

## CHAPTER 9

# SAWN HARDWOOD CONSUMPTION, PRODUCTION AND TRADE

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### Highlights

- European sawn hardwood consumption rose in 1998 for the second consecutive year signalling the end of the long decline.
- European trade, both imports and exports, was at record volumes.
- North American consumption, production and imports climbed to record levels in 1998.
- Russian sawn hardwood consumption continued to decline.
- Both North American and European exports, which had been constricted by the downturn in Asian demand in 1998, were recovering in mid 1999 with renewed demand from Asia.
- Sawn hardwood export volumes were roughly equal after European exports rose and North American exports fell.
- Flooring markets were strong in both North America and Europe and European production of wine barrels was consuming increasing quantities of white oak.
- Exports of beech sawnwood and logs to Asia drove up prices in Europe.
- North American hardwood prices rose in 1998 and early 1999 as demand outstripped capacity.

### 9.1 Introduction

This chapter will begin by discussing demand as measured by consumption, then analyse its components, i.e. production and trade. Regular readers of the *Review* will find the customary discussion of tropical hardwood markets has been expanded into an individual chapter, number 13.

### 9.2 Consumption

Apparent consumption in Europe rose in 1998 by 5.7%, confirming the Timber Committee's forecast that the long decline in sawn hardwood consumption has ended (table 9.2.1 and graph 9.2.1). The consumption of 17.5 million m<sup>3</sup> brings it back near the 1992 level. A 12.1% rise in imports overcame the 9.9% rise in exports and the remaining demand was met by increased production in Europe.

The increase in European sawn hardwood consumption was especially due to the larger (above 500,000 m<sup>3</sup> per year) consuming countries partial or

full recovery back to former consumption levels: France (up 5.8%), Germany (up 12.5%), Italy (up 6.7%), Portugal (up 4.9%) and Turkey (up 14.5%). It is assumed that Spain's consumption increased considerably, but statistics were not received. Conversely, consumption in the United Kingdom fell by 15.0%, as did Poland (down 17.1%) and Romania (down 2.3%). Full consumption statistics appear in the annex.

In 1998 in North America apparent consumption of sawn hardwood moved up strongly by 6.6% consistent with Timber Committee forecasts. North American production rose by 5.1% and imports increased by 6.0% to meet the domestic demand. Exports fell 5.3%, primarily due to the weakness in most Asian markets. Markets for hardwood have been strong for high-end products such as furniture, flooring, and mouldings, as well as the 40% of consumption which goes to lower-grade usages of pallets, packaging and railroad ties (sleepers). Weakening net trade in the United States, for the second year in a row, aided the rise in consumption.

TABLE 9.2.1

## Sawn hardwood balance in Europe, the Russian Federation and North America, 1994 to 1998

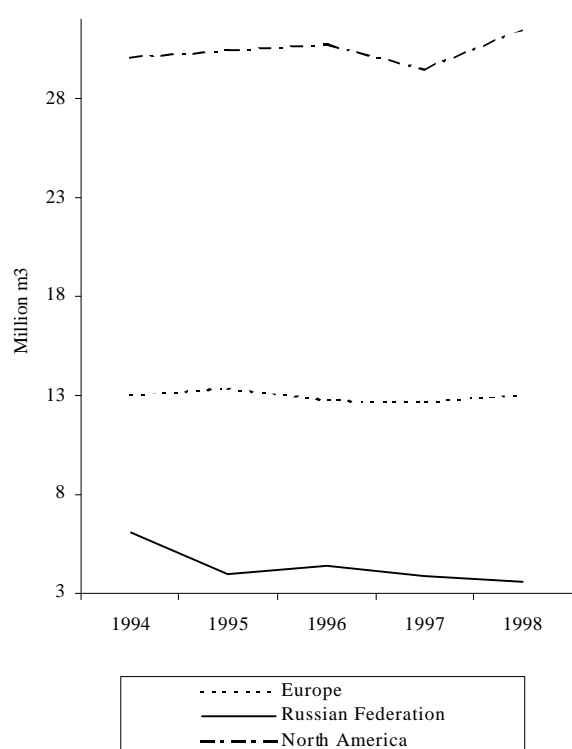
	1994	1995	1996	1997	1998	Timber Committee estimates <sup>a</sup> for 1998 for 1999		
	(million m <sup>3</sup> )							
<b>EUROPE</b>								
Production	13.02	13.40	12.71	12.56	12.95	12.95	13.19	
Imports	6.40	6.66	6.02	7.25	8.12	7.41	7.36	
Exports	3.28	3.21	3.23	3.25	3.57	3.35	3.39	
Net trade b/	-3.12	-3.45	-2.79	-4.00	-4.55	-4.06	-3.97	
Apparent consumption	16.14	16.85	15.50	16.56	17.50	17.01	17.16	
<b>RUSSIAN FEDERATION</b>								
Production	6.08	3.97	4.38	3.92	3.56	3.72	3.92	
Imports	0.01	0.01	0.01	0.05	0.05	0.05	0.05	
Exports	0.07	0.27	0.25	0.25	0.24	0.25	0.25	
Net trade b/	0.06	0.26	0.24	0.20	0.19	0.20	0.20	
Apparent consumption	6.02	3.71	4.14	3.72	3.37	3.52	3.72	
<b>NORTH AMERICA</b>								
Production	30.06	30.44	30.65	31.28	32.89	31.81	33.84	
Imports	1.58	1.59	1.45	2.12	2.25	2.07	2.13	
Exports	3.17	3.26	3.55	3.89	3.68	4.03	4.06	
Net trade b/	1.59	1.67	2.10	1.77	1.43	1.96	1.93	
Apparent consumption	28.47	28.77	28.55	29.51	31.46	29.85	31.91	

<sup>a</sup> At September 1998 session. The Committee's estimates for 1998 and 1999 have been adjusted to make them comparable with the historical (actual) data for 1994-1998.

<sup>b</sup> Negative values are net imports.

GRAPH 9.2.1

## Sawn hardwood consumption, 1994 to 1998



United States hardwood market appears to be undergoing some important changes. Production continued to grow in 1998 but an increasing percentage of consumption is from tropical and Canadian imports (table 9.2.2). Apparent consumption advanced as exports decreased by 13.4% overall, with a larger than average fall to Asian markets.

Russian Federation consumption of sawn hardwood was negatively affected by the mid-1998 economic crisis and continued falling. At 3.4 million m<sup>3</sup>, consumption was about one-third of its 1992 volume. (In 1992 separate statistics became available for some countries in the former USSR. Sawn hardwood consumption may have been higher than in 1992 in Russia during the latter 1980s.) The entire fall in consumption reflects a 9.3% drop in production as trade in sawn hardwood remains stagnant at a very low level.

### 9.3 Production

Sawn hardwood production in Europe rose 3.1% in 1998 to reach 13.0 million m<sup>3</sup>, a volume below all but the most recent two years of the last 34 years (table

TABLE 9.2.2  
**United States hardwood market shares, 1996 to 1998**  
*(1000 m<sup>3</sup>)*

	1996	1997	1997/1996	1998	1997/1998
Consumption	27,476	28,650	4.3%	30,653	7.0%
Exports to					
Europe	455.0	557.1	22.4%	514.6	-7.6%
Canada	264.2	334.2	26.5%	303.6	-9.2%
Asia	692.4	743.6	7.4%	514.4	-30.8%
Imports from					
Canada	543.7	708.5	30.3%	919.8	29.8%
Tropical imports	302.4	315.2	4.2%	354.1	12.3%

*Sources:* TIMBER database and USDA Foreign Agricultural Service.

9.3.1). Until the last two years, the long-term decline was undoubtedly the result of loss of market share as traditional hardwood applications were replaced by softwood, veneer-covered MDF and non-wood substitutes.

France, the largest European producer of sawn hardwood, increased production in 1998 to cover more of the growing domestic market. This was the case in Turkey and Germany, whose consumption grew by

15% and 13% respectively.

In Europe in 1998 and early 1999 white oak and beech were in high demand and were being produced for both domestic and export markets (more information on the European beech and oak trade may be found below). Many countries in central and eastern Europe had large production increases on relatively small volumes.

The Baltic Countries' softwood market

TABLE 9.3.1  
**Production of sawn hardwood, 1995 to 1998**

	1995	1996	1997	1998	Change 1997 to 1998	
					Volume	Per cent
					<i>(1000 m<sup>3</sup>)</i>	
EUROPE	13,402	12,713	12,558	12,953	395	3.1
of which :						
France	3,021	3,094	2,807	2,950	143	5.1
Turkey	1,829	1,766	1,801	1,889	88	4.9
Germany	1,180	1,144	1,048	1,165	117	11.2
Italy	1,050	900	963	900	-63	-6.5
Poland	1,050	780	900	840	-60	-6.7
Romania	900	769	746	744	-2	-0.3
Croatia	478	484	505	522	17	3.4
Slovakia	219	203	266	420	154	57.9
Czech Republic	270	305	293	320	27	9.2
Other countries	3,405	3,268	3,229	3,203	-26	-0.8
Russian Federation	3,975	4,383	3,925	3,560	-365	-9.3
Canada	1,093	1,000	835	1,027	192	23.0
United States	29,344	29,650	30,444	31,860	1,416	4.7
North America	30,437	30,650	31,279	32,887	1,608	5.1

developments were discussed in the previous chapters. It deserves mention that their sawn hardwood production increased by a greater percentage, although on considerably lower volumes, with most of the increase consumed domestically (9.3.2). These developments were not uncommon in other countries in central and eastern Europe.

TABLE 9.3.2

**Baltic Countries sawn hardwood production,  
1992 to 1998  
(1000 m<sup>3</sup>)**

	1996	1997	1998	1998/1997
Estonia	40	73	85	16%
Latvia	104	150	400	167%
Lithuania	100	120	250	108%

Source: TIMBER database, 1999.

North American production of sawn hardwood increased in 1998, by an estimated 1.6 million m<sup>3</sup> to a record level of 32.9 million m<sup>3</sup>. In contrast with Europe, North American production of sawn hardwoods has been increasing slowly but steadily over the last three decades. Canadian production rose by 23.0% in 1998 to again come above 1 million m<sup>3</sup>, but not back to the high levels prior to 1994.

Over the long term, United States production increases during the last decade have gone more to export markets, for example to Europe and Japan than to the domestic market. Over the last nine years, between 8% and 10% of United States production has been exported. This percentage has risen slowly from 2% to 3% from the 1960s. Growing domestic consumption has taken the remaining share of the additional increased production over this 30-year period.

In the United States in mid 1999, sawn hardwood wholesalers and sawmills could not keep up with demand (*Hardwood Review Export*). As log supplies were good, mills were operating at capacity. United States mills have increased their efficiency of sawing high grade hardwood through improved bandsawing technology, including computerised headrig networks (the mechanism on the carriage which moves the log toward the saw blade) and more precise downstream operations within the mill.

With the strong United States economy, pallet production, most of which is from low-grade hardwoods, was also strong in mid 1999 (*Weekly Hardwood Review*). Likewise the demand for pallet cants, from which pallet deckboards and runners are resawn, and squared timbers or cants, both for railroad

ties and for landscape squares, was also strong. (More analysis below of these markets.)

These markets are critical to sawmills, especially those sawing lower grade and smaller diameter logs which can generate 50% or more low-grade sawnwood and cants. Without the markets for solid sawnwood, hardwood mills would generate considerably higher volumes of chips, which in mid 1999 were marginally profitable due to the oversupplied pulpwood (including chip) market described in chapter 11.

## 9.4 Trade

### (i) ECE region

Sawn hardwood export volumes in the ECE region were about equal between Europe and North America in 1998. However this disguises the two continents contrasting developments: European exports rose almost 10% while North American exports fell by over 5% (table 9.4.1). ECE region imports, both temperate and tropical, advanced strongly over the gains made in 1997.

### (ii) European developments

Europe imports more than twice as much sawn hardwood as it exports. In 1998 imports rose strongly, by 12%, to a record 8.1 million m<sup>3</sup> (table 9.4.1). A portion of the imports, roughly 18.8% based on volume, were tropical (without Spain and the United Kingdom two important tropical importers that did not report tropical imports).

Many European countries have good hardwood resources which meet domestic needs for both high value and low value products. Special woods are imported, for example tropical species or red oak from the United States. However as the popularity of red oak declines in Europe, imports have fallen. A decade ago red oak made up 23% of the American hardwood imported into Europe, but today it accounts for less than 8% (additional breakdown on imported species below).

Italy, by far the largest sawn hardwood importer in the ECE region, increased imports by 14.8% in 1998 and broke the 2 million m<sup>3</sup> mark. Italy has had a policy to import more sawnwood and further-processed products from both temperate and tropical hardwoods (Federazione Nazionale dei Commercianti del Legno). Sawn tropical timber imports were up by 26.6% in 1998 while temperate sawnwood increased by only 7.9% on a greater volume. Similarly, softwood log imports in Italy fell by 3.2% in 1998 and were replaced by a 4.8% increase in sawnwood. While the

TABLE 9.4.1  
Exports and imports of sawn hardwood, 1995 to 1998

	1995	1996	1997	1998	Change 1997 to 1998	
					Volume	Per cent
	(1000 m <sup>3</sup> )					
<b>EXPORTS</b>						
EUROPE	3,214	3,228	3,246	3,567	320	10
of which :						
France	761	754	565	543	-22	-4
Germany	320	304	365	393	28	8
Poland	246	228	296	358	62	21
Roumania	252	331	325	333	8	2
Slovakia	110	106	195	279	84	43
Belgium-Luxembourg	171	139	158	152	-6	-4
Hungary	130	150	163	...	...	...
Italy	79	45	103	125	22	21
Netherlands	135	142	123	...	...	...
Austria	144	160	115	122	7	6
Slovenia	114	114	103	106	3	3
Other countries	752	756	735	870	134	18
Canada	769	859	1,003	1,183	180	18
United States	2,495	2,692	2,890	2,502	-388	-13
North America	3,264	3,551	3,893	3,685	-208	-5
<b>IMPORTS</b>						
EUROPE	6,659	6,018	7,247	8,122	875	12
of which :						
Italy	1,777	1,576	1,760	2,021	261	15
Germany	708	553	852	955	103	12
Belgium-Luxembourg	532	634	737	900	163	22
Spain	719	514	900	...	...	...
France	519	425	565	562	-3	-1
Netherlands	631	583	542	...	...	...
United Kingdom	501	575	611	505	-106	-17
Austria	154	165	192	224	32	17
Portugal	138	144	161	194	33	20
Sweden	135	109	106	123	17	16
Other countries	845	741	822	1,196	375	46
Russian Federation	7	8	46	46	0	0
Canada	892	928	1,027	955	-72	-7
United States	698	518	1,096	1,295	199	18
North America	1,590	1,446	2,123	2,250	127	6

domestic construction industry was stagnant in 1998, the renovation and remodelling market was strong.

In early 1999 United Kingdom imports of American hardwoods were "bullish" but importing agents feared buyers' resistance to rising prices for

upper grades (*Timber & Wood Products*). Keeping pace with imports, *exports* rose, by 10% to a new record of 3.6 million m<sup>3</sup>. Most European countries increased hardwood exports, although quantities were relatively small.

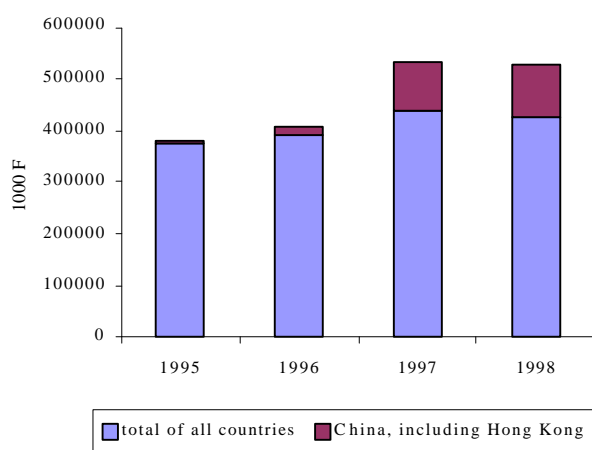
In 1998 Germany, France, Denmark and several other countries exported large volumes of beech sawnwood (approximately 100,000 m<sup>3</sup>) and logs (approximately 200,000 m<sup>3</sup>) to China and Hong Kong and to Mediterranean countries (*EUWID Timber*, USDA Foreign Agricultural Service attaché reports and European Organisation of the Sawmill Industry). In China and other Asian countries sawnwood is not only used for furniture, but is also sliced paper-thin for veneer applications.

Germany's beech sawnwood exports jumped 18.5% in the first quarter of 1999 (*Holz Journal*, *ZMP*). Of the total 85,000 m<sup>3</sup> exported, 31% went to China and Hong Kong, 26% went to Spain and the rest went primarily to European destinations.

An example from France gives an indication of this widespread trend (graph 9.4.1). As a result of the export demand for beech sawnwood and logs, in 1999 there was intense competition for quality sawlogs and some sawmills reported unaffordable beech sawlog prices. A similar situation in beech log exports is described in the roundwood chapter 7.

GRAPH 9.4.1

#### Beech sawnwood exports from France, 1995 to 1998



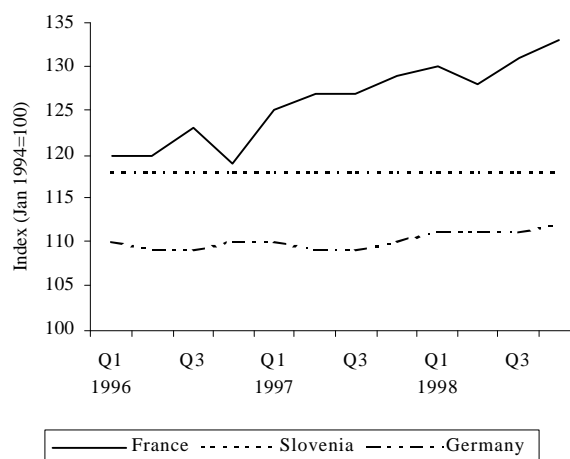
*Source:* French customs as reported by *Arborescences*, 1999.

Beech sawnwood prices in Europe reacted to the heightened export demand and rose in 1998 (graph 9.4.2). Sawnwood prices for high-quality beech exported to China were \$900/ m<sup>3</sup> in 1998 while logs

were not far behind, at \$600 to \$700 (*EUWID Timber*). The rise in beech prices turned some buyers toward alternative species and demand rose for ash.

GRAPH 9.4.2

#### European beech sawnwood price indices, 1996 to 1999



*Source:* "Forest Products Prices, 1996-1998", *Timber Bulletin*, UN-ECE/FAO, 1999.

White oak demand in Europe was driven by an exploding demand for barrel staving (European Organisation of the Sawmill Industry and American Hardwood Export Council). Both European production of oak and imports of white oak from the United States have supplied this booming market. The year 2000 promises to be an important year for wine consumption. 225 litre barrels, which cost about \$600, have been in high demand for the last several years (*La Forêt*). Some of the European production of barrels and staving was exported to other wine-producing regions such as California (United States), Chile, South Africa and Australia. Wine which is aged in oak barrels acquires the taste of the tannins. Production of barrels begins with clear, defect-free boards which are steamed, bent and then dried for up to two years before being worked into staves and assembled into barrels.

The use of oak barrels is not confined to the wine industry. Some special ales are also fermented in unions, i.e. a 150-gallon (537 litre) oak cask. Unlike wine barrels which are more frequently recycled into sherry manufacturing, beer barrels can be reused and repaired for 40+ years (*Timber & Wood Products*).

As a result of the elevated demand for white oak barrels in 1998, log prices rose by 10% to 20%. These price rises made oak logs less affordable for veneer and sawnwood producers as raw material costs could not be passed on to furniture and parquet manufacturers.

Hardwood flooring was another important market in 1998 and the first half of 1999 in Europe as well as in North America, as described in the next section. In Europe there is a mix of softwood flooring and laminated flooring, for example with a hardwood face and a softwood core and back. In Germany sales of wood flooring increased 2% in 1998 to DM20.2 billion. In volume the wood floor sector grew 8% and was forecast to sustain that rate in 1999 (*Timber & Wood Products*).

In Europe parquet production increased by 8.2% to 58 million m<sup>3</sup> and consumption increased by 5% to 66 million m<sup>3</sup> in 1998 over 1997 (Fédération Européenne du Parquet). In Europe wood flooring represents about 5.5% of the floor coverings, up from 4% in 1993. Sweden produces 25% of the European output, with Germany at 18% and France at 13%. Germany accounts for 28% of the total European consumption, followed by Italy (14%) and Spain (11%).

Traditionally wood flooring was "solid". But the production of laminated flooring has increased by over 100% in the 1990s and is now over half the wood flooring market in countries such as France. In France in 1998, some 80% of parquet was oak, followed by tropical species (7%), chestnut (6%) and beech (5%). These percentages vary considerably by country depending on species availability and fashion.

France, the largest producer and exporter of sawn hardwood in Europe, expanded production in 1998 by 5.1%, which went almost entirely to the stronger domestic market. The oak sector held its own in 1998 with solid market strength for flooring, beams for construction and barrel staving, but the railroad tie market remained stagnant (*Le Bois National*). The beech market was strong as noted in graph 9.4.1.

Of the other French species, cherry had strong demand for high grades, sycamore was sought like the beech it resembles and ash and poplar were increasing in demand. Poplar which is mainly used for fruit and vegetable crates was undergoing substitution by plastics. In response the French packaging association, *Syndicat de l'Emballage Léger*, initiated a promotional campaign by printing *J'aime le bois* (I love wood) on their products.

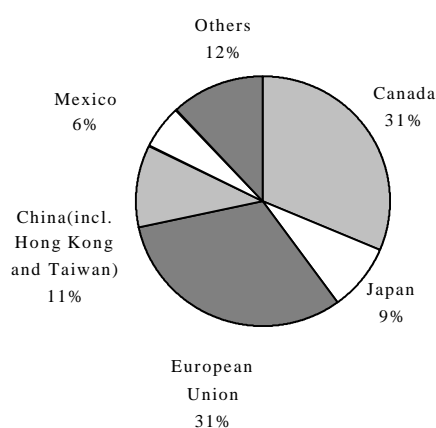
### (iii) North American developments

In North America the trade in sawn hardwood was negatively affected by the Asian crisis in 1998. United States exports, which generally increased steadily over the last decades, fell by 13.4% to 3.7 million m<sup>3</sup>. This drop was not entirely due to the downfall of Asian markets, as European demand was met by greater European domestic production and

more tropical wood (graphs 9.4.3 and 9.4.4). Exports to Mexico rose 15% to \$112 million over 1997 but dropped by 2% in the total sawn hardwood export volume (*Import/Export Wood Purchasing News*).

GRAPH 9.4.3

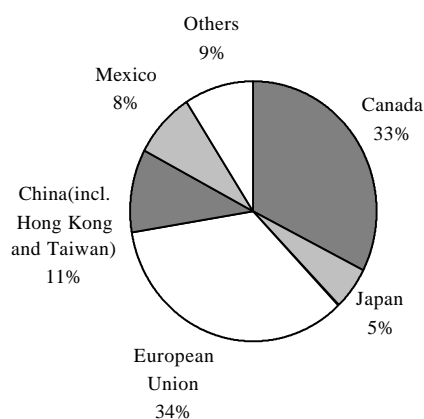
#### United States sawn hardwood export destinations, 1997



Source: USDA Foreign Agricultural Service, 1999.

GRAPH 9.4.4

#### United States sawn hardwood export destinations, 1998



Source: USDA Foreign Agricultural Service, 1999.

Canada's exports of sawn hardwood rose sharply, by 17.9% on lower volumes. While the previous chapter mentioned Québec, Canada's softwood production and trade, the sawn hardwood market in Québec was exceptionally strong in the first quarter of 1999 (*Import/Export Wood Purchasing News*). The active market in Québec was characterised by strong buying activity, but as supplies of hard and soft maple, birch, cherry and basswood are high, there has been pressure to keep prices from rising.

At the beginning of 1999, United States hardwood exports had not recovered from depressed 1998 levels (*Import/Export Wood Purchasing News*). In the first two months of 1999, sawn hardwood moved up 1% on volume to reach \$210 million with greatest quantities going to China (as in 1998) and Korea. In contrast, exports to Japan fell by 22% and to the European Union by 11%. However United States exports were recovering in mid 1999 due to higher demand in almost all Asian countries (*Hardwood Review Export* and USDA Foreign Agricultural Service).

Mexico is an important market for American hardwoods and exports have increased since implementation of the North American Free Trade Agreement. For the first four months of 1999, sales to Mexico (mainly of red oak) were up nearly 32% compared to the same period in 1998 (*Hardwood Review Export*).

In mid 1999 the 8.9% fall in the value of the euro during its six-month life has hindered imports of American hardwoods, although Spain, Ireland and France benefited by lower interest rates (*Tropical Timbers*). Outside the euro zone, United States exports to the United Kingdom did not fare better due to contraction in construction.

United States imports of hardwood, which like softwoods are mostly from Canada (71% for hardwood), rose by 18.2% in 1998. Canada's exports of sawn hardwoods to the United States rose by almost 30% (to approximately 0.9 million m<sup>3</sup>) in volume, but only 17% in value (to approximately \$200 million).

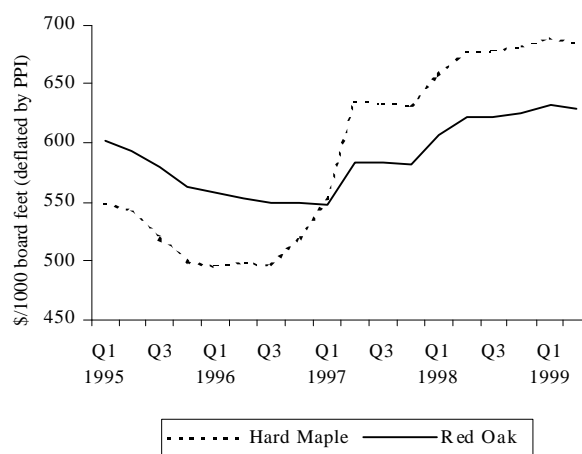
The remaining 30% of United States imports, about 370,000 m<sup>3</sup>, was almost entirely from tropical producing countries (USDA Foreign Agricultural Service). This increase reflects sawnwood only. Figures would be much higher, especially in value, if secondary manufactured products such as furniture were included. As in Europe, exterior furniture made from tropical species like teak is popular. Consumer resistance to purchase tropical woods because of environmental concerns seems to have been overcome as tropical sawnwood imports have been growing

strongly over the last five years: by 14.5% in volume and up by more, 24.5% in value to almost \$200 million.

With strong United States domestic demand 30.7 million m<sup>3</sup> plus an additional export demand of 2.5 million m<sup>3</sup>, coupled with low stocks of both kiln-dried and green sawnwood, hardwood prices have climbed to new records in 1998 and mid 1999 (graph 9.4.5). As mentioned above in the discussion of European imports, there was a weaker demand within the United States for red oak which was reflected in the actual prices shown in the graph: hard maple became more valuable on an actual board foot (or cubic metre) basis than red oak.

GRAPH 9.4.5

## United States sawn hardwood prices, 1995 to 1999



**Note:** Prices for 4/4 inch thick, 1 common grade, Appalachian Region hard maple and red oak sawnwood. Deflated by the United States producer price index with a 1982 base.

**Source:** *Hardwood Market Report*, 1999.

European importers of United States hardwoods are increasingly purchasing non-traditional species. Ten years ago two species, white and red oak, accounted for 73% of all United States hardwood lumber exports to the European Union (USDA Foreign Agricultural Service). Today United States exports to the EU include sassafras, tulipwood (yellow poplar), willow, sycamore, hackberry, cottonwood, red alder, cherry and other species. There was a growing trend in North America by local craftsmen, government agencies and trade associations to promote character-marked hardwood furniture which incorporates the sound, natural 'defects' such as knots and stain.

As in Europe, wood floors are *à la mode* in North America. While style can never be fully explained, one impetus for wood floors is that they are hypo-

allergenic, an important attribute in today's society where allergies are becoming more common. In the United States wood flooring is often solid oak in residential and commercial applications, and maple in gymnasiums and health club applications. In 1997 2.6 million m<sup>3</sup> of hardwood went into the manufacture of solid wood flooring and an additional unknown volume into laminated flooring (*Trends in Domestic/Export Hardwood Markets* by B. Hansen and C. West, 1998). In the last two years exports of hardwood flooring have more than doubled to 2.9 million square metres (USDA Foreign Agricultural Service).

The hardwood dimension and component industry is the third largest consumer of sawnwood behind pallets and furniture. Dimension is sold semi-finished as an intermediary product which is then further manufactured into furniture, cabinetry and millwork. Consumption of sawn hardwood for dimension production increased by approximately 85% from 1991 and in 1997 was 5.7 million m<sup>3</sup> (Hansen and West, 1998). Hardwood dimension production has grown to approximately 2.8 million m<sup>3</sup> (using the 50% rough conversion factor in the Hansen and West study) as final product manufacturers increased purchases for economic and quality control reasons.

Over the last decade the volume of hardwood dimension exported has grown although it is estimated to have maintained a steady 10% share of United States dimension production (Wood Component Manufacturers Association). More and more United States sawmills are producing higher value-added products like dimension. Rough dimension producers are upgrading their products to produce semi- or fully-machined component parts. The advantage of shipping semi-finished dimension and components is that they are pre-manufactured to rough or final size and do not contain wasteful defects like knots, stain or splits. In addition, buyers know exact costs for the important 'make or buy' decision. (In a 'make or buy' decision a manufacturer chooses, based on cost comparisons, whether to produce (make) a part internally or to out-source (buy) the part.) In mid 1999 the United States dimension producers had order backlogs for Europe and Asia (*Weekly Hardwood Review*).

United States hardwood dimension and component production were expected to reach \$325 million in 1998, a 7.7% increase over 1997. Species follow furniture and cabinetry demands: in 1998 red oak was most popular, followed in order by hard maple, tulipwood, white oak, cherry and soft maple.

Railroad ties (sleepers) are a crucial market for hardwood sawmills to 'package' the defects (knots and juvenile wood) from the centre of the log (also known as boxing the heart of the log). Sawn hardwood used in ties increased by one-third from 1991 to 1997 to reach 1.9 million m<sup>3</sup> (Hansen and West reporting statistics of the Railway Tie Association).

Although total railroad mileage continues to decrease, wood has a secure place in the North American tie market. Over 14 million ties were produced in 1998 and the market in 1999 was forecast to be strong (Railway Tie Association). The demand for ties by Mexico has been increasing as well. Considerable additional volumes of preservative-treated wood are used in railroad bridges and culverts.

Non-wood (concrete and steel) ties, which cost 3 to 4 times more, are limited to special applications only. The North American situation is opposite to that of Europe where sawmills have lost most of the rail tie market to concrete. Concrete ties are more expensive to lay, but need less maintenance and are more suited to high-speed passenger trains.