

EXAMINATION OF WORLDWIDE HARDWOOD LUMBER PRODUCTION, TRADE, AND APPARENT CONSUMPTION: 1995-2013¹

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Abstract. Worldwide hardwood lumber production fluctuated between 1995 and 2013 and changed considerably with respect to regional market shares. Similarly, worldwide hardwood lumber imports and exports have been constantly changing. Understanding these changes is important because collectively, they define the hardwood lumber consumption of a region or country. In 1995, North America accounted for 25% of worldwide hardwood lumber production whereas East Asia and Oceania (EAO) produced 26%. In the current century, a decline in production in the United States and increased production in China and Vietnam resulted in the EAO region accounting for more than 48% of worldwide hardwood lumber production in 2013. Much of the international trade of hardwood lumber is carried out by EAO and European countries and is intraregional among countries within these regions. Hardwood lumber consumption generally has been moderately to poorly correlated with population at the country level since 1995 and uncorrelated with gross domestic product. However, several other factors also appear to affect current consumption including loss or gain of secondary hardwood industries, age of the population, urbanization, and in recent years, slow economic growth in countries with high per capita gross national product.

Keywords: International hardwood consumption, hardwood exports, hardwood imports.

INTRODUCTION

Hardwood lumber is a product manufactured from the woody portion of dicotyledonous angiosperm trees. Traditionally, hardwood lumber has been associated with material used in the production of furniture, millwork, cabinetry, flooring, and other appearance-based applications. However, it is also used in the production of crossties, pallets, and other industrial products (Sinclair 1992). It also can be used for building construc-

tion in regions in which there is little or no coniferous lumber available. Hardwoods with commercial value grow in all continents of the world (with the exception of Antarctica) and in both temperate and tropical regions of these continents (Bumgardner et al 2014). However, there appears to have been considerable variations in the amount of lumber produced, traded, and ultimately consumed by these regions during the past 20 yr.

It is important for manufacturers and researchers to keep abreast of changes in international hardwood markets. For example, in recent years, exports have become the single-most important market for US hardwood lumber (Luppold

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and Bumgardner 2013). Furthermore, lumber that is exported and imported often has a higher average value than lumber produced and consumed locally (especially when longer distances are involved). Ultimately, hardwood lumber production, importation, and exportation of a region define its consumption (Gregory 1972). At the household level, theory suggests that consumption increases with increased wealth (Boyes and Melvin 1991). Also, greater wealth within a country can lead to greater per capita consumption of raw materials (Randall 1987), such as hardwood lumber. Although it appears obvious, based on derived demand for raw materials (Randall 1987), that increased (or decreased) consumption of secondary wood products would increase (or decrease) demand for hardwood lumber globally, relative comparative advantages among countries and/or world regions means such impacts might not be uniform (Bressler and King 1970).

The objective of this study was to examine worldwide trends and variations in hardwood lumber production, importation, exportation, and ultimately consumption, on a regional basis. This analysis also will examine the major countries involved and determine if there have been changes in the rankings of these countries on these four measures. This study will place additional focus on regional changes in trade, ie hardwood lumber exports and imports relative to lumber production and consumption. The analysis is concluded by examining the impact of population and per capita gross domestic product (GDP) on hardwood lumber consumption for major consuming countries, as the other factors studied (production, imports, and exports) ultimately define consumption.

One area of the world in which hardwood lumber is produced is the former Union of Soviet Socialist Republics (USSR) and the countries in the former Eastern Bloc. The countries in these areas underwent considerable political change after 1991 including the dissolution of the USSR, the separation of the former Czechoslovakia into the Czech Republic and Slovakia in 1993, and the Croatian and

Bosnian wars that ended in 1995. Because of these events, it was decided to begin the analysis in 1995 and continue the analysis through 2013, the last year for which data were available.

METHODS

Worldwide hardwood lumber production varied considerably between 1995 and 2013, but there were three major turning points (Fig 1) that impacted the methods used in this study. Hardwood lumber production decreased by 19% between 1995 and 2002 but increased by 17% between 2002 and 2007. The worldwide recession, which started in December 2007 in the United States, caused production to decrease by 10%, but production expanded again after 2009 and reached 2007 levels by 2013. Because of these major turning points, this analysis will focus on five years: 1995, 2002, 2007, 2009, and 2013.

For the analyses, data from the United Nations, Food and Agricultural Organization (UN FAO 2014a, 2014b) for production, importation, and exportation of hardwood lumber were used. Apparent hardwood lumber consumption (hereafter termed consumption) was estimated by adding imports to production then subtracting exports. A similar procedure but also factoring in changes in stocks or inventories (not available for this study) has been used in other studies (Gregory 1972). The specific regions for which these variables were examined are shown in Fig 2 and are termed Africa; East Asia and

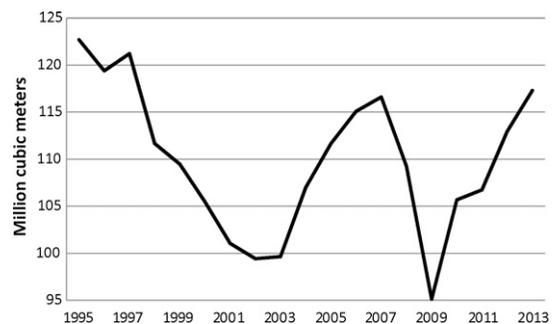


Figure 1. Worldwide hardwood lumber production 1995-2013 (UN FAO 2014a).



Figure 2. World regions analyzed in the study.

Oceania (EAO); North America; Latin America (South America, Central America, and the Caribbean); Europe; and Russia, Central and South Asia, and the Middle East (RCSAME). For the country-level analysis, 12 countries with the greatest hardwood consumption, representing the five most important consuming regions, were examined.

Lastly, the country-level associations of population and GDP with hardwood lumber consumption were analyzed for the years 1995, 2002, and 2013 by calculating rank (Spearman) correlation coefficients. These years were chosen to correspond with the beginning point, the end point, and the first major turning point of the period examined, as previously discussed (thus 2007 and 2009 were not included). Rank correlation, a nonparametric method applying the formula for linear correlation to within-series data ranks rather than the data values themselves (Ott 1993), was used because of outliers and high variability within many of the data series. For example, the population and consumption data contained extreme outliers (defined as three times the interquartile range plus the 75% quartile; Ott

1993), and the per capita consumption data also contained an extreme outlier. For convenience, descriptive bounds for the correlation coefficients were defined as follows: highly correlated data were deemed to be $r_s = 0.85$ or greater, moderately correlated data were considered $r_s = 0.70-0.84$, poorly correlated data were from $r_s = 0.50-0.69$, and $r_s < 0.50$ was considered uncorrelated data (Luppold et al 2014). These bounds aid in discussion of the results because no probabilities were associated with the correlation coefficients (they were not derived from a random sample).

RESULTS AND DISCUSSION

Regional Analysis of Hardwood Lumber Production, Imports, Exports, and Consumption

Production. In 1995, more than 50% of the hardwood lumber produced worldwide was manufactured in North America and EAO (Table 1). RCSAME accounted for an additional 18% of worldwide production, whereas combined European and Latin American production

Table 1. Percentage market share of hardwood lumber production, imports, exports, and consumption by geographical region in 1995, 2002, 2007, 2009, and 2013^a with ranks in parentheses (UN FAO 2014a).

Quantity	Region	Year				
		1995	2002	2007	2009	2013
		Percentage (rank)				
Production	Africa	4.5 (6)	5.2 (6)	4.7 (6)	6.1 (6)	5.7 (6)
	EAO	25.5 (1)	21.2 (2)	31.9 (1)	40.4 (1)	48.3 (1)
	North America	24.9 (2)	29.9 (1)	23.4 (2)	16.7 (2)	17.0 (2)
	Latin America	15.5 (4)	19.1 (3)	17.1 (3)	14.3 (3)	9.9 (3)
	Europe	11.3 (5)	14.3 (4)	12.2 (4)	11.0 (5)	9.3 (5)
	RCSAME	18.3 (3)	10.3 (5)	10.5 (5)	11.6 (4)	9.8 (4)
Imports	Africa	4.9 (4)	3.9 (5)	5.9 (5)	7.8 (4)	7.4 (4)
	EAO	44.8 (1)	42.1 (1)	36.3 (2)	47.9 (1)	54.7 (1)
	North America	9.0 (3)	14.8 (3)	12.3 (3)	8.3 (3)	10.3 (3)
	Latin America	3.9 (5)	1.3 (6)	1.6 (6)	1.6 (6)	1.2 (6)
	Europe	34.0 (2)	32.6 (2)	37.6 (1)	27.8 (2)	19.2 (2)
	RCSAME	3.3 (6)	5.2 (4)	6.2 (4)	6.6 (5)	7.2 (5)
Exports	Africa	7.4 (5)	6.6 (5)	7.8 (5)	8.7 (5)	9.7 (4)
	EAO	36.4 (1)	39.8 (1)	33.8 (1)	38.5 (1)	36.6 (1)
	North America	18.8 (3)	18.5 (3)	14.8 (3)	13.5 (3)	19.3 (3)
	Latin America	13.5 (4)	8.4 (4)	10.4 (4)	8.8 (4)	4.8 (5)
	Europe	21.0 (2)	24.1 (2)	30.7 (2)	27.0 (2)	25.4 (2)
	RCSAME	2.8 (6)	2.5 (6)	2.6 (6)	3.5 (6)	4.3 (6)
Consumption	Africa	4.2 (6)	4.5 (6)	4.3 (6)	5.9 (6)	5.4 (6)
	EAO	27.0 (1)	22.1 (2)	32.5 (1)	42.0 (1)	51.4 (1)
	North America	23.3 (2)	28.8 (1)	22.9 (2)	15.9 (2)	15.4 (2)
	Latin America	13.9 (4)	17.2 (3)	15.3 (3)	13.1 (3)	9.1 (4)
	Europe	13.5 (5)	16.6 (4)	13.7 (4)	11.0 (5)	8.4 (5)
	RCSAME	18.1 (3)	10.8 (5)	11.3 (5)	12.1 (4)	10.3 (3)

^a May not add up to 100% because of rounding error.

accounted for another 27%. Reported hardwood lumber production in Africa was a relatively modest 5.6 million m³ in 1995 (UN FAO 2014a), which was equivalent to 19% of US production that year.

The decline in worldwide hardwood lumber production between 1995 and 2002 was confined mostly to the EAO and RCSAME regions. Conversely, the increase in hardwood lumber production between 2002 and 2007 was largely the result of a 76% increase in the EAO region and a 20% increase in the RCSAME region (UN FAO 2014a). Hardwood lumber production in the other regions was relatively steady between 2002 and 2007, except for North America, in which production decreased by 7%. In 2007, nearly a third of the hardwood lumber produced worldwide was from EAO (Table 1). East Asian production accounted for 95% of the overall EAO volume.

The worldwide decline in hardwood lumber production between 2007 and 2009 was the result of a large decline in North American, Latin American, and European production (UN FAO 2014a). By contrast, lumber production in EAO and Africa modestly increased during this period. Hardwood lumber production increased in Africa, EAO, North America, and RCSAME between 2009 and 2013, with the greatest increase occurring in the EAO region. In contrast, production in Latin America decreased during this period. By 2013, more than 48% of worldwide lumber production was from the EAO region (Table 1), and 98% of EAO production occurred in East Asia.

Imports. The regions with the greatest volume of hardwood lumber imports in 1995 were Europe and EAO (Table 1). Imports into EAO and European regions continued to remain relatively high in 2002, 2007, and 2009, whereas imports by Africa, Latin America, and RCSAME

remained low. Between 2009 and 2013, lumber imports by countries in EAO increased relative to other regions, although the percentages listed in Table 1 could be misleading. In 2011, Thailand imported large quantities of lumber from other East Asian countries and exported large quantities to China (UN FAO 2014b), suggesting the potential of reexport from Thailand (China as identified in this study includes mainland China and the special administrative regions of Hong Kong and Macao. Although no hardwood lumber production is reported for Macao, it does import and consume hardwood lumber). Similarly in Europe, Belgium exported 50% more lumber than it produced in 2013 and imported twice as much lumber than it produced in that year.

Exports. The region with the greatest hardwood lumber export volume in 1995 was EAO (Table 1). Europe and North America were the second- and third-most important export regions, respectively. Latin America also exported a relatively large volume of lumber in 1995, whereas Africa accounted for 7.4% of worldwide exports. Exports for RCSAME were small in 1995, and 91% of these exports originated from Russia.

Although worldwide hardwood lumber production declined between 1995 and 2002, exports increased in all regions except Latin America (UN FAO 2014a). EAO maintained its top position, and all other regional rankings remained the same (Table 1). Worldwide exports peaked in 2004 (Fig 3), then started to decline, resulting in exports in 2007 that were nearly iden-

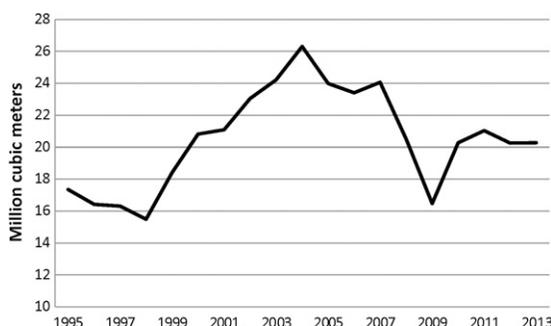


Figure 3. Worldwide hardwood lumber exports 1995-2013 (UN FAO 2014a).

tical to 2002. The decrease in exports was primarily the result of decreased shipments by EAO and North America, whereas exports by Europe and Africa increased. Worldwide exports continued to decline until reaching 1997 levels in 2009. These declines occurred in all regions, but regional ranking remained unchanged. Exports increased in all regions other than Latin America between 2009 and 2013, but the greatest increases were in North America and EAO.

Historically, most hardwood lumber exported by EAO, North America, and Europe was intra-regional (ie going to other countries within the region), whereas exports from Latin America, Africa, and RCSAME went to countries outside of these regions (UN FAO 2014b). For instance, in 2007, 75% of European exports went to other European countries, whereas 64% of African exports also went to European countries. One trade flow that has changed is exports from the United States. In 2000, 72% of exports from the United States went to Canada, Europe, and Mexico with Canada being the largest market (USDA FAS 2014). In 2013, 61% of exports from the United States went to EAO, and China was the largest export market with a 43% market share.

Consumption. In 1995, EAO and North America combined accounted for more than 50% of worldwide hardwood lumber consumption (Table 1). RCSAME was the third-most important consumption region whereas Latin America and Europe were the fourth- and fifth-most important consumption regions, respectively. Between 1995 and 2002, worldwide consumption declined by 19%, but most of this decline was limited to RCSAME and EAO whereas consumption in Europe, North America, and Latin America remained virtually unchanged (UN FAO 2014a). As a result, North America displaced EAO as the largest hardwood-consuming region, and RCSAME declined from the third-most important consuming region to the fifth-most important region.

Between 2002 and 2007, worldwide hardwood lumber consumption increased by 15%, primarily

as a result of increased consumption in EAO (UN FAO 2014a). During this period, consumption in Europe, North America, and South America decreased slightly, and as a result, EAO displaced North America as the most important hardwood-consuming region (Table 1). After 2007, the great recession decreased hardwood lumber consumption, especially in North America, Europe, and Latin America. As a result, regional rankings changed again with EAO accounting for 42% of worldwide hardwood lumber consumption followed by North America, Latin America, RCSAME, Europe, and Africa. Between 2009 and 2013, worldwide consumption of hardwood lumber increased by 20%, but most of this increase was confined to EAO and North America, in which consumption increased by 54% and 22%, respectively. Consumption in RCSAME and Africa also increased, whereas European and Latin American consumption decreased. These changes caused regional rankings for Latin America and RCSAME to change and resulted in EAO accounting for more than 50% of worldwide hardwood lumber consumption in 2013.

Major Hardwood Lumber Producing, Importing, Exporting, and Consuming Countries

Production. In 1995, the United States accounted for nearly 24% of the hardwood lumber produced worldwide (Table 2). Other major lumber producers were India, Brazil, China, and Malaysia. Between 1995 and 2002, worldwide hardwood lumber production declined with the greatest declines occurring in India, China, and Malaysia, whereas Indonesian and Brazilian production remained relatively constant (UN FAO 2014a). The 77% decline in Indian hardwood lumber production during this period (UN FAO 2014a) appears to be the result of a ban on most logging that was instituted in the late 1990s to stop serious depletion of the country's forest resources (Rattan 1999). As a result, there was a reordering of the major hardwood-producing countries other than the United States.

Worldwide hardwood lumber production surged in the mid-2000s as a result of a 370% increase in production in China and a 41% increase in production in India between 2002 and 2007

Table 2. Top five hardwood lumber producers, importers, exporters, and consumers in 1995, 2002, 2007, 2009, and 2013 with percentage market share in parentheses (UN FAO 2014a).

Quantity	Rank	Year				
		1995	2002	2007	2009	2013
Production	1	U.S. (23.9)	U.S. (27.9)	U.S. (22.0)	China (19.7)	China (30.9)
	2	India (12.2)	Brazil (14.3)	China (14.1)	U.S. (15.5)	U.S. (15.5)
	3	Brazil (10.8)	Indonesia (6.3)	Brazil (12.7)	Brazil (8.8)	Vietnam (5.1)
	4	China (8.1)	Malaysia (4.7)	Malaysia (4.3)	Vietnam (5.3)	Brazil (5.1)
	5	Malaysia (6.7)	China (3.5)	India (4.2)	India (5.1)	India (4.2)
Imports	1	Thailand (10.1)	China (21.6)	China (16.4)	China (23.3)	China (33.3)
	2	Italy (9.1)	Italy (7.7)	Thailand (7.8)	Thailand (9.9)	Thailand (10.3)
	3	Japan (9.0)	Thailand (7.2)	Italy (6.6)	Italy (5.6)	U.S. (3.8)
	4	Taiwan (7.1)	U.S. (7.0)	U.S. (5.1)	Malaysia (4.6)	Egypt (3.6)
	5	China (5.9)	Canada (4.4)	Canada (4.6)	Egypt (3.8)	Mexico (3.5)
Exports	1	Malaysia (23.9)	U.S. (12.5)	U.S. (11.4)	Malaysia (13.6)	U.S. (17.0)
	2	U.S. (14.4)	Indonesia (11.8)	Thailand (10.8)	Thailand (12.4)	Thailand (14.5)
	3	Brazil (8.8)	Malaysia (10.9)	Malaysia (10.3)	U.S. (11.5)	Malaysia (10.1)
	4	China (4.7)	Thailand (6.8)	Brazil (7.1)	Romania (4.0)	Indonesia (6.0)
	5	France (4.5)	China (6.6)	Germany (4.3)	Indonesia (3.8)	Russia (3.7)
Consumption	1	U.S. (22.1)	U.S. (26.3)	U.S. (20.6)	China (23.2)	China (36.3)
	2	India (12.0)	U.S. (12.7)	China (16.9)	U.S. (14.1)	U.S. (13.1)
	3	Brazil (9.7)	China (7.3)	Brazil (11.3)	Brazil (8.3)	Vietnam (5.5)
	4	China (8.3)	Indonesia (3.5)	India (4.2)	Vietnam (5.7)	Brazil (4.7)
	5	Indonesia (4.9)	India (3.5)	Vietnam (3.9)	India (5.2)	India (4.3)

(UN FAO 2014a). During this period, Malaysian hardwood lumber production increased by 9%, but Indonesian production decreased by 30%. This again shifted the rankings of the most important hardwood lumber producing countries in 2007, but the United States remained the most important producer.

Between 2007 and 2009, hardwood lumber production in China and Vietnam increased by 14% and 11%, respectively, whereas production in the United States and Brazil decreased by 35% and 40%, respectively (UN FAO 2014a). This caused a major shift in the rankings of hardwood-producing countries as China became the largest producer and the United States dropped to second place (Table 2). Vietnam replaced Malaysia as the fourth-largest hardwood lumber producer, whereas India remained in fifth place. Between 2009 and 2013 Chinese hardwood lumber production surged by 93%, US production increased by 23%, and Brazilian production continued to decline. As a result, the United States remained in second place but China's proportion of worldwide hardwood lumber production increased to more than 30%.

Imports. In 1995, Thailand was the largest importer of hardwood lumber followed closely by Italy and Japan (Table 2). Between 1995 and 2002, hardwood imports by China increased by nearly 370% as the wood furniture industry moved from Taiwan to mainland China (Luppold and Bumgardner 2011). Imports by the United States increased by 150%, whereas imports by Canada increased by 16%, which was the result of increased trade between these two countries. By contrast, imports by Japan and Thailand decreased by 51% and 8%, respectively. This resulted in China becoming the largest hardwood lumber importer, Japan falling out of the top five importers, Thailand becoming the third-most important importer, and the United States and Canada moving to the fourth and fifth positions, respectively.

Although worldwide hardwood lumber import volumes in 2007 were slightly lower than that in 2002 (UN FAO 2014a), China, Italy, and the

United States decreased imports and Thailand increased imports, resulting in a reranking in 2007 (Table 2). Imports declined for most countries between 2007 and 2009, and the greatest decline occurred in the United States (57%). By contrast, imports by Malaysia increased making this country the fourth-most important importer. Worldwide imports increased between 2009 and 2013, led by a 95% increase in China. Thailand maintained its second ranking whereas Egypt and Mexico moved into the top five. Egypt started to increase imports from Romania and Croatia in the late 2000s whereas Mexico sourced lumber from North America and Latin America.

Exports. In 1997, Malaysia was the greatest exporter of hardwood lumber and the bulk of these exports went to other EAO countries (the first year that data on exports to individual countries were available is 1997; in that year, more than 80% of Malaysian exports went to other EAO destinations). The other major exporters in 1997 were the United States, Brazil, China, and France (Table 2). Between 1995 and 2002, US exports increased by 15% and Indonesian exports increased by 300%, whereas exports from Thailand increased by more than 3000% (UN FAO 2014a). Most of the lumber exports from Thailand appear to be imported from other countries in the region, because exports were six times higher than production in 2002. By contrast, exports from Malaysia declined sharply. Between 2002 and 2007, exports from China declined sharply whereas exports from the United States, Indonesia, and Malaysia declined slightly. In contrast, exports from Thailand, Brazil, and Germany increased. As a result, the top five exporters in 2007 were the United States, Thailand, Malaysia, Brazil, and Germany.

In the recessionary period of 2007-2009, hardwood lumber exports by Brazil, Germany, the United States, Thailand, and Malaysia decreased by 66%, 49%, 31%, 2%, and 9%, respectively (UN FAO 2014a). Romania experienced a 7% decline in hardwood lumber exports, but all other major exporting countries had larger declines, making Romania fourth in the rankings in 2009. Between 2009 and 2013, exports from Malaysia

declined by 9% whereas exports from the United States, Thailand, Indonesia, and Russia increased, which again changed the rankings of the major exporting countries.

Consumption. The major hardwood-consuming countries in 1995 were the United States, India, Brazil, China, and Indonesia (Table 2). These countries also are the world's most populous (Knoema 2014). Between 1995 and 2002, hardwood lumber consumption in India declined by 76%, which parallels the 77% decline in Indian hardwood lumber production during this period (UN FAO 2014a). Consumption declined by smaller amounts in most other large consuming countries other than Brazil, in which consumption increased by 6%. Chinese hardwood lumber consumption surged by 168% between 2002 and 2007, whereas Vietnamese consumption increased by 68%. These increases were, in part, the result of increased furniture production and exports to the United States during this period, especially for Vietnam (Luppold and Bumgardner 2011).

Between 2007 and 2009, hardwood lumber consumption in the United States and Brazil declined by 45% and 41%, respectively (UN FAO 2014a). By contrast, consumption in China and Vietnam increased during this period, whereas consumption in India remained nearly constant. As a result, the United States fell to the second-largest consumer in 2009. Between 2009 and 2013, consumption in Vietnam increased by 22%, whereas Brazil consumption declined by 29%, which again changed the consumption rankings of these countries. Chinese consumption continued to increase between 2009 and 2013, and China accounted for more than 36% of worldwide consumption in 2013.

Exports as Percentage of Production and Imports as Percentage of Consumption

The importance of international trade for the six regions of the world can be examined in terms of hardwood lumber exports as a percentage of production and imports as a percentage of consumption. The more dependent on exports a region is, the higher the percentage of hard-

wood lumber exports relative to production. Similarly, the more dependent on imports a region is, the higher the percentages of hardwood lumber imports relative to consumption.

Exports have been growing as a proportion of African production, steadily increasing between 1995 and 2007, then decreasing between 2007 and 2009, and then increasing again between 2009 and 2013 (Table 3). Most African exports originate from the tropical sub-Saharan portion of this region. The Ivory Coast, Cameroon, and Gabon were the most important exporters in 1995 (UN FAO 2014a). EAO exports grew as a percentage of production between 1995 and 2002, primarily as a result of intraregional trade. China was the most important export market in 2002 (UN FAO 2014b). Since 2002, exports have declined relative to hardwood lumber production because China increased production by more than 10-fold between 2002 and 2013 (UN FAO 2014a). Exports as a percentage of production have been increasing in North America. In 1997, most North American exports were either intraregional or to Europe. By 2011, nearly 55% of North American exports went to EAO, and China was the largest EAO market.

Since 1995, Latin American exports have declined as a percentage of production because exports from Brazil have declined (Table 3; UN FAO 2014a). By contrast, exports have increased relative to production in Europe and exceeded 47% in 2013. Much of the increase in European exports during this period was a result of expansion of the European Union, which boosted intraregional trade in Europe. The region with the lowest level

Table 3. Exports as a percentage of production by world region for 1995, 2002, 2007, 2009, and 2013.

Region	Year				
	1995	2002	2007	2009	2013
Africa	23.2	29.7	34.0	24.7	29.1
EAO	20.2	43.6	21.8	16.5	13.1
North America	10.7	14.4	13.0	14.0	19.7
Latin America	12.4	10.2	12.5	10.7	8.4
Europe	26.3	39.1	51.7	42.6	47.3
RCSAME	2.2	5.7	5.1	5.2	7.5

Table 4. Imports as a percentage of consumption by world region for 1995, 2002, 2007, 2009, and 2013.

Region	Year				
	1995	2002	2007	2009	2013
Africa	18.4	21.2	28.3	22.4	25.3
EAO	25.8	46.9	23.2	19.3	19.6
North America	6.1	12.7	11.1	8.9	12.3
Latin America	4.4	1.9	2.2	2.0	2.4
Europe	39.3	48.5	56.9	42.7	42.3
RCSAME	2.8	11.7	11.4	9.2	12.8

of exports relative to production from 1995 to 2009 was RCSAME. The major hardwood-producing country in this region is India, which does not export much of its production. The growth of exports from this region in 2013 was primarily the result of increased exports by Russia.

Although most hardwood lumber production in Africa occurs in the tropical sub-Saharan portion of the continent, most lumber imported by Africa is by Saharan countries, especially Egypt (UN FAO 2014a). Since 1995, African imports have increased relative to consumption (Table 4). Imports as a percentage of consumption increased rapidly for the EAO region between 1995 and 2002 with China accounting for nearly 46% of these imports in 2002. Between 2002 and 2013 EAO imports accounted for about 20% of consumption with China accounting for most of these imports. Imports by North America increased as

a percentage of consumption between 1995 and 2002. Most of this increase was the result of intraregional trade.

Since 2002, Latin America has consistently had the lowest level of imports relative to consumption, usually less than 3% (Table 4). By contrast, Europe has the highest level of imports relative to consumption, but most of these imports have been intraregional (UN FAO 2014b). Imports as a percentage of consumption by countries in RCSAME have been trending upward, mainly as a result of imports by Middle Eastern countries and India.

Population and GDP Impacts on Hardwood Lumber Consumption

It might be expected that greater population and wealth within a country would lead to more hardwood lumber consumption. However, information presented in Tables 5 and 6 suggests that other factors must also be considered. An examination of Table 5 indicates that population and consumption generally have been moderately to poorly correlated since 1995, ranging from $r_s = 0.73$ in 1995 to $r_s = 0.57$ in 2002. An examination of Table 6 indicates that per capita GDP and volume consumed per million people were uncorrelated in 1995 ($r_s = 0.47$), 2002 ($r_s = 0.36$), and 2013 ($r_s = -0.22$).

Table 5. Population and consumption of hardwood lumber for major hardwood-consuming countries in 1995, 2002, and 2013 (Knoema 2014; UN FAO 2014a) and results of correlation analysis.^a

Country	Year			Year		
	1995	2002	2013	1995	2002	2013
	Population in millions			Consumption in thousand m ³		
United States	266	288	316	27,547	26,595	15,556
India	956	1077	1252	14,945	3522	5139
Brazil	162	179	200	12,154	12,865	5601
China	1205	1280	1358	10,298	7356	43,200
Indonesia	194	215	250	6157	3548	3069
Malaysia	21	24	30	4479	2825	2138
Russia	148	145	143	3543	1895	1571
Japan	125	127	127	2846	1275	360
France	60	62	66	2781	2276	1274
Germany	82	82	81	1568	1235	876
Italy	57	57	60	2748	2666	1076
Vietnam	72	80	90	1579	2738	6520

^a Spearman's correlation coefficients between population and consumption are 0.73 for 1995, 0.57 for 2002, and 0.65 for 2013.

Table 6. Per capita GDP (purchasing power parity (PPP) based dollars)^a and cubic meters of hardwood lumber consumed per million people for major hardwood-consuming countries in 1995, 2002, and 2013 (Knoema 2014; UN FAO 2014a) and results of correlation analysis.^b

Country	Year			Year		
	1995	2002	2013	1995	2002	2013
	Per capita GDP			m ³ consumed per thousand people		
United States	28,763	38,123	53,101	103.6	92.3	49.2
India	1176	1706	4077	15.2	3.3	4.1
Brazil	6487	7575	12,221	75.0	71.9	28.0
China	1517	2884	9844	8.5	5.7	31.8
Indonesia	2303	2660	5214	31.7	16.5	12.3
Malaysia	7547	9515	17,748	213.3	117.7	71.9
Russia	6439	8839	17,884	23.9	13.1	11.0
Japan	22,955	26,749	36,899	22.8	10.0	2.8
France	21,402	27,451	35,784	46.4	36.7	19.3
Germany	22,044	27,475	40,007	19.1	15.1	10.9
Italy	20,279	26,228	30,289	48.2	46.8	18.0
Vietnam	1102	1651	4012	21.9	34.2	109.0

^a GDP converted to international dollars using PPP rates (Callen 2014) and divided by total population.

^b Spearman's correlation coefficients between per capita GDP and cubic meters consumed per thousand people are 0.47 for 1995, 0.36 for 2002, and -0.22 for 2013.

The volume consumed per million people shown in Table 6 is probably the most interesting measure in that it shows different trends for individual countries. In the United States, India, Brazil, Indonesia, Malaysia, Russia, Japan, France, Germany, and Italy, consumption has been trending downward with the greatest decrease occurring in Japan. By contrast, consumption by China and Vietnam has been trending upward, with the greatest increase occurring in Vietnam. Although it is difficult to fully isolate the factors that have influenced these trends, there are some points of discussion.

Between 1995 and 2013, hardwood lumber consumption per million people in the United States declined by more than 50%, but most of this decline occurred after 2002 (Table 6). The cause of this decline was 2-fold: the loss of the furniture manufacturing industry to other regions (mostly EAO) followed by a steep decrease in domestic home construction (Luppold et al 2014). Although a part of the increase in hardwood lumber consumption in China since 2002 can be attributed to increases in furniture production and exports (Luppold and Bumgardner 2011), the 241% increase in per capita GDP since 2002 (Table 6) may be the most important contributor to increased Chinese consumption.

For example, most of the furniture produced in China also is consumed there (about 25% of production was exported in 2009), with a trend of increasing domestic consumption (Shi and Smith 2012).

The decrease in hardwood lumber consumption in Malaysia and Indonesia appears to contradict the increasing size and wealth of the population of these countries but may be the result of urbanization. Both of these countries produce much more hardwood than softwood lumber (UN FAO 2014a) and have had large increases in the percentage of the population living in urban areas (Knoema 2014). Many homes in rural areas of the tropics are made from regional materials, which in the case of Indonesia and Malaysia, probably would include hardwood lumber given that more than 60% of Indonesia's and 67% of Malaysia's land area was forested in 1995 (Knoema 2014). Because populations have shifted to urban areas, construction methods might also be shifting to more nonwood materials.

The decreased use of hardwood lumber in western Europe and Russia is in part attributable to an aging population and, more recently, slow economic growth (Bumgardner et al 2014). The rapid rise in hardwood lumber consumption by

Vietnam since 2002 appears to be heavily influenced by increased furniture production and exports and increased hardwood lumber production (Table 2; Fig 2) in this increasingly forested country (Knoema 2014). In 1995, 32% of the land in Vietnam was classified as forest land, and in 2011, 45% of the land was classified as forest land.

SUMMARY AND CONCLUSION

Hardwood lumber consumption and production was highly variable between 1995 and 2013, as was the source and consuming regions and countries. In 1995, EAO and North America produced 26% and 25% of the world's hardwood lumber, respectively, and consumed similar proportions. The decline in North America's market for secondary hardwood products after 2007 and the increase in EAO production resulted in North America dropping to second place in regional production and the EAO region surging to more than 48% of worldwide production. Similarly, consumption by EAO increased to more than 51% of worldwide consumption.

EAO has also been a major importer of hardwood lumber but has exported lesser amounts. Most of the imports and exports in EAO were intraregional. The region with the second highest levels of hardwood lumber imports and exports was Europe, and most of this trade also was intraregional. Although North American trade historically has been intraregional as well, EAO became the most important export market for this region in 2010 (UN FAO 2014b).

In 1995, Europe had the highest level of exports as a percentage of production as well as imports as a percentage of consumption. Africa also had a high level of exports as a percentage of production and imports as a percentage of consumption. Exports originated in tropical regions of this continent, whereas the importing countries were primarily in North Africa. By 2013, 47% of European production was exported and 42% of European consumption was imported. Africa also became more dependent on import and export trade as a percentage of production

and consumption. By contrast, Latin America was the least dependent on international trade in 2013.

An examination of changes in hardwood lumber consumption indicated that although consumption was moderately to poorly correlated with the population of a country, consumption was uncorrelated with GDP. All major hardwood-consuming countries with high per capita GDP decreased hardwood lumber consumption between 1995 and 2013 for reasons that ranged from decreased production of secondary hardwood products to changing demographics, and in recent years, to slow economic growth. Hardwood lumber consumption also has decreased in Indonesia and Malaysia, but these decreases could be the result of increased urbanization and changing building practices. The two countries that had large increases in hardwood lumber consumption were China and Vietnam. Both of these countries have thriving furniture industries, and in the case of China, this furniture is both exported and consumed domestically.

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