bureau of Labor Statistics 2008) deflated using all-commodity producer price index).

Pulpwood Consumption and Prices for Pulpwood, Paper, and Paperboard

Changes in U.S. pulp, paper, and paperboard production deeply affected the pulpwood market, as reflected by substantially lower real prices for pulpwood since the late 1990s (Fig. 36). The real price of pulpwood generally declined over the past 25 years, but during a transitory period in the 1990s, the real price of pulpwood increased. However, after 1998 the real price of pulpwood declined sharply as U.S. wood pulp production peaked and declined (Fig. 35). This declining real price indicates a decreasing economic scarcity for pulpwood. Pulpwood is becoming more abundant in the United States relative to the U.S. demands. This is due to increasing supplies of pulpwood relative to demand, particularly growth of southern pine plantations; level to declining consumption; increasing net imports; and improvements in harvesting or conversion technology and associated non-wood costs of production.

In the decade between 1998 and 2008, the real price of pulpwood in the United States dropped by 42%, according to producer price indexes reported by Bureau of Labor Statistics (Fig. 36). Consolidation in the paper industry helped avoid a similar collapse in real paper and paperboard prices, but real prices for paper and paperboard have also been generally declining with weaker demand since the late 1990s (Fig. 36).

Demands for paper and paperboard were sufficient to sustain elevated real prices for paper and paperboard through the 1990s, but declining real prices imply that market demands have weakened for paper and paperboard since the late 1990s. Real prices for paper and paperboard were generally increasing prior to the late 1990s, when paper and paperboard production and consumption were still increasing in line with GDP growth. Real prices have not increased since the late 1990s.

Pulpwood Consumption

Pulpwood consumption in the United States depends on wood pulp production, which in turn depends on paper and paperboard production. Both woodpulp production and paper and paperboard production peaked in the 1990s and have generally declined since then. Both U.S. woodpulp production and estimated pulpwood consumption at U.S. wood pulp mills have declined by around 15% to 20% since peaking in the mid-1990s.

Apart from wood pulp, the leading alternative use for pulpwood in the United States is oriented strandboard (OSB), used primarily in housing construction. Output of OSB expanded rapidly since its first commercial use in the United States in 1979. Thus, North American OSB consumption was affected by the recent downturn in U.S. housing construction (2006–2009), but a notable decrease in net imports of OSB helped avert a more significant collapse in U.S. production (Fig. 37). Oriented strandboard exports from the United States were boosted also by generally lower OSB prices, a weaker U.S. dollar, and excess capacity. On the other hand, Canada lost roughly half of its OSB output just from 2006 to 2008, as the housing slump and a strong Canadian dollar reduced demand for Canadian OSB exports (Fig. 37).

Potential of Pulpwood Demand for Energy

Wood and bark residues, pulping liquors, and conventional fuelwood harvest account for almost all wood energy production in the United States. Generally pulpwood-quality wood (roundwood pulpwood or clean wood chips) has higher value than fuel residues like bark or whole-tree chips. However, with limitations on residue supply some

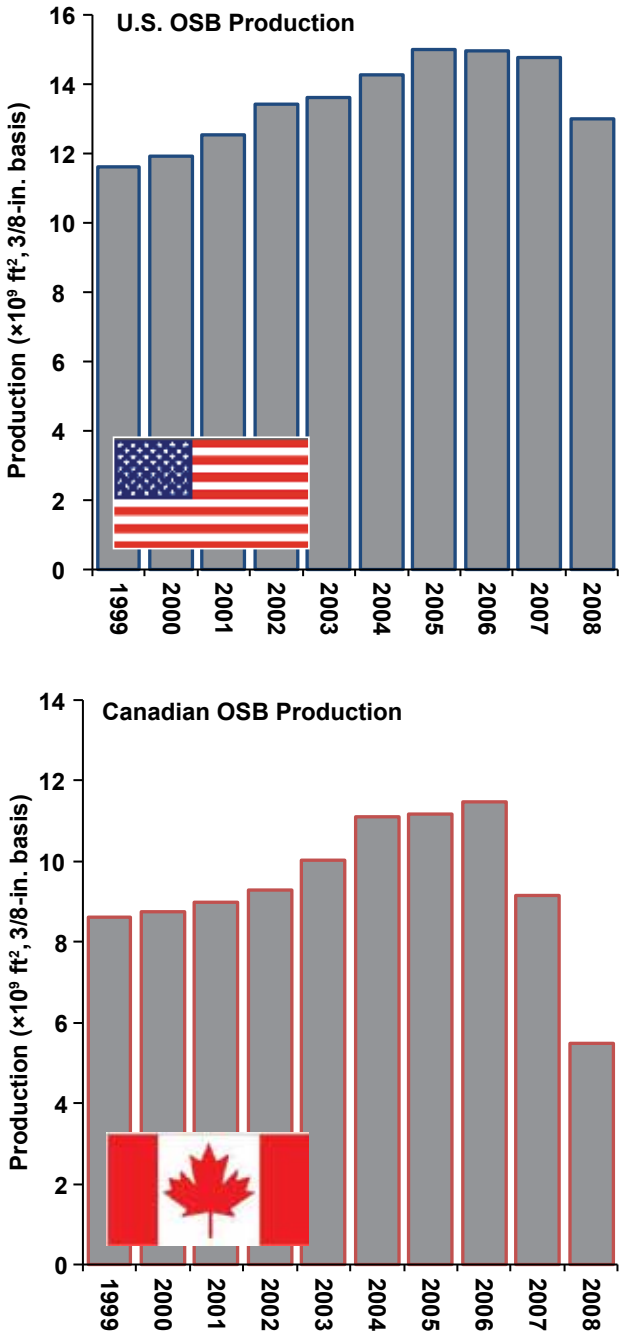

Figure 37. U.S. and Canadian OSB production, 1999–2008 (APA—The Engineered Wood Association 2008); 2008 estimate based on data through third quarter.

pulpwood is also beginning to be used for energy (e.g., for wood pellets).

With increased oil prices and related policy responses, biofuels or biochemicals would appear to represent a potential emerging future demand for wood that could potentially compete for pulpwood. However, technology for efficiently converting wood to biofuels or biochemicals on a large scale is yet to be demonstrated and large-scale investment and research and development efforts would be needed to create such competitive demands for pulpwood. Also, the precipitous drop in oil price that occurred in the second half of 2008 suggests less impetus for rapid commercial expansion of biofuel production in the near term, although there continues to be strategic interest and continued industry support for biotechnology development.

Based on recent prices for various product alternatives, production of wood pulp still offers much higher revenue potential for pulpwood than does production of wood-based biofuels such as cellulosic ethanol. Taking into account total costs of production, the profit margins would be lower for conversion of pulpwood into ethanol versus wood pulp. Of course, prices and costs vary over time for ethanol, wood pulp, and pulpwood.

Higher future market prices for ethanol or other biofuels or improved production cost efficiency could increase competitiveness of biofuel production from wood. Also joint production of wood pulp and biofuels at integrated forest product biorefineries is a potentially more lucrative opportunity that is being explored by the forest industry.

Summary

U.S. paper and paperboard purchases peaked in 1999 and then declined along with U.S. industrial production in 2000–2001. Comparatively modest growth was experienced from 2002 to 2007 (averaging less than 1% per year), and yet another downturn in industrial production and paper and paperboard demand occurred in 2007–2008 along with a more generalized global recession. The recent downturn was associated with declining retail sales and consumer spending. Paper and board consumption rebounded solidly in 2010, but consumption was still less than in 2008, yielding a decade of generally declining U.S. consumption for paper and paperboard. Domestic consumption of paper and paperboard in 2010 was more than 20% below the 1999 peak level, according to AF&PA data.

Average historical growth rates before 1999 were above 2% per year for U.S. production and consumption of paper and paperboard, but 2001–2008 growth rates have averaged 0% per year.

U.S. pulpwood prices (deflated) have been declining over the past 25 years, and especially since the late 1990s, as pulpwood demand has receded while supply sources have expanded.

Increasing OSB production is demanding a growing amount of pulpwood, but the consumption is still small compared with pulpwood consumption at wood pulp mills. The recent downturn in housing construction has decreased OSB demand.

Wood Energy Consumption, Trade, Production, and Prices

Wood is currently consumed for energy in four primary sectors: residential (for home heating), commercial businesses (primarily for heating), industrial (primarily as black liquor and mill residue in lumber, panel, and pulp plants for heat and power) and electric power. Presently, no commercial production of liquid fuels uses wood in the United States. These four primary sectors use wood in several forms. The primary forms are 1) logs or chips directly from a forest (termed roundwood), 2) mill residue from a lumber, panel, or pulp mill, and 3) black liquor from a pulp mill. In addition, some forms require more processing. Wood pellets are made from mill residue or roundwood. Torrified wood is wood that is heat treated, such as torrified wood pellets. Two benefits of torrified wood are lower transport cost per unit of energy and ability to be crush to a powder for co-firing with coal.

Most wood energy has been used in the residential and industrial sectors, averaging 19% and 70% of total wood energy, respectively, from 2000 to 2009 (Fig. 38).

Industrial Wood Energy Consumption

The main driver of industrial wood energy use is the need for energy in pulp production including chemical recovery kilns and electric power production for internal use. A secondary driver is needed for heat by lumber mills for kiln drying. After a steady increase since the 1950s, the stable to declining trend in industrial wood energy use since the mid 1980s is linked in part to declining pulp production as shown in Figure 35. However, the leveling off of industrial wood energy use began about 10 years earlier than the pulp production decline in the mid 1980s. This earlier decline is explained in part by decreasing prices for natural gas beginning in the 1980s (Fig. 39). However, increasing natural gas prices since the mid 1990s have not increased industrial wood energy use, as pulp production has declined. Going forward, industrial wood energy consumption will likely continue to be influenced by trends in pulp production, lumber production, and the associated need for dry kilns, and by industrial prices for natural gas for pulp and lumber mills. Industrial use in pulp and lumber mills is facilitated by ready access to residue and roundwood for energy. In the absence of government incentives, expansion of wood energy for process heat or electricity in other industrial sectors would likely require a notable price increase for natural gas (or fuel oil) used in those sectors.

Residential Wood Energy Consumption

A key driver of residential wood energy use in colder climates has been the price for alternate fossil heating fuels, primarily fuel oil and natural gas (or propane). The substantial increase in residential wood use in the late 1970s and

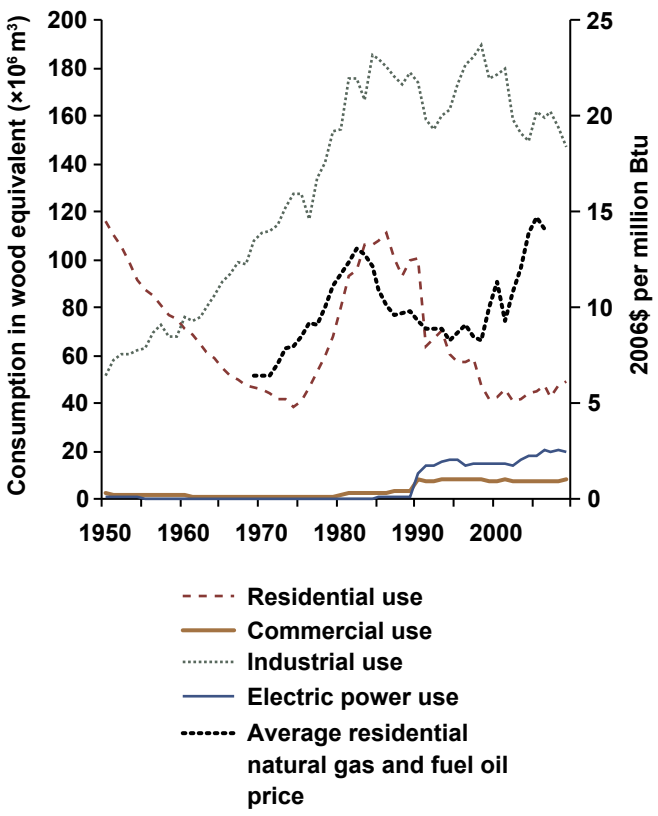

Figure 38. Wood energy consumption by end-use sector and average residential natural gas and fuel oil price.

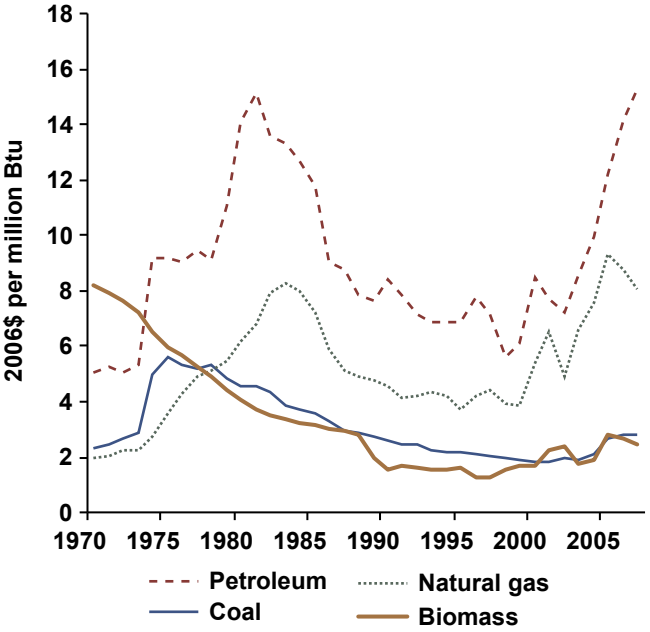

Figure 39. Fuel feedstock prices for industrial users.

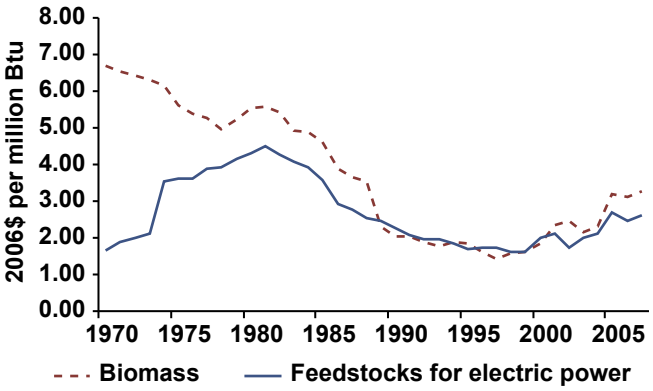

Figure 40. Biomass price and average feedstock price for electric power plants.

1980s was preceded by a substantial increase in the consumption-weighted average price for fuel oil and natural gas for housing (Fig. 38). Residential wood energy use declined after the mid 1980s as average fuel oil and natural gas prices decreased. Since the late 1990s, average fuel oil and natural gas price have increased but residential wood energy use continued to decline until the early 2000s and has since increased slowly. The continued decline in residential is likely related to a number of factors including improved efficiency of natural gas furnaces, improved efficiency of wood stoves and furnaces, and increased prices for wood fuel. Going forward, residential wood energy consumption will continue to be influenced by residential heating demand (which may be moderated by efficiency improvements), greater use of more efficient wood pellet furnaces, increases in price for key alternate fossil fuels, such as natural gas, fuel oil, and propane (in rural areas).

Electric Power Wood Energy Consumption

One driver of expansion of electric power production since the early 1990s (Fig. 38) has been the decrease in the price for wood feedstocks (Fig. 40). The comparison of feedstock prices in Figure 40 is per Btu contained in the feedstock. Other influences on the price for electric power from biomass or fossil fuel include the efficiency to convert the feedstock to electricity and the capital and operating costs for a plant. Wood has a lower conversion efficiency than coal and natural gas in similar power plants. Going forward, wood electric power production will also be influenced by incentives or regulations that support electric power production such as renewable portfolio standards of states. By December 2010, 46 states had renewable energy portfolio standards that can be met by many forms of renewable energy including wind, solar, geothermal, and biomass (DSIRE 2010). The degree to which wood-based electric power may expand to meet state targets will also depend on wood plant costs compared with costs for plants using other types of renewable energy.

Wood Pellet Consumption, Trade, and Production

The primary driver of wood pellet fuel consumption in the United States has been for residential heating in pellet stoves and furnaces. The estimated number of stoves or furnaces in use has increased from 163,000 in 2000 to 814,000 in 2008 (Spelter and Toth 2009). In 2010, the number may have been 1 million units. With an estimated average use of 2 metric tons of pellets per unit, consumption in 2008 was about 1.6 million metric tons and may be about 2 million for 2010. Use of pellets is more expensive than use of round logs per Btu of wood input to stoves and furnaces but comes with benefits including easy-to-handle bags of pellets and easy feeding of pellets into the stove or furnace. The high cost per Btu of pellet input can be offset to some degree by relatively high conversion efficiency of pellets to heat compared with conversion of roundwood to heat. In 2008, about 84% of pellets were made from wood residues, primarily sawmill residue. But the fraction of pellets made from roundwood (logs or chips), about 16% in 2008, has been increasing as sawmill production declined since 2008 and demand for pellets for domestic use and for export has increased.

Since 2006, demand for pellets for export to Europe has increased sharply. In 2008, an estimated 20% of U.S. production was exported to Europe and total U.S. pellet capacity has increased from less than 2 million metric tons in 2006 to more than 4 million tons in 2009. Much of the production from expanded capacity is going to Europe to help meet the objective to produce 20% of its energy needs from renewable fuels by 2020 (Rakos 2008).

In November 2009, an estimated average cost in the United States for bagged pellets was $276 per ton ($304/t) with a range of $176 to $600 per ton (Pirraglia and others 2010). Using 17 million Btu per ton, this is $16.24 per million Btu. This average compares favorably with residential propane price in December 2010, which was about $2.50 per gallon or $27.41 million Btu and residential heating oil at about $3.05 per gallon or $21.97 (USDOE EIA 2011), provided pellet conversion efficiency is at least 60% or 75% as good as for propane and heating oil, respectively. Pellet fuel would also be less expensive than residential electric heat, which has recently been $30 per million Btu, provided it is 54% as efficient as electric heating. But pellets are currently more expensive than residential natural gas where prices that have been below $10.00 per million Btu (Fig. 39). So, currently pellet fuel use could expand in areas where natural gas is not available for home heating.

Demand for industrial pellets could increase in the United States if they are used to co-fire coal power plants. One way for electric utilities to meet state renewable fuel portfolio standards is to co-fire with wood in existing coal plants.

Dry pelletized wood can be pulverized to a particle size that allows injection in pulverized coal boilers. Stoker boilers could use less expensive chipped or chunked wood. The opportunity to use pellets will be limited by their costs. The average price for pellets shipped from the southern United States to Europe in 2010 was about $130 per ton at U.S. ports or about $7.55 per million Btu while price of coal delivered to power plants was $2.26 per million Btu (Sikkema 2011). The opportunity to use wood in pellet or chip form to co-fire with coal is being evaluated extensively (e.g., Abt and others 2010; EPRI 2011).

The outlook for roundwood requirements for pellet production for domestic residential use and for export begins with 1.6 to 2 million metric tons for recent residential use and an additional 2 million metric tons of production capacity for pellet export, or 2.7 to 3.4 × 10^6 m^3 for residential use and up to 3.4 × 10^6 m^3 for export (98 to 121 × 10^6 ft^3). For a total domestic consumption plus export of 6.8 × 10^6 m^3 up to 20% may currently be coming from roundwood (up from 16% in 2008) or 1.4 × 10^6 m^3. This is small in relation to estimated U.S. harvest in 2009 of 346 × 10^6 m^3.

Going forward, residential pellet use could expand for housing that does not have natural gas, pellet use could expand for export to meet European renewable energy targets, and pellet use for electric power production could expand if it is a competitive with other technologies (e.g., wind and solar) that can be used to meet state renewable fuel portfolio standards.

Wood Feedstocks and Pulpwood for Energy–Consumption of Roundwood, Mill Residue and Black Liquor

Data on wood used for energy are limited. The Forest Service estimates amounts from two sources of wood fuel feedstock, roundwood fuelwood harvest and mill residue, used for fuel. Information is also available on total wood energy use from Department of Energy surveys that include using black liquor in pulp mills and any other sources not captured by the Forest Service roundwood fuelwood and mill residue estimates. One small source that is not captured by Forest Service surveys is mill residues from secondary wood products mill (e.g., flooring and furniture) that is used for energy. By deducting roundwood fuelwood and mill residue from the total wood energy consumption, we estimate an amount that includes black liquor and any additional mill residue or roundwood. Included in this "black liquor +" group could be some pulpwood used by electric power plants that have increased wood use from very low levels prior to 1990 to about
20 × 10^6 m^3 in 2009. Electric power plants use mill residue and some roundwood, which could include pulpwood, but data are not available on proportions.

Total consumption of wood for energy was relatively stable between 1950 and the mid 1970s just above 150 × 10^6 m^3 per year (Fig. 41). Over this period, roundwood used for fuelwood ranged from 64 to 30 × 10^6 m^3. Use of mill residue and black liquor ranged from 170 to 142 × 10^6 m^3 wood equivalent. From the mid 1970s to the mid 1980s, roundwood fuelwood and black liquor/residue use both roughly doubled then both declined.

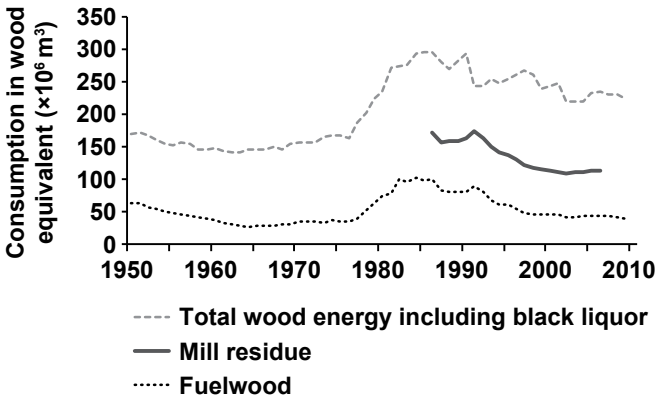

Figure 41. Wood sources used for energy, cumulative.

Since the mid 1980s, roundwood fuelwood has declined steadily while "black liquor +" use increased since 2002. Black liquor use has been supported by a tax credit in the last several years.

The use of mill residue is limited by the total amount of residue generated by production of lumber, panels and pulp and by competition for cleaner residues for use in pulp or panel production. The proportion of residue used for fuel has remained relatively stable between 1986 and 2006 at 40% to 42%.

Going forward, as demand for wood fuel feedstock for energy increases for electric power production or for biofuels, the availability of mill residue will remain limited by lumber, panel, and pulp production, so use of roundwood would increase. This roundwood can come from logging residue currently left on harvest sites or from pulpwood (main stem of pole timber trees). Mill residue use could increase with increasing primary products production or, as wood feedstock prices increase, by drawing away residue from current uses to make pulp or panels.

Overview–Trends in U.S. Output of Wood and Paper Products and Energy and Required Inputs of Wood and Wood Fiber

The demands for wood products and energy production in the U.S. compete for a range of wood and fiber inputs. The purpose of this section is to look at trends in competition among the outputs for inputs and the trends in the inputs used.

The mix of U.S. wood, paper, and energy outputs (production) is shown in Figures 42 and 43 and the mix of wood

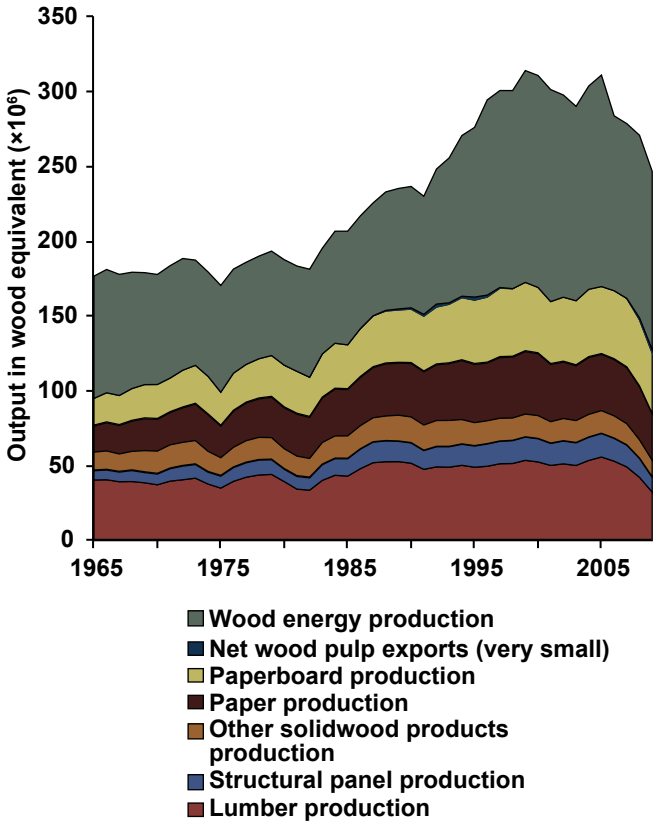

Figure 42 – Outputs of solid wood, paper, and pulp products and energy from U.S. wood, 1965–2009.

and wood fiber inputs is shown in Figures 44 and 45. From these figures we can see general trends. Outputs do not match inputs exactly because of differences among data sources.

Following are the key reasons outputs do not match inputs exactly:

- Outputs include use of wood and bark mill residue for pulp, panels, and energy but do not include wood mill residue that is unused (a small fraction) or is used for miscellaneous uses such as mulch and animal bedding. Inputs include only the part of bark mill residue used for fuel. So the input figure contains some wood and bark mill residue (going to miscellaneous uses) that does not appear in the output figure.
- The estimates for wood energy use are based on US-DOE estimates, and surveys of wood energy users whose estimates of wood use for energy will differ or conflict with Forest Service estimates (Fig. 42 compared with Fig. 44).
- Uncertainty in factors used to convert from original units (board feet, square feet of compressed panel, BTUs of energy) to dry metric tons of wood mean that the absolute levels of outputs and inputs are uncertain but the trends should be accurate.

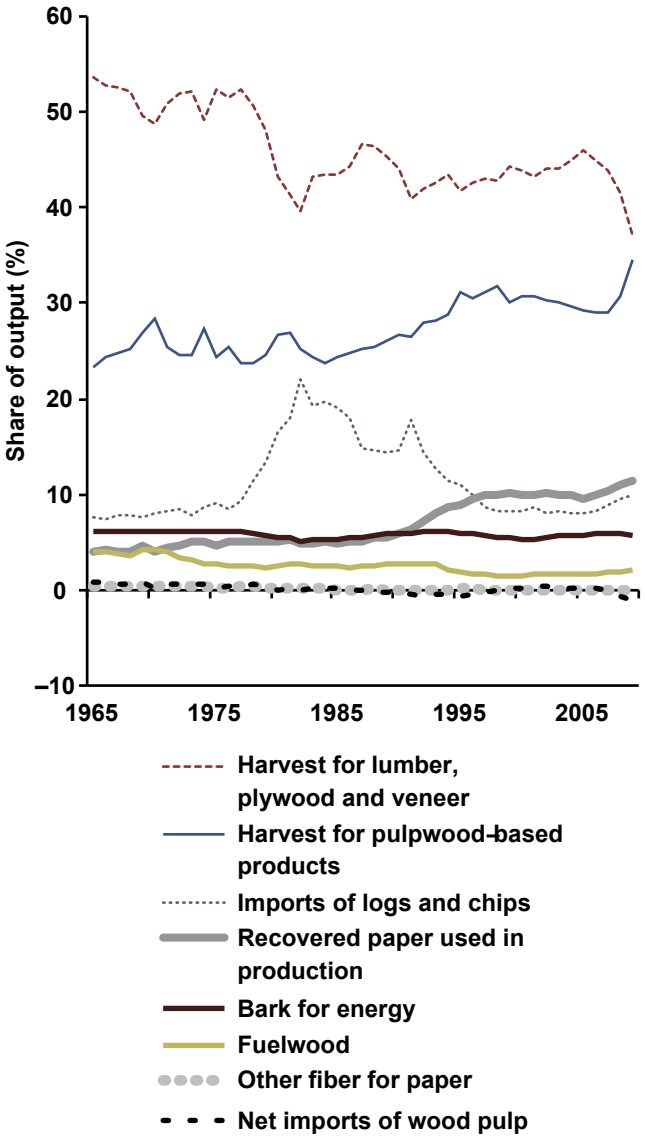

Figure 43 – Solid wood, paper, and pulp production as a share of all non-energy wood products output for the United States, 1965–2009.

Outputs of wood energy grew more rapidly than outputs of solid wood and paper products between the early 1980s and the late 1990s because of increases in both industrial and residential wood energy use (Fig. 39). During the 1990s to 2008, the wood energy share of outputs was about 44% (Fig. 42).

Going forward, certain structural changes could increase wood energy demand and wood energy share above 44% of outputs. These changes could include an increase in the ratio of fossil fuel prices to wood fuel prices, an increase in wood energy conversion efficiencies and costs, and further regulation or incentives favoring wood energy use. Since mill residues and black liquor are already heavily used for energy, substantially increasing wood energy use will require use

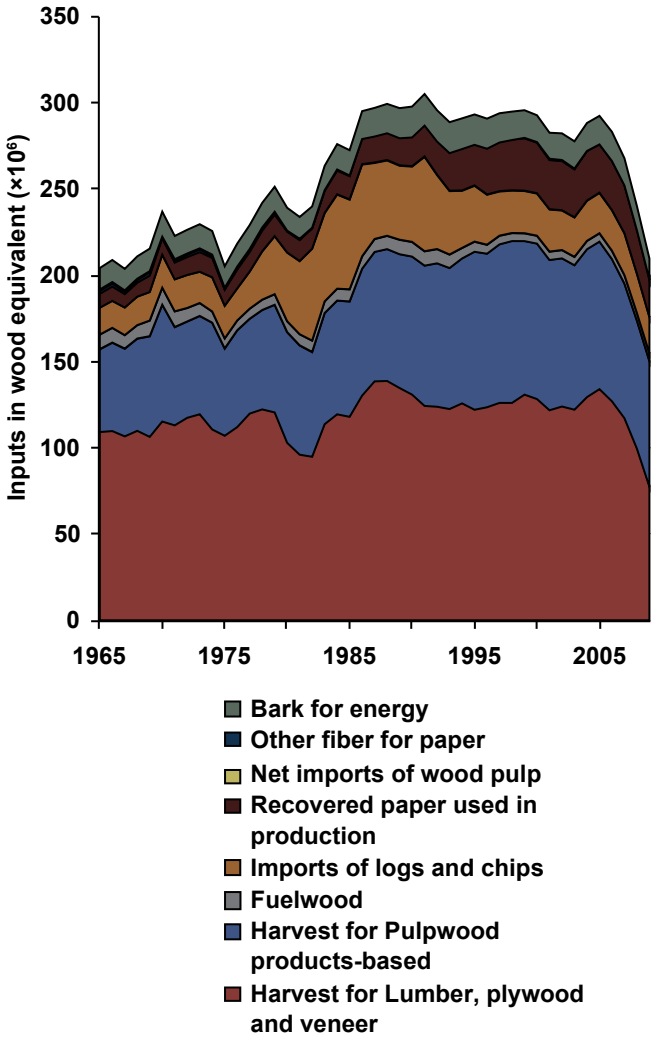

Figure 44. Inputs of wood and wood fiber to produce solid wood, paper, and pulp products and energy, 1965–2009.

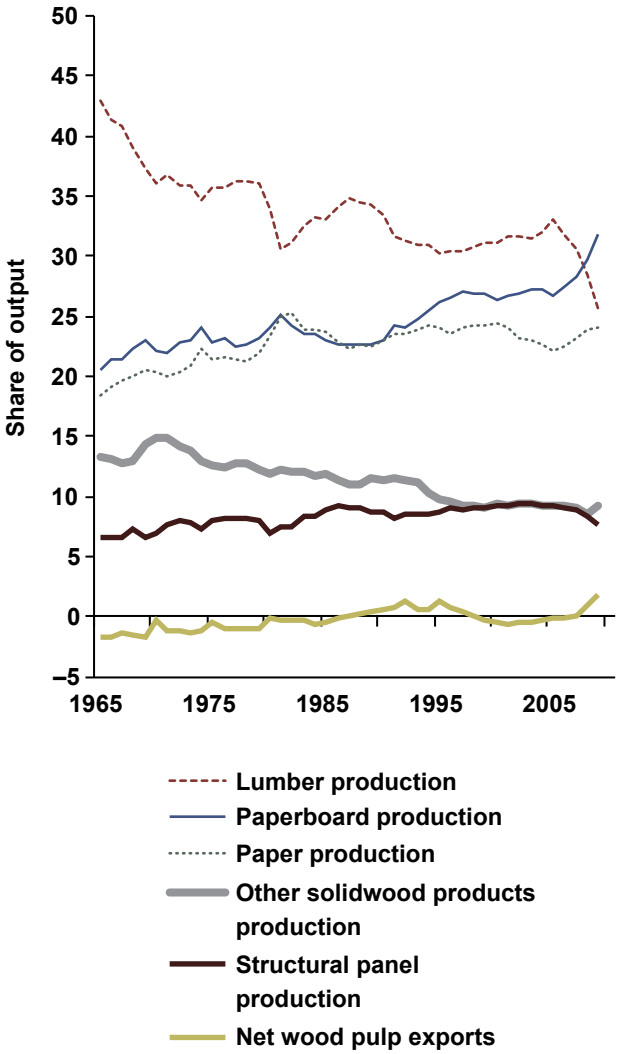

Figure 45. Wood and wood fiber sources as a share of all wood and wood fiber inputs for the United States, 1965–2009.

of logging residue and, with increasing wood energy prices, pulpwood.

For the 56% portion of outputs that are wood and paper products, only the paperboard share has been increasing, from 20% to 32% between 1965 and 2009. The shares of other products has declined and their levels of production have been relatively stable from the late 1980s to 2005 (Figs. 42, 43).

Going forward, solid wood and paper products production could return to prerecession levels when housing starts recover a substantial part of their 70% decline between 2005 and 2009 and GDP growth recovers. Recovery of housing starts may be slow given the number of housing units on the market due to foreclosures and tighter lending conditions. Increase to prerecession levels of production would be supported by continuation of a relatively low dollar exchange rate that would hold down net imports.

Among inputs to make products and energy, domestic sawlog/veneer log harvest has continued to be the major source, totally about 50% of inputs up to 1975. After 1975, this share declined to about 43% as net log imports increased by 10 percentage points to 20% in about 1980. As log import share declined in the early 1980s, pulpwood share and recovered paper share increased and kept sawlog/veneer share at about 43% (Fig. 45).

Going forward, input shares could shift depending on which demand drivers are strongest. A low dollar exchange rate could keep the log import share low. Recovery of housing starts and GDP growth will help maintain sawlog/veneer log harvest and pulpwood harvest. Pulpwood share would be supported with continued substitution of OSB for softwood plywood and an increase in paperboard production. An increase in wood use for energy could add logging residue as

a notable wood input and also increase use of pulpwood size material for energy.

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