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Global Effects of Accelerated Tariff Liberalization in the Forest Products Sector to 2010

Shushuai Zhu, Joseph Buongiorno, and David J. Brooks

Authors

Shushuai Zhu is a graduate student and **Joseph Buongiorno** is John N. McGovern professor, Department of Forest Ecology and Management, University of Wisconsin, Madison, 1630 Linden Drive, Madison, WI 53706; **David J. Brooks** is a research forester, U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Forestry Science Laboratory, 3200 SW Jefferson Way, Corvallis, OR 97331.

Abstract

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This study projects the effects of tariff elimination on the world sector. Projections were done for two scenarios: (1) progressive tariff elimination according to the schedule agreed to under the current General Agreement on Tariff or Trade (GATT) and (2) complete elimination of tariff on wood products as proposed within the Asia-Pacific Economic Cooperation (APEC) Accelerated Tariff Liberalization (ATL) initiative. Projections were made by using the global forest products model, which provides equilibrium projections of prices and quantities produced, consumed, and traded for 14 commodity groups. Key assumptions include rates of economic growth, availability of wood, demand (price) elasticities, and tariff scenarios.

Keywords: Accelerated tariff liberalization, ATL, import tariffs, equilibrium projection, market model, forest products, fuelwood, industrial roundwood, pulp, recycled fibers, paper, paperboard.

Summary

The objective of this study was to project the effects of elimination of import tariffs on the world forest sector. The projections are done for two scenarios: (1) progressive tariff reduction according to the current General Agreement on Tariff or Trade schedule and (2) complete elimination of all tariffs within the Asia-Pacific Economic Cooperation countries.

The projections were obtained with the global forest product model (GFPM). The model gives market equilibrium projections of quantities produced, consumed, imported, and exported by each country for 14 commodity groups including fuelwood, industrial roundwood, pulp and recycled fibers, and paper and paperboard. The model also projects world equilibrium prices, up to 2010. Key assumptions include rates of economic growth, availability of wood, demand elasticities, and scenarios for tariff reduction.

This report introduces the problem and objective of this study; summarizes the structure of the GFPM and its assumptions; presents the trends in consumption and net trade from 1997 to 2010, by main world regions, under the Accelerated Tariff Liberalization (ATL) scenario; and shows the effects of ATL agreements on consumption, production, import, and export from 1997 to 2010, for main world regions and the United States. Detailed tables by country and product are in the appendixes (http://www.fs.fed.us/pnw/pubs/rp534).

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Introduction

The United States sought elimination of all tariffs in the forest products sector during the Uruguay Round. The round resulted in a reciprocal "zero-for-zero" tariff elimination agreement between the United States, Canada, Finland, Austria, Singapore, Hong-Kong, Japan, European Union (E.U.), Korea, and New Zealand for paper products by 2004. At the same time, there was agreement to reduce, over 5 years, tariffs on wood products. In the United States, such reductions amounted to a cut in average tariffs from about 3.1 to 1.8 percent. Under the Uruguay Agreement Act, Congress gave the Administration authority to seek reduction in tariffs on other wood products (Council on Environment Quality 1999).

In 1997, ministers of Asia-Pacific Economic Cooperation (APEC) countries called for the nomination of sectors for early voluntary sectoral liberalization (EVSL) among their countries. The United States, Canada, Indonesia, and New Zealand proposed the forest sector. In 1998, APEC leaders agreed to move the tariff portion of the EVSL initiative to the World Trade Organization, to conclude an agreement by the end of 1999.

Tariffs remain a significant barrier to trade for forest products (Bourke and Leitch 1998). Although tariffs in countries that are members of the Organization for Economic Cooperation and Development are generally low, they remain high for some products; for example, wood-based panels. In other countries, tariffs between 10 and 20 percent are common and can reach 40 percent.

The Accelerated Tariff Liberalization (ATL) initiative covers all forest products, such as logs and wood products (chapter 44), pulp, paper, and paper products (chapters 47, 48, and 49). Parties to the Uruguay Round zero-for-zero agreement would move up the elimination of tariffs on pulp, paper, and paper products from 1 January 2004 to 1 January 2000. Others would attempt to remove tariffs by the same date but could delay removal until 1 January 2002. The proposal calls for the elimination of tariffs on all other products by 1 January 2002.

The objective of this study was to project the effects of the ATL agreement for the global forest sector in general, and for the APEC countries in particular. For each country and 14 forest groups of forest products, we project consumption, production, imports, exports, and prices. The projections are to 2010, for two scenarios: (1) continuation of the current tariff agreements or (2) elimination of tariffs according to the ATL schedule.

The methods use a dynamic spatial equilibrium model of the world forest sector. The model was applied to project forest product consumption, production, trade, and prices under specific scenarios of economic growth, timber supply, and technical change. These assumptions are held constant in the simulations of the alternative ATL scenarios to judge the effect of the tariff reductions only.

This report reviews the methodology of the global forest products model (GFPM) and describes the countries or regions and the products included in the model, the demand equations, and the timber supply assumptions. Projections from 1997 to 2010 of consumption, net trade, and prices in the main regions of the world are summarized; and the ATL effects of consumption, production, import, and export for the main regions of the world and the United States for the main product groups are presented. The appendixes[1] contain the detail of trends and ATL effects for individual APEC countries.

[1] The appendixes are available on the web at: http:www.fs.fed.us/pnw/pubs/rp534

Methods

Model Structure

Projections of the effects of the ATL agreement were obtained with the GFPM. The GFPM is based on the price endogenous linear programming system (PELPS III) (Zhang et al. 1993), with recent modifications. The model simulates market equilibrium by mathematical programming. The theory is that of spatial equilibrium in competitive markets. The GFPM solves the equilibrium by maximizing the value of the products, minus the cost of production, subject to material balance and capacity constraints in each country and each year. Because material flows throughout the system must balance, the model ensures data consistency within countries and coherence of projections between countries.

In each projection year, for each country and commodity, supply (domestic production plus imports) equals demand (final consumption, plus input in other processes, plus exports). Final demand is price responsive; demand for wood or intermediate products derives from the demand for final products through input-output coefficients that describe technologies in each country. The supply of raw wood and nonwood fibers in each country is price responsive. The supply of recycled paper is constrained by the waste paper supply, which itself depends on the paper consumption and the recycling rate. Each country exports to the world market and imports from the world market. Projected prices are such that they clear markets: at those prices, demand equals supply in each country.

From one year to the next, demand changes in each country because of changes in income. The wood supply shifts according to the chosen scenario. The amount of recycled fiber used for making paper and paperboard changes with technology and recycling policy. Capacity increases or decreases according to new investments that depend on past production and the profitability of production in different countries, as revealed by the shadow price of capacity. Tariff changes affect the cost of imports, ad valorem. Then, a new equilibrium is computed subject to the new demand and supply conditions, new technology, new capacity, and new tariff. Trade changes with inertia tied to past trade and production.

The general principle of the GFPM, then, is that global markets optimize the allocation of resources in the short run (within 1 year). Longrun resource allocation is partly governed by market forces, as in capacity expansion and trade, and also by political forces such as the wood supply shifts determined by forest policy, the waste paper recovery rates by environmental policy, the trade tariffs that change the cost of imports, and the techniques of production determined by exogenous progress.

Earlier versions of PELPS and GFPM have been used by the United States and Canadian Forest Services to develop the North American pulp and paper model and the solid wood model, and by the International Tropical Timber Organization to develop the Asia-Pacific tropical timber trade model. The Asia-Pacific forest products model (Zhang et al. 1997) also was built with PELPS, and the Food and Agricultural Organization (FAO 1999) forest products outlook study included GFPM-based projections (Zhu et al. 1998).

Table 1—Countries in the global forest products model[a]

Code in model	Country	Code in model	Country	Code in model	Country	Code in model	Country
	Africa:		North and Central America:		Asia:		Europe:
1	Algeria	1	Bahamas	1	Afghanistan	1	Albania
2	Angola	2	Barbados	2	Bahrain	2	Austria
3	Benin	3	Belize	3	Bangladesh	3	Belgium-Luxembourg
4	Botswana	4	Canada	4	Bhutan	4	Bosnia-Herzegovina
5	Burkina Faso	5	Cayman Islands	5	Brunei Darussalam	5	Bulgaria
6	Burundi	6	Costa Rica	6	Cambodia	6	Croatia
7	Cameroon	7	Cuba	7	China	7	Czech Republic
8	Cape Verde	8	Dominica	8	Cyprus	8	Denmark
9	Central African Republic	9	Dominican Republic	9	Hong Kong	9	Finland
10	Chad	10	El Salvador	10	India	10	France
11	Congo	11	Guatemala	11	Indonesia	11	Germany
12	Côte d'Ivoire	12	Haiti	12	Iran, Islamic Republic	12	Greece
13	Djibouti	13	Honduras	13	Iraq	13	Hungary
14	Egypt	14	Jamaica	14	Israel	14	Iceland
15	Equatorial Guinea	15	Martinique	15	Japan	15	Ireland
16	Ethiopia	16	Mexico	16	Jordan	16	Italy
17	Gabon	17	Netherlands Antilles	17	Korea, DPR	17	Macedonia
18	Gambia	18	Nicaragua	18	Korea, REP	18	Malta
19	Ghana	19	Panama	19	Kuwait	19	Netherlands
20	Guinea	20	Saint Vincent	20	Laos	20	Norway
21	Guinea-Bissau	21	Trinidad and Tobago	21	Lebanon	21	Poland
22	Kenya	22	United States	22	Macau	22	Portugal
23	Lesotho			23	Malaysia	23	Romania
24	Liberia	23	South America:	24	Mongolia	24	Slovakia
25	Libyan Arab Jamahiriya	24	Argentina	25	Myanmar	25	Slovenia
26	Madagascar	25	Bolivia	26	Nepal	26	Spain
27	Malawi	26	Brazil	27	Oman	27	Sweden
28	Mali	27	Chile	28	Pakistan	28	Switzerland
29	Mauritania	28	Colombia	29	Philippines	29	United Kingdom
30	Mauritius	29	Ecuador	30	Qatar	30	Yugoslav Fed. Rep.
31	Morocco	30	French Guiana	31	Saudi Arabia		
32	Mozambique	31	Guyana	32	Singapore	31	Former U.S.S.R:
33	Niger	32	Paraguay	33	Sri Lanka	32	Armenia
34	Nigeria	33	Peru	34	Syrian Arab Republic	33	Azerbaijan
35	Reunion	34	Suriname	35	Thailand	34	Belarus
36	Rwanda	35	Uruguay	36	Turkey	35	Estonia
37	Sao Tome and Principe		Venezuela	37	United Arab Emirates	36	Georgia
38	Senegal			38	Viet Nam	37	Kazakhstan
39	Sierra Leone			39	Yemen	38	Kyrgyzstan
40	Somalia					39	Latvia

Table 1—Countries in the global forest products model[a] (continued)

Code in model	Country	Code in model	Country	Code in model	Country	Code in model	Country
	Africa continued:				Oceania:		Former U.S.S.R. continued:
41	South Africa			40	Australia	40	Lithuania
42	Sudan			41	Cook Island	41	Moldova, Rep.
43	Swaziland			42	Fiji	42	Russian Federation
44	Tanzania, United Republic			43	French Polynesia	43	Tajikistan
45	Togo			44	New Caledonia	44	Turkmenistan
46	Tunisia			45	New Zealand	45	Ukraine
47	Uganda			46	Papua New Guinea		Uzbekistan
48	Zaire			47	Samoa		
49	Zambia			48	Soloman Islands		
50	Zimbabwe			49	Tonga		
				50	Vanuatu		

[a] Region names are for this study only.

Countries and Products

The GFPM deals with 180 countries (see table 1). Each country may produce and trade one or all of the products. This level of resolution was chosen to facilitate data verification, as most international data are collected at country level. Calculating projections by country also facilitates review and criticism of the projections because expert knowledge is more available at the country level than at more aggregate regional or global levels. The list of countries in table 1 is the same as that used by FAO (1998a), and it uses the same nomenclature.

The forest products considered in the GFPM are shown in table 2. They correspond to product groups used by the FAO (1998a) in its statistical work. In the GFPM, there are econometric demand equations for fuelwood and charcoal, other industrial roundwood, sawnwood, veneer sheets and plywood, particle board, fiberboard, newsprint, printing and writing paper, and other paper and paperboard. The supply equations for fuelwood and charcoal, industrial roundwood, and other fiber pulp are price elastic, up to the maximum sustainable production, which is set exogenously. Waste paper supply is constrained by the quantity of paper recovered, an endogenous function of paper consumption. Figure 1 shows the wood and nonwood material flows.

Final Demand

The demand equations for the end products (table 3) are based on derived demand theory for raw material inputs. Dynamic demand models lead then to empirical elasticities of demand for each forest product in relation to national income (measured by real gross domestic product [GDP]) and real product price, in constant U.S. dollars (Baudin and Lundberg 1987, Buongiorno 1978).

The elasticities of demand used in analyzing the effects of ATL are shown in table 3. Different elasticities were used for countries with high or low GDP per person. Elasticities for low-income countries were generally larger in absolute value.

The world price for each commodity in the base year (1997) was the weighted average of unit values of imports and exports, across all countries. In the GFPM, prices are

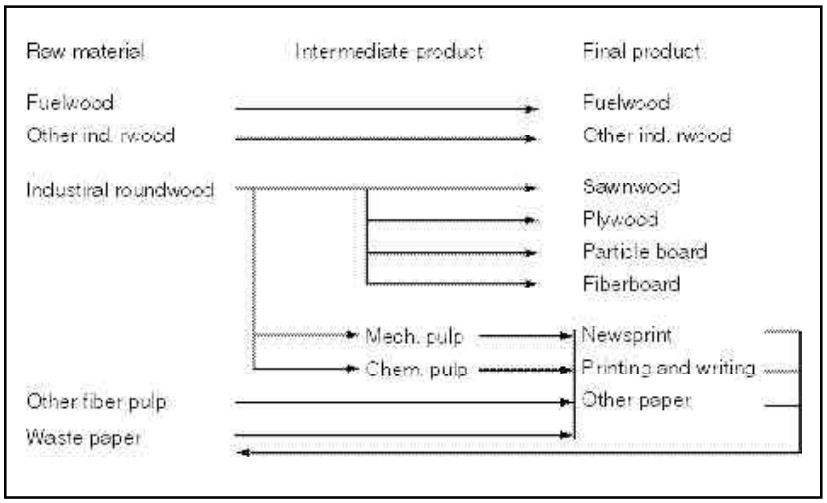

Figure 1—Product transformations in the global forest products model.

Table 2—Products in the global forest products model[a]

SITC code	Product	Unit	Demand	Supply
245	Fuelwood and charcoal	1000 m^3	E	E
246/247	Sawlogs and pulpwood	1000 m^3	I	E
	Other industrial roundwood	1000 m^3	E	E
248	Sawnwood	1000 m^3	E	I
634.1,634.3/4	Veneer and Plywood	1000 m^3	E	I
634.2	Particle board	1000 m^3	E	I
634.5	Fiberboard	1000 m^3	E	I
251.2	Mechanical wood pulp	1000 M.T.	I	I
251.91,.61,.62,.3,.4,.5	Chem/semichem. wood pulp	1000 M.T.	I	I
251.92	Other fiber pulp	1000 M.T.	I	E
251.1	Waste paper	1000 M.T.	I	E
641.1	Newsprint	1000 M.T.	E	I
641.2/3	Printing and writing paper	1000 M.T.	E	I
EX641	Other paper and paperboard	1000 M.T.	E	I

[a] E indicates demand or supply is represented with an econometric equation; I indicates that it is represented with input-output coefficients.
M.T. = metric ton.

endogenous (the equilibrium between demand and supply leads to the prices). So, no assumption has to be made about future prices.

The data on production, imports, and exports in each country and in the base year (1997) were obtained from the FAO statistical database (FAO 1999).

The GDP data are exogenous to the GFPM and nothing else is used to shift demand. The assumptions on the GDP growth rate of each country and the implications for the regions are summarized in table 4. Real GDP was assumed to grow at about 4 percent per year from 1994 to 2010 in Africa, at 2.7 percent per year in America, 4.6 percent per year in Asia, and 2.4 percent per year in Europe.

Table 3—Price and income elasticities of demand for end products

Product	Country	Price	Income
Fuelwood and charcoal			
	High income[a]	-0.62	-2.26
	Low income[b]	-.10	.40
Other industrial roundwood			
	High income	-.05	-.58
	Low income	-.37	.19
Sawnwood			
	High income	-.16	.32
	Low income	-.21	.46
Veneer and plywood			
	High income	-.13	.73
	Low income	-.22	.74
Particle board			
	High income	-.24	1.15
	Low income	-.05	.65
Fiberboard			
	High income	-.52	.82
	Low income	-.52	.82
Newsprint			
	High income	-.05	1.14
	Low income	-.18	1.05
Printing and writing paper			
	High income	-.15	1.66
	Low income	-.37	1.11
Other paper and paperboard			
	High income	-.06	.94
	Low income	-.14	.92

[a] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Israel, Italy, Japan, Kuwait, Luxembourg, Netherlands, Norway, New Zealand, South Africa, Spain, Sweden, Switzerland, United Kingdom, and United States.
[b] Rest of the world.

Raw Material Supply

In any given year and country, the supply of industrial roundwood is a function of the price of industrial roundwood. The price elasticity of supply was set at 0.8. This price elasticity indicates the percentage of change in supply that would result from a 1-percent change in price, other things being equal.

In addition, the supply equations are assumed to shift over time to simulate changes in supply independent of prices. The rates of shifts were estimates of how much timber production would change without a change in price. These rates of shift differ by country and are based on various information about past production, forest area and stock, growth rates, extent of plantations, and policies of each country. In some countries of Asia, upper bounds were set on the timber supply, regardless of price, to reflect perceived limits on the potential sustainable timber production of the country. The rate of shifts relied mostly on the data of the global fiber supply study (GFSS, FAO 1998b); the rate of shift is the annual percentage change in the “commercially available wood supply” projected by the GFSS. The resulting aggregate average rates of shift of industrial roundwood supply, by region, were 0.71 percent in North, Central, and South America, 0.63 percent in Europe and the former U.S.S.R., 1.14 percent in Africa, and 1.4 percent in Asia and Oceania. The detailed rates of shift used in the ATL analysis are shown in table 5.

Table 4—Growth rate of real gross domestic product (percent per year^{-1})

Country	1997-2000	2001-2005	2006-2010
Africa:	3.94	4.03	4.03
Algeria	3.47	3.61	3.61
Angola	2.93	5.00	5.00
Benin	4.28	6.30	6.30
Botswana	6.23	6.50	6.50
Burkina Faso	4.14	4.87	4.87
Burundi	4.41	4.76	4.76
Cameroon	4.86	3.86	3.86
Cape Verde	6.82	7.28	7.28
Central African Republic	3.62	3.65	3.65
Chad	4.05	4.89	4.89
Congo	5.54	3.52	3.52
Côte d'Ivoire	5.40	5.10	5.10
Djibouti	2.70	3.19	3.19
Egypt	3.89	3.60	3.60
Equatorial Guinea	2.15	4.26	4.26
Ethiopia	5.59	5.82	5.82
Gabon	2.12	4.40	4.40
Gambia	2.48	4.26	4.26
Ghana	5.43	5.56	5.56
Guinea	4.48	4.54	4.54
Guinea-Bissau	4.99	6.00	6.00
Kenya	4.11	5.52	5.52
Lesotho	6.53	7.52	7.52
Liberia	.14	.82	.82
Libyan Arab Jamahiriya	2.00	3.00	3.00
Madagascar	3.33	4.29	4.29
Malawi	2.99	2.74	2.74
Mali	4.68	5.52	5.52
Mauritania	3.47	3.54	3.54
Mauritius	6.89	7.17	7.17
Morocco	5.67	4.54	4.54
Mozambique	5.00	5.50	5.50
Niger	4.96	5.13	5.13
Nigeria	3.52	3.63	3.63
Reunion	6.00	5.00	5.00
Rwanda	5.13	5.77	5.77
Sao Tome and Principe	5.92	5.98	5.98
Senegal	4.65	5.75	5.75
Sierra Leone	.63	6.13	6.13
Somalia	1.60	1.94	1.94
South Africa	3.12	3.04	3.04
Sudan	3.48	3.09	3.09
Swaziland	4.53	7.87	7.87
Tanzania, United Republic	4.85	5.14	5.14
Togo	6.31	6.95	6.95
Tunisia	5.38	4.83	4.83
Uganda	6.53	6.09	6.09
Zaire	5.00	5.00	5.00
Zambia	3.73	3.02	3.02
Zimbabwe	5.21	5.14	5.14

Table 4—Growth rate of real gross domestic product (percent per year[-1]) (continued)

Country	1997-2000	2001-2005	2006-2010
America:	2.65	2.73	2.73
North and Central America—			
Bahamas	2.00	3.00	3.00
Barbados	3.34	3.50	3.50
Belize	4.00	4.50	4.50
Canada	2.75	2.97	2.97
Cayman Islands	4.00	4.50	4.50
Costa Rica	2.02	4.17	4.17
Cuba	2.00	3.50	3.50
Dominica	2.00	3.00	3.00
Dominican Republic	3.28	3.28	3.28
El Salvador	4.77	4.52	4.52
Guatemala	3.96	3.65	3.65
Haiti	3.12	3.37	3.37
Honduras	3.96	4.05	4.05
Jamaica	.93	2.04	2.04
Martinique	2.00	2.00	2.00
Mexico	4.52	4.88	4.88
Netherlands Antilles	1.00	1.00	1.00
Nicaragua	3.81	3.21	3.21
Panama	3.37	4.19	4.19
Saint Vincent	3.00	3.50	3.50
Trinidad and Tobago	2.83	3.60	3.60
United States	2.45	2.40	2.40
South America—			
Argentina	4.41	4.88	4.88
Bolivia	4.21	3.76	3.76
Brazil	3.26	4.01	4.01
Chile	6.49	6.04	6.04
Colombia	3.86	4.66	4.66
Ecuador	3.12	3.49	3.49
French Guiana	1.50	1.50	1.50
Guyana	3.06	3.34	3.34
Paraguay	2.48	3.26	3.26
Peru	3.49	4.58	4.58
Suriname	1.60	2.00	2.00
Uruguay	2.37	2.90	2.90
Venezuela	2.47	3.13	3.13
Asia Pacific:	4.56	4.58	4.58
Asia—			
Afghanistan	2.00	2.50	2.50
Bahrain	1.52	2.50	2.50
Bangladesh	5.04	6.27	6.27
Bhutan	5.00	5.00	5.00
Brunei Darussalam	2.00	2.00	2.00
Cambodia	6.00	6.00	6.00
China	8.06	7.30	7.30
Cyprus	5.20	5.00	5.00
Hong Kong	5.22	5.50	5.50
India	6.21	5.95	5.95
Indonesia	7.79	7.53	7.53
Iran, Islamic Republic	3.59	3.55	3.55

Table 4—Growth rate of real gross domestic product (percent per year^{-1}) (continued)

Country	1997-2000	2001-2005	2006-2010
Asia continued—			
Iraq	10.07	4.40	4.40
Israel	4.50	5.00	5.00
Japan	3.12	2.97	2.97
Jordan	5.01	4.98	4.98
Korea, DPR	2.00	2.00	2.00
Korea, REP.	6.26	6.32	6.32
Kuwait	2.30	2.00	2.00
Laos	5.00	6.00	6.00
Lebanon	7.00	8.00	8.00
Macau	5.50	6.00	6.00
Malaysia	7.95	7.68	7.68
Mongolia	2.00	3.00	3.00
Myanmar	6.14	4.44	4.44
Nepal	5.07	5.46	5.46
Oman	2.58	3.41	3.41
Pakistan	5.56	5.49	5.49
Philippines	5.31	5.34	5.34
Qatar	1.00	3.00	3.00
Saudi Arabia	2.30	2.76	2.76
Singapore	6.88	6.44	6.44
Sri Lanka	5.77	6.51	6.51
Syrian Arab Republic	4.60	5.12	5.12
Thailand	6.19	7.00	7.00
Turkey	3.61	5.71	5.71
United Arab Emirates	1.80	3.00	3.00
Viet Nam	6.00	6.50	6.50
Yemen	2.98	3.08	3.08
Oceania—			
Australia	3.60	3.50	3.50
Cook Island	2.00	3.00	3.00
Fiji	1.99	2.68	2.68
French Polynesia	3.50	4.00	4.00
New Caledonia	1.00	1.50	1.50
New Zealand	2.66	2.80	2.80
Papua New Guinea	1.86	2.28	2.28
Samoa	1.50	1.50	1.50
Solomon Islands	5.00	5.50	5.50
Tonga	3.00	3.50	3.50
Vanuatu	1.50	2.00	2.00
Europe and Former U.S.S.R.:	2.36	2.91	2.91
Europe—			
Albania	1.00	1.50	1.50
Austria	1.90	2.20	2.20
Belgium	2.24	2.40	2.40
Bosnia-Herzegovina	5.00	5.50	5.50
Bulgaria	.48	3.38	3.38
Croatia	4.90	5.50	5.50
Czech Rep.	4.60	4.90	4.90
Denmark	2.52	2.30	2.30
Finland	3.46	2.80	2.80
France	2.08	2.53	2.53
Germany	2.37	2.67	2.67

Table 4—Growth rate of real gross domestic product (percent per year^{-1}) (continued)

Country	1997-2000	2001-2005	2006-2010
Europe continued—			
Greece	2.74	2.48	2.48
Hungary	2.72	4.31	4.31
Iceland	3.81	2.20	2.20
Ireland	6.60	5.40	5.40
Italy	1.97	2.57	2.57
Macedonia	2.00	3.00	3.00
Malta	4.11	3.38	3.38
Netherlands	2.86	2.60	2.60
Norway	3.56	3.00	3.00
Poland	5.11	4.81	4.81
Portugal	3.08	2.80	2.80
Romania	2.09	4.24	4.24
Slovakia	4.60	4.90	4.90
Slovenia	4.90	5.50	5.50
Spain	2.92	3.10	3.10
Sweden	1.92	2.10	2.10
Switzerland	1.55	2.52	2.52
United Kingdom	2.56	2.52	2.52
Yugoslav Federal Republic	3.50	4.00	4.00
Former U.S.S.R.—			
Armenia	6.19	5.90	5.90
Azerbaijan	8.90	11.63	11.63
Belarus	.24	4.60	4.60
Estonia	4.00	5.30	5.30
Georgia	9.40	9.18	9.18
Kazakhstan	3.49	5.48	5.48
Kyrgyzstan	6.10	5.00	5.00
Latvia	3.79	4.80	4.80
Lithuania	3.71	4.80	4.80
Moldova Rep	.38	5.00	5.00
Russian Federation	1.40	5.80	5.80
Tajikistan	-5.06	5.20	5.20
Turkmenistan	.50	5.00	5.00
Ukraine	-.56	5.86	5.86
Uzbekistan	1.80	4.50	4.50

Supply curves for fuelwood and charcoal had the same elasticities and rates of shifts as those for industrial roundwood. For industrial roundwood used in the round (other industrial roundwood), the supply curves were assumed to be horizontal so that supply in each country was equal to the projected demand, at current prices and projected income. This simplification is legitimate because the world trade of this product is small.

The supply of other fiber pulp (from straw, bagasse, etc.) had the same price elasticity as industrial roundwood, 0.8, and a shift rate of 3 percent per year in China (the main supplier of other fiber pulp) and 4 percent per year in other countries. The supply of waste paper was assumed to be horizontal, with an upper bound defined by the previous year's consumption and the maximum recycling rate for the country.

Table 5—Roundwood supply shift rate, 1997-2010

Country	Percent per year	Country	Percent per year	Country	Percent per year	Country	Percent per year
Africa:	1.14	America:	0.71	Asia Pacific:	1.43	Europe and U.S.S.R.:	0.63
Algeria	0.00	North and Central America:		Asia—		Europe—	
Angola	0.42	Bahamas	0.00	Afghanistan	0.50	Albania	-1.25
Benin	0.00	Barbados	0.00	Bahrain	0.50	Austria	0.53
Botswana	0.00	Belize	0.30	Bangladesh	-0.80	Belgium	0.00
Burkina Faso	0.00	Canada	0.60	Bhutan	0.56	Bosnia-Herz.	0.00
Burundi	0.00	Cayman Islands	0.00	Brunei	-0.07	Bulgaria	1.55
Cameroon	1.35	Costa Rica	-1.95	Cambodia	0.26	Croatia	2.26
Cape Verde	0.00	Cuba	-0.16	China	1.15	Czech Rep.	0.27
Central Af. Rep.	0.55	Dominica	0.00	Cyprus	0.50	Denmark	0.65
Chad	0.00	Dominican Rep.	-1.39	Hong Kong	0.00	Finland	0.94
Congo	2.00	El Salvador	3.72	India	2.54	France	0.78
Côte d'Ivoire	-0.30	Guatemala	-1.68	Indonesia	2.13	Germany	0.15
Djibouti	0.00	Haiti	0.00	Iran	0.50	Greece	0.00
Egypt	0.00	Honduras	-2.03	Iraq	0.50	Hungary	0.69
Equatorial Guinea	-0.18	Jamaica	0.00	Israel	0.50	Iceland	0.00
Ethiopia	0.00	Martinique	0.00	Japan	1.52	Ireland	3.49
Gabon	-0.03	Mexico	-0.12	Jordan	0.50	Italy	0.24
Gambia	0.00	Netherlands Antil.	0.00	Korea, DPR	0.67	Macedonia	0.00
Ghana	-0.94	Nicaragua	-1.99	Korea, Rep.	2.21	Malta	0.00
Guinea	-0.99	Panama	-1.67	Kuwait	0.00	Netherlands	0.52
Guinea Bissau	0.32	Saint Vincent	0.00	Laos	1.37	Norway	1.24
Kenya	3.14	Trinidad &Tobago	0.00	Lebanon	0.50	Poland	0.09
Lesotho	0.00	United States	0.60	Macau	0.50	Portugal	0.53
Liberia	-0.26			Malaysia	-1.09	Romania	0.00
Libyan Arab Jam.	0.00	South America:		Mongolia	-0.70	Slovakia	0.36
Madagascar	-0.72	Argentina	2.98	Myanmar	0.86	Slovenia	0.77
Malawi	10.07	Bolivia	1.00	Nepal	1.32	Spain	1.03
Mali	0.00	Brazil	1.34	Oman	0.00	Sweden	0.63
Mauritania	0.00	Chile	1.69	Pakistan	1.49	Switzerland	0.46
Mauritius	0.00	Colombia	0.53	Philippines	1.80	United Kingd	2.21
Morocco	1.69	Ecuador	-0.73	Qatar	0.50	Yugoslav FR	0.00
Mozambique	0.00	French Guiana	1.82	Saudi Arabia	0.50		
Niger	0.00	Guyana	0.56	Singapore	0.00	Former U.S.S.R.:	
Nigeria	-0.69	Paraguay	-1.69	Sri Lanka	1.29	Armenia	0.20
Reunion	0.00	Peru	0.61	Syrian Arab Rep	0.50	Azerbaijan	0.20
Rwanda	0.00	Suriname	1.53	Thailand	-0.06	Belarus	2.10
Sao Tome and Pr.	0.00	Uruguay	2.36	Turkey	0.50	Estonia	2.79
Senegal	0.00	Venezuela	0.10	Un. Arab Em.	0.00	Georgia	0.20
Sierra Leone	-2.60			Vietnam	3.03	Kazakhstan	0.20
Somalia	0.00			Yemen, Rep.	0.50	Kyrgyzstan	0.20
South Africa	2.02					Latvia	1.41
Sudan	-0.59			Oceania—		Lithuania	2.18
Swaziland	3.00			Australia	1.02	Moldova Rep	2.10
Tanzania, U. Rep.	4.20			Cook Is	-1.79	Russian Fed	0.20
Togo	0.00			Fiji	8.33	Tajikistan	0.20
Tunisia	3.00			French Polyn.	0.00	Turkmenistan	0.20
Uganda	3.50			New Caledon.	0.50	Ukraine	2.10
Zaire	0.57			New Zealand	3.80	Uzbekistan	0.20
Zambia	1.51			Papua New Guinea	3.84		
Zimbabwe	4.45			Samoa	0.00		
				Solomon Is	3.00		
				Tonga	0.50		
				Vanuatu	3.19		

Intermediate Product Supply and Demand

The GFPM simulates the transformation, in each country, of wood and other raw materials (other fiber pulp and waste paper) into end products (sawnwood and panels), or intermediate products (pulps), which are in turn transformed into end products (papers). These successive transformations, and the attendant supplies and demands, are represented by activity analysis.

The corresponding input-output coefficients were estimated for the base year (1997). The estimation procedure was such that the implied consumption, production, and trade of all products were as close as possible to the national statistics, as reported in FAO (1999), whereas the input-output coefficients stayed within a plausible range, given prior knowledge of the technology. For example, the total amount of pulp and other fibers consumed per ton of paper had to be close to unity.

Each production activity represented with input-output coefficients corresponds to a manufacturing cost. This is the cost of all inputs (capital, wages, energy, etc.), excluding the cost of raw materials explicit in the model. This cost was estimated in the base year (1997) as the unit value of the output, minus the cost of all inputs, at world prices.

Similarly, all the supply curves for raw materials and the demand curves for end products were calibrated to supply or demand the amounts observed in each country at world price. Because the calibration is made at world import price, the supply curves and manufacturing costs include the cost of transportation, which is therefore set at zero for all trade flows in the base year.

Calibrated in this way, the solution of the model in the base year is almost identical to the observed quantities and corresponding prices for all products and countries.

Assumptions on Accelerated Tariff Liberalization

In the GFPM, a change in tariff is equivalent to a change in transport cost for imported commodities. Most tariffs are ad valorem, so the effect of a change in tariff changes with the price level. For technical reasons, the new tariff is based on last year's world price, computed by the spatial equilibrium mechanism.

Two scenarios were implemented: (1) a base scenario, analog to the continuation of current agreements (2) and an ATL scenario to simulate the accelerated removal of tariffs. The details of the tariff reductions assumed in the two scenarios are shown in table 6.

Base scenario—According to Barbier (1996), because of the Uruguay Round of global agreement on trade and tariffs (GATT), major developed countries were committed to reducing tariffs by 50 percent on solid wood products over 5 years starting in 1995, and completely phasing out tariffs on pulp and paper by 2004.

For this study, we had data on tariffs in 1997. For solid wood products (fuelwood, industrial roundwood, sawnwood, veneer and plywood, particle board, and fiberboard), we assumed that tariffs had been reduced by one-sixth from 1995 to 1997, and that they would be reduced further by one-sixth each year in 1998 and 1999. For pulp (mechanical pulp, chemical pulp, other fiber pulp, and waste paper) and paper (newsprint, printing and writing paper, other paper, and paperboard), we reduced 1997 tariffs by one-seventh each year from 1998 onwards, thereby leading to total tariff elimination by 2004.

Text continues on page 19.

Table 6—Tariff rates in alternative scenarios

Country and commodity	Tariff rates							
				Base scenario			ATL scenario	
	1997	1998	1999	2000	2004	2010	2000	2010
America:								
Canada—				*Percent*				
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	0	0	0	0	0	0	0	0
Veneer and plywood	6	5	4	4	4	4	0	0
Particle board	2.5	2.1	1.7	1.7	1.7	1.7	0	0
Fiberboard	0	0	0	0	0	0	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	0	0	0	0	0	0	0	0
Other paper and paperboard	2	1.7	1.4	1.1	0	0	0	0
Mexico—								
Fuelwood and charcoal	10	8.3	6.7	6.7	6.7	6.7	0	0
Saw logs and pulpwood	10	8.3	6.7	6.7	6.7	6.7	0	0
Industrial roundwood (other)	10	8.3	6.7	6.7	6.7	6.7	0	0
Sawnwood	10	8.3	6.7	6.7	6.7	6.7	0	0
Veneer and plywood	15	12.5	10	10	10	10	0	0
Particle board	20	16.7	13.3	13.3	13.3	13.3	0	0
Fiberboard	15	12.5	10	10	10	10	0	0
Mechanical wood pulp	5	4.3	3.6	2.9	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	5	4.3	3.6	2.9	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	15	12.9	10.7	8.6	0	0	0	0
Printing and writing paper	10	8.6	7.1	5.7	0	0	0	0
Other paper and paperboard	10	8.6	7.1	5.7	0	0	0	0
United States—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	0	0	0	0	0	0	0	0
Veneer and plywood	5	4.2	3.3	3.3	3.3	3.3	0	0
Particle board	0.8	0.7	0.5	0.5	0.5	0.5	0	0
Fiberboard	0.6	0.5	0.4	0.4	0.4	0.4	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	1.5	1.3	1.1	0.9	0	0	0	0
Other paper and paperboard	2.4	2.1	1.7	1.4	0	0	0	0

Table 6—Tariff rates in alternative scenarios (continued)

Country and commodity	Tariff rates							
				Base scenario			ATL scenario	
	1997	1998	1999	2000	2004	2010	2000	2010
Brazil—				*Percent*				
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	10	8.3	6.7	6.7	6.7	6.7	0	0
Sawnwood	10	8.3	6.7	6.7	6.7	6.7	0	0
Veneer and plywood	10	8.3	6.7	6.7	6.7	6.7	0	0
Particle board	10	8.3	6.7	6.7	6.7	6.7	0	0
Fiberboard	2	1.7	1.3	1.3	1.3	1.3	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	20	17.1	14.3	11.4	0	0	0	0
Other paper and paperboard	12.5	10.7	8.9	7.1	0	0	0	0
Chile—								
Fuelwood and charcoal	11	9.2	7.3	7.3	7.3	7.3	0	0
Saw logs and pulpwood	11	9.2	7.3	7.3	7.3	7.3	0	0
Industrial roundwood (other)	11	9.2	7.3	7.3	7.3	7.3	0	0
Sawnwood	11	9.2	7.3	7.3	7.3	7.3	0	0
Veneer and plywood	11	9.2	7.3	7.3	7.3	7.3	0	0
Particle board	11	9.2	7.3	7.3	7.3	7.3	0	0
Fiberboard	11	9.2	7.3	7.3	7.3	7.3	0	0
Mechanical wood pulp	11	9.4	7.9	6.3	0	0	0	0
Chemical and semichemical wood pulp	11	9.4	7.9	6.3	0	0	0	0
Other fiber pulp	11	9.4	7.9	6.3	0	0	0	0
Waste paper	11	9.4	7.9	6.3	0	0	0	0
Newsprint	11	9.4	7.9	6.3	0	0	0	0
Printing and writing paper	11	9.4	7.9	6.3	0	0	0	0
Other paper and paperboard	11	9.4	7.9	6.3	0	0	0	0
Asia and Oceania:								
Brunei—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	20	16.7	13.3	13.3	13.3	13.3	0	0
Industrial roundwood (other)	20	16.7	13.3	13.3	13.3	13.3	0	0
Sawnwood	20	16.7	13.3	13.3	13.3	13.3	0	0
Veneer and plywood	20	16.7	13.3	13.3	13.3	13.3	0	0
Particle board	20	16.7	13.3	13.3	13.3	13.3	0	0
Fiberboard	0	0	0	0	0	0	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	0	0	0	0	0	0	0	0
Other paper and paperboard	0	0	0	0	0	0	0	0

Table 6—Tariff rates in alternative scenarios (continued)

Country and commodity	Tariff rates							
				Base scenario			ATL scenario	
	1997	1998	1999	2000	2004	2010	2000	2010
	Percent							
China—								
Fuelwood and charcoal	9	7.5	6	6	6	6	0	0
Saw logs and pulpwood	2	1.7	1.3	1.3	1.3	1.3	0	0
Industrial roundwood (other)	6	5	4	4	4	4	0	0
Sawnwood	9	7.5	6	6	6	6	0	0
Veneer and plywood	20	16.7	13.3	13.3	13.3	13.3	0	0
Particle board	22	18.3	14.7	14.7	14.7	14.7	0	0
Fiberboard	22	18.3	14.7	14.7	14.7	14.7	0	0
Mechanical wood pulp	2	1.7	1.4	1.1	0	0	0	0
Chemical and semichemical wood pulp	2	1.7	1.4	1.1	0	0	0	0
Other fiber pulp	2	1.7	1.4	1.1	0	0	0	0
Waste paper	2	1.7	1.4	1.1	0	0	0	0
Newsprint	15	12.9	10.7	8.6	0	0	0	0
Printing and writing paper	20	17.1	14.3	11.4	0	0	0	0
Other paper and paperboard	15	12.9	10.7	8.6	0	0	0	0
Hong Kong—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	0	0	0	0	0	0	0	0
Veneer and plywood	0	0	0	0	0	0	0	0
Particle board	0	0	0	0	0	0	0	0
Fiberboard	0	0	0	0	0	0	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	0	0	0	0	0	0	0	0
Other paper and paperboard	0	0	0	0	0	0	0	0
Indonesia—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	10	8.3	6.7	6.7	6.7	6.7	0	0
Veneer and plywood	20	16.7	13.3	13.3	13.3	13.3	0	0
Particle board	10	8.3	6.7	6.7	6.7	6.7	0	0
Fiberboard	10	8.3	6.7	6.7	6.7	6.7	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	25	21.4	17.9	14.3	0	0	0	0
Newsprint	5	4.3	3.6	2.9	0	0	0	0
Printing and writing paper	15	12.9	10.7	8.6	0	0	0	0
Other paper and paperboard	10	8.6	7.1	5.7	0	0	0	0

Table 6—Tariff rates in alternative scenarios (continued)

Country and commodity	Tariff rates							
				Base scenario			ATL scenario	
	1997	1998	1999	2000	2004	2010	2000	2010
	Percent							
Japan—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	6.8	5.7	4.5	4.5	4.5	4.5	0	0
Veneer and plywood	7.1	5.9	4.7	4.7	4.7	4.7	0	0
Particle board	6	5	4	4	4	4	0	0
Fiberboard	3.1	2.6	2.1	2.1	2.1	2.1	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	2.5	2.1	1.8	1.4	0	0	0	0
Other paper and paperboard	2.1	1.8	1.5	1.2	0	0	0	0
Korea—								
Fuelwood and charcoal	2	1.7	1.3	1.3	1.3	1.3	0	0
Saw logs and pulpwood	2	1.7	1.3	1.3	1.3	1.3	0	0
Industrial roundwood (other)	2	1.7	1.3	1.3	1.3	1.3	0	0
Sawnwood	5	4.2	3.3	3.3	3.3	3.3	0	0
Veneer and plywood	8	6.7	5.3	5.3	5.3	5.3	0	0
Particle board	8	6.7	5.3	5.3	5.3	5.3	0	0
Fiberboard	8	6.7	5.3	5.3	5.3	5.3	0	0
Mechanical wood pulp	2	1.7	1.4	1.1	0	0	0	0
Chemical and semichemical wood pulp	2	1.7	1.4	1.1	0	0	0	0
Other fiber pulp	2	1.7	1.4	1.1	0	0	0	0
Waste paper	2	1.7	1.4	1.1	0	0	0	0
Newsprint	8	6.9	5.7	4.6	0	0	0	0
Printing and writing paper	8	6.9	5.7	4.6	0	0	0	0
Other paper and paperboard	8	6.9	5.7	4.6	0	0	0	0
Malaysia—								
Fuelwood and charcoal	20	16.7	13.3	13.3	13.3	13.3	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	0	0	0	0	0	0	0	0
Veneer and plywood	40	33.3	26.7	26.7	26.7	26.7	0	0
Particle board	20	16.7	13.3	13.3	13.3	13.3	0	0
Fiberboard	20	16.7	13.3	13.3	13.3	13.3	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	5	4.3	3.6	2.9	0	0	0	0
Printing and writing paper	15	12.9	10.7	8.6	0	0	0	0
Other paper and paperboard	20	17.1	14.3	11.4	0	0	0	0

Table 6—Tariff rates in alternative scenarios (continued)

Country and commodity	Tariff rates							
				Base scenario			ATL scenario	
	1997	1998	1999	2000	2004	2010	2000	2010
	Percent							
Philippines—								
Fuelwood and charcoal	3	2.5	2	2	2	2	0	0
Saw logs and pulpwood	3	2.5	2	2	2	2	0	0
Industrial roundwood (other)	3	2.5	2	2	2	2	0	0
Sawnwood	10	8.3	6.7	6.7	6.7	6.7	0	0
Veneer and plywood	20	16.7	13.3	13.3	13.3	13.3	0	0
Particle board	20	16.7	13.3	13.3	13.3	13.3	0	0
Fiberboard	20	16.7	13.3	13.3	13.3	13.3	0	0
Mechanical wood pulp	3	2.6	2.1	1.7	0	0	0	0
Chemical and semichemical wood pulp	3	2.6	2.1	1.7	0	0	0	0
Other fiber pulp	3	2.6	2.1	1.7	0	0	0	0
Waste paper	3	2.6	2.1	1.7	0	0	0	0
Newsprint	10	8.6	7.1	5.7	0	0	0	0
Printing and writing paper	3	2.6	2.1	1.7	0	0	0	0
Other paper and paperboard	10	8.6	7.1	5.7	0	0	0	0
Singapore—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	0	0	0	0	0	0	0	0
Veneer and plywood	0	0	0	0	0	0	0	0
Particle board	0	0	0	0	0	0	0	0
Fiberboard	0	0	0	0	0	0	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	0	0	0	0	0	0	0	0
Other paper and paperboard	0	0	0	0	0	0	0	0
Thailand—								
Fuelwood and charcoal	1	0.8	0.7	0.7	0.7	0.7	0	0
Saw logs and pulpwood	1	0.8	0.7	0.7	0.7	0.7	0	0
Industrial roundwood (other)	1	0.8	0.7	0.7	0.7	0.7	0	0
Sawnwood	5	4.2	3.3	3.3	3.3	3.3	0	0
Veneer and plywood	20	16.7	13.3	13.3	13.3	13.3	0	0
Particle board	20	16.7	13.3	13.3	13.3	13.3	0	0
Fiberboard	20	16.7	13.3	13.3	13.3	13.3	0	0
Mechanical wood pulp	7	6	5	4	0	0	0	0
Chemical and semichemical wood pulp	7	6	5	4	0	0	0	0
Other fiber pulp	7	6	5	4	0	0	0	0
Waste paper	7	6	5	4	0	0	0	0
Newsprint	35	30	25	20	0	0	0	0
Printing and writing paper	35	30	25	20	0	0	0	0
Other paper and paperboard	35	30	25	20	0	0	0	0

Table 6—Tariff rates in alternative scenarios (continued)

Country and commodity	Tariff rates							
				Base scenario			ATL scenario	
	1997	1998	1999	2000	2004	2010	2000	2010
	Percent							
Australia—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	5	4.2	3.3	3.3	3.3	3.3	0	0
Veneer and plywood	5	4.2	3.3	3.3	3.3	3.3	0	0
Particle board	5	4.2	3.3	3.3	3.3	3.3	0	0
Fiberboard	5	4.2	3.3	3.3	3.3	3.3	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	0	0	0	0	0	0	0	0
Printing and writing paper	5	4.3	3.6	2.9	0	0	0	0
Other paper and paperboard	5	4.3	3.6	2.9	0	0	0	0
New Zealand—								
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	0	0	0	0	0	0	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	8	6.7	5.3	5.3	5.3	5.3	0	0
Veneer and plywood	8	6.7	5.3	5.3	5.3	5.3	0	0
Particle board	7.5	6.3	5	5	5	5	0	0
Fiberboard	6.5	5.4	4.3	4.3	4.3	4.3	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	7.5	6.4	5.4	4.3	0	0	0	0
Printing and writing paper	7.5	6.4	5.4	4.3	0	0	0	0
Other paper and paperboard	7.5	6.4	5.4	4.3	0	0	0	0
Papua New Guinea—								
Fuelwood and charcoal	40	33.3	26.7	26.7	26.7	26.7	0	0
Saw logs and pulpwood	40	33.3	26.7	26.7	26.7	26.7	0	0
Industrial roundwood (other)	40	33.3	26.7	26.7	26.7	26.7	0	0
Sawnwood	40	33.3	26.7	26.7	26.7	26.7	0	0
Veneer and plywood	100	83.3	66.7	66.7	66.7	66.7	0	0
Particle board	55	45.8	36.7	36.7	36.7	36.7	0	0
Fiberboard	55	45.8	36.7	36.7	36.7	36.7	0	0
Mechanical wood pulp	40	34.3	28.6	22.9	0	0	0	0
Chemical and semichemical wood pulp	40	34.3	28.6	22.9	0	0	0	0
Other fiber pulp	40	34.3	28.6	22.9	0	0	0	0
Waste paper	40	34.3	28.6	22.9	0	0	0	0
Newsprint	11	9.4	7.9	6.3	0	0	0	0
Printing and writing paper	11	9.4	7.9	6.3	0	0	0	0
Other paper and paperboard	11	9.4	7.9	6.3	0	0	0	0

Table 6—Tariff rates in alternative scenarios (continued)

	Tariff rates							
				Base scenario			ATL scenario	
Country and commodity	**1997**	**1998**	**1999**	**2000**	**2004**	**2010**	**2000**	**2010**
Europe:								
European Union[a]—				*Percent*				
Fuelwood and charcoal	0	0	0	0	0	0	0	0
Saw logs and pulpwood	1	0.8	0.7	0.7	0.7	0.7	0	0
Industrial roundwood (other)	0	0	0	0	0	0	0	0
Sawnwood	2	1.7	1.3	1.3	1.3	1.3	0	0
Veneer and plywood	8.2	6.8	5.5	5.5	5.5	5.5	0	0
Particle board	8.2	6.8	5.5	5.5	5.5	5.5	0	0
Fiberboard	8.2	6.8	5.5	5.5	5.5	5.5	0	0
Mechanical wood pulp	0	0	0	0	0	0	0	0
Chemical and semichemical wood pulp	0	0	0	0	0	0	0	0
Other fiber pulp	0	0	0	0	0	0	0	0
Waste paper	0	0	0	0	0	0	0	0
Newsprint	4.5	3.9	3.2	2.6	0	0	0	0
Printing and writing paper	7.2	6.2	5.1	4.1	0	0	0	0
Other paper and paperboard	5.7	4.9	4.1	3.3	0	0	0	0

[a] Each country of the European Union is treated individually: Austria, Belgium-Luxembourg, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and United Kingdom.

Accelerated tariff liberalization scenario—Under the ATL scenario, tariffs are the same as in the base scenario for 1998 and 1999. Beginning in 2000, the tariffs would be eliminated for all commodities.

There are 180 countries in the GFPM. Changes in tariffs corresponding to each scenario were assumed only for the countries listed below (For other countries, it was assumed that there would be no change):

- America:
  Canada, Mexico, United States, Brazil, and Chile

- Asia and Oceania:
  Brunei, China, Japan, Hong Kong, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand; Australia, New Zealand, and Papua New Guinea

- European Union:
  Austria, Belgium-Luxembourg, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, and United Kingdom

Thus, it was assumed that forest products would be traded more freely worldwide between 1997 and 2010 in response to market responses to the tariff cuts. The adjustment of trade flows between countries or regions, however, will likely take time, thus inertia constraints were introduced to limit yearly trade changes to be within a specified fraction of the previous year's net supply (i.e., domestic supply plus imports,

also equal to domestic consumption plus exports). As detailed in the appendixes (see footnote 1), this is an extension of earlier trade inertia constraints (Buongiorno and Gilless 1984, Kallio et al. 1987, Zhang et al. 1997), meant to recognize the effect of the size of the domestic market on trade (Devarajan et al. 1997).

Other Assumptions

Other assumptions governing the projected effects of the ATL agreement related to changes in capacity, fiber input mix, and trade inertia. In the GFPM, capacity changes are endogenous. They depend on changes in past production and on relative profitability of additional capacity in different countries. Capacity data for the base year, 1997, were estimated from the production data. Thereafter, global capacity growth is predicted with a distributed-lag function linking capacity change to changes in past production. Then, global capacity growth is allocated to different countries according to the shadow price (the marginal value of one unit of additional capacity) revealed by the equilibrium computations (Gilless and Buongiorno 1987, Zhang et al. 1993).

The technology, defined by input-output coefficients and associated manufacturing costs, was held constant at the 1997 level, except for paper and paperboard. For paper and paperboard, it was assumed that the amount of recycled paper used in newsprint, printing and writing paper, and paper and paperboard would increase gradually between 1997 and 2010 to reach levels predicted by other studies (Ince 1994, Mabee 1998).

Mathematical Formulation of Global Forest Product Model

The GFPM simulates dynamic market equilibrium for the global forest sector. Every year, demand, supply, trade, and prices are computed that clear markets for all products and in all regions (static phase). Then, the model parameters are updated to reflect exogenous and endogenous changes from one year to the next (dynamic phase). Exogenous changes include economic growth, technical change, potential timber supply, and trade inertia; they are assumptions. Endogenous changes include capacity growth and availability of recycled fibers; they are determined by the model. The model then computes the quantity-price equilibrium next year as shaped by the intervening changes. It reiterates the static and dynamic phases for every year until the end of the projection.

Static phase—The equilibrium for each year of the projection is obtained with an optimization model that simulates world markets. It finds the production, consumption, and trade that maximize the total value of consumption minus the total cost of production and transport, for all products in all countries, in a given year. All the variables refer to that year. Objective function:

$$max\ Z = \sum_i \sum_k \int_0^{D_{ik}} P_{ik}(D_{ik})dD_{ik} - \sum_i \sum_k \int_0^{S_{ik}} P_{ik}(S_{ik})dS_{ik} - \sum_i \sum_k Y_{ik} m_{ik} - \sum_i \sum_j \sum_k c_{jk} T_{ijk} \quad , \qquad (1)$$

where

i,j = country;
k = product;
P = price in U.S. $;
D = final product demand;
S = raw material supply;

Y = quantity manufactured;
m = cost of manufacture;
T = quantity transported. In this version of the model, each country exports to the world market and imports from the world market; and
c = cost of transportation, including tariff.

Demand for final products:

$$D_{ik} = a_{ik} P_{ik}^{\ s_{ik}} X_i^{\alpha_{ik}} D_{ik,-1}^{\ h_{ik}} , \tag{2}$$

where

D_{-1} = demand in the previous year;
X = gross domestic product, in real U.S. $;
s,a,h = elasticities with respect to price, GDP, and past demand.

Wood supply and nonwood fiber supply:

$$\begin{aligned} P_{ik} &= P_{ik}^{\ 0} , \\ S_{ik} &\leq S_{ik}^{\ U} \end{aligned} \tag{3}$$

where

P^0 = cost of production, and
S^u = potential supply.

Material balance:

$$\sum_j T_{jik} + S_{ik} + Y_{ik} - D_{ik} - \sum_n a_{ikn} Y_{in} - \sum_j T_{jik} = 0 \qquad \forall\ i,k$$

$$T_{jik}^{\ L} \leq T_{ijk} \leq T_{ik}^{\ u} \qquad \forall i,j,k , \tag{4}$$

where

a_{ikn} = input of commodity k per unit of n, and
T^u, T^L = upper and lower bounds on imports and exports.

Price:

The market-clearing price is the shadow price of the material balance constraint (4).

Manufacturing capacity:

$$Y_{ik} \leq K_{ik} \qquad \forall\ i,k , \tag{5}$$

where

K = current capacity of production.

Waste paper recovery:

$$S_{ir} \leq S_{ir}^{U} \qquad \forall i,r \ , \tag{6}$$

where

r = recycled paper, and
S^U = upper bound on recycled paper supply.

Dynamic phase—Yearly changes in the market equilibrium conditions are brought about by:

- Shifts of the demand curves, due to changes in X at the projected GDP growth rate.
- Shifts of the upper bounds on wood supply, S, at the assumed rate of growth of potential supply.
- Changes of manufacturing coefficients m to reflect technical change, especially increasing use of paper recycling.
- Changes of capacity, determined as follows:

At global level, capacity change is a function of changes in production during the past 3 years:

$$\Delta K_k = b_{1k}\Delta Y_{k,-1} + b_{2k}\Delta Y_{k,-2} + b_{3k}\Delta Y_{k,-3} \ , \tag{7}$$

then, global capacity change is allocated to each country in proportion of its production level and the marginal value of capacity revealed by the shadow price of capacity in the static phase.

$$\Delta K_{ik} = \frac{Y_{ik}\pi}{\sum_j Y_{ik}\pi} \Delta K_k \ , \tag{8}$$

where

Δ = yearly change, and

π = shadow price of capacity (endogenous, from constraint (5).

• Changes in waste paper recovery:

$$S_{ir}^{U} = \sum_{k} w_{ikr} D_{ik,-1} \ , \tag{9}$$

where

w_{ikr} = maximum possible recovery rate (exogenous).

• Changes in tariff:

$$c_{ij} = c_{ij,-1} + (t_j - t_{j,-1}) P_{jk,-1} \ , \tag{10}$$

where

t = the ad valorem tariff rate, in percentage.

• Trade inertia:

$$T_{ijk}^{U} = \left(\frac{T_{ijk,-1}}{N_{ik,-1}} + e_{ijk}\right) N_{ik,-1}$$

$$T_{ijk}^{L} = \left(\frac{T_{ijk,-1}}{N_{ik,-1}} + e_{ijk}\right) N_{ik,-1}$$

$$N_{Nik} = S_{ik} + \sum_{j} T_{Jik} = D_{ik} + \sum_{j} T_{ijk} \ , \tag{11}$$

where

e = the absolute value of the maximum yearly change in the ratio of import or export to net supply (exogenous).

Projections with Accelerated Tariff Liberalization, 1997-2010

The outlook presented here corresponds to the scenario with ATL. The purpose is to compare the projections from 1997 to 2010 with past trends from 1965 to 1997. The detailed projections under this scenario are in appendixes 1 through 4 (see footnote 1), where they also are compared to projections without the ATL (see also “The Effects of Tariff Liberalization, 1997-2001”).

The global forest sector has expanded greatly during the last three decades, and overall trends show a rising production, domestic consumption, and trade. In most parts of the world, the major measurable factors affecting consumption of forest products are general economic growth and prices. Many other influences, however, are relevant and reflected indirectly by the GDP and price elasticities: level of residential investment, technical and economic competitiveness of sawnwood and panels in the building sector, development in electronic media, competitiveness of paper and paperboard for packaging, for example.

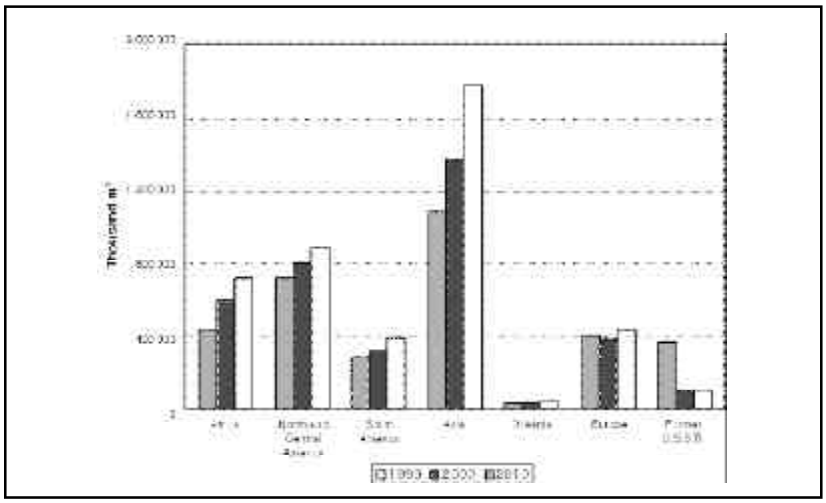

Figure 2—Consumption of roundwood.

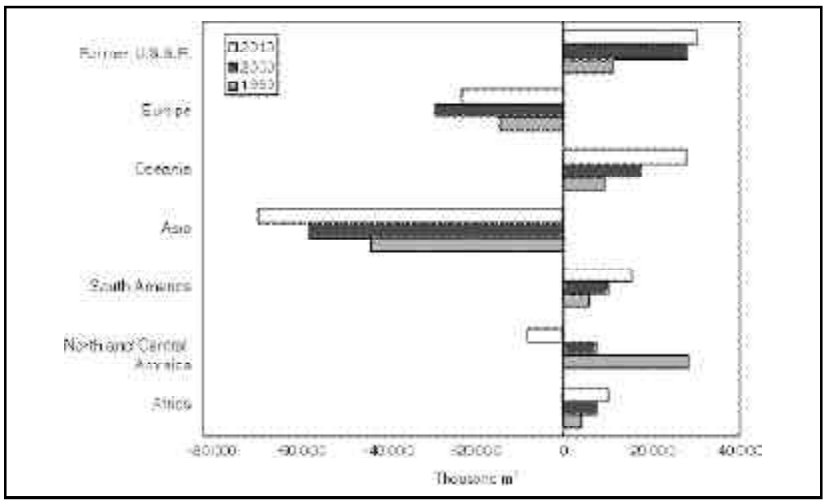

Figure 3—Net trade of roundwood.

Roundwood

Total consumption of roundwood in the world has increased almost 50 percent between 1961 and 1997, from 2.2 billion m^3 to nearly 3.4 billion m^3. The projections show that the world demand for wood will continue to rise, especially in Asia where rapidly growing economies are concentrated (fig. 2). According to the projections, the world total roundwood consumption would reach 3.6 billion m^3 by 2000 and 4.4 billion m^3 by 2010, an increase of 8 percent and 29 percent, respectively, from the 1997 level. In 1997, Asia and Europe were net importers of roundwood. By 2010, the projections show that all regions will retain their trading status, but North and Central America will become net importer (fig. 3). This reflects, in part, the effects of timber harvest restrictions implemented in the United States.

Fuelwood and Charcoal

The world total consumption of fuelwood and charcoal increased 61 percent from 1 billion m^3 in 1965 to about 1.8 billion m^3 in 1997. The projections show that the world demand for fuelwood and charcoal will continue to rise, especially in Asia and Africa

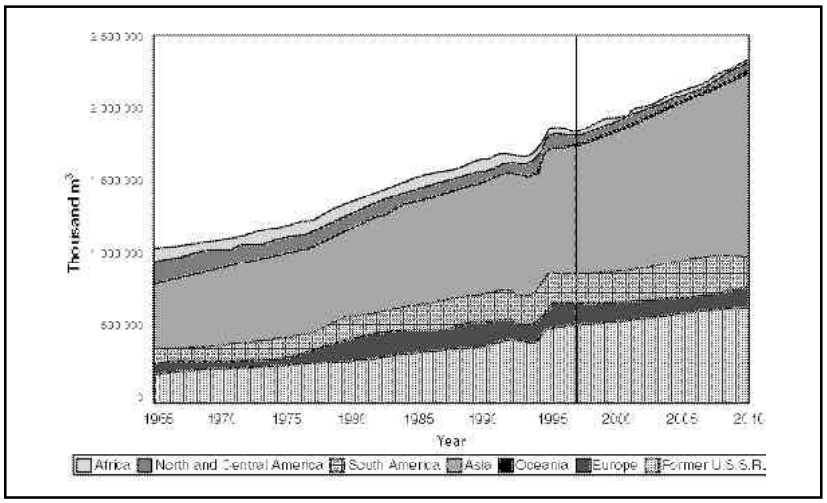

Figure 4—Consumption of fuelwood.

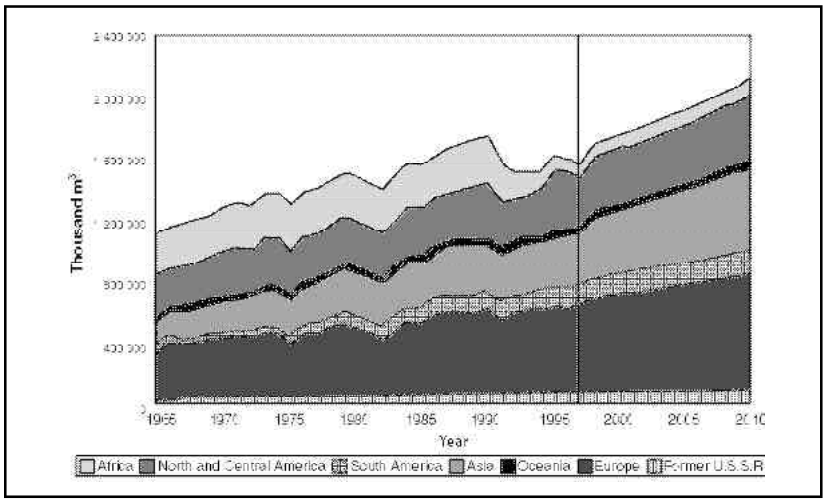

Figure 5—Consumption of industrial roundwood.

(fig. 4). Growth would occur however, at a slower rate than in the past decade, in all regions. In North and Central America, Oceania, and Europe, fuelwood consumption is expected to decrease slightly in the next 13 years.

Industrial Roundwood

Between 1965 and 1997, because of moderate growth in population and rapid growth in the economy, world consumption of industrial roundwood has shown sustained increases. Total consumption was about 1523 million m^3 in 1997, about one-third above the 1965 level. According to the projections, the world industrial roundwood consumption would reach 2039 million m^3 by 2010, an increase of 34 percent from the 1997 level (fig. 5). Because of the regional imbalance between production and consumption, there would be an increase in trade. The trade deficit of Asia would increase from 56 million in 1997 to 68 million m^3 in 2010, and the trade deficit of Europe would decrease slightly (fig. 6). Exports of South America are projected to almost double, whereas North and Central America would become a net importer in 2010.

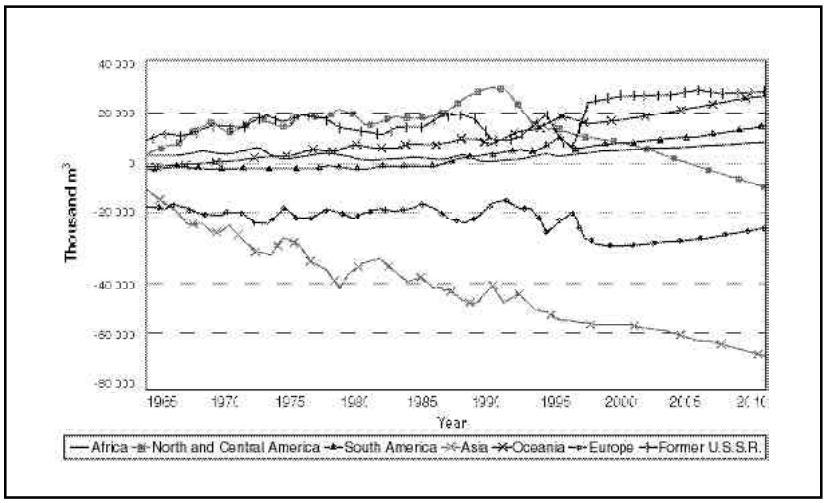

Figure 6—Net trade of industrial roundwood.

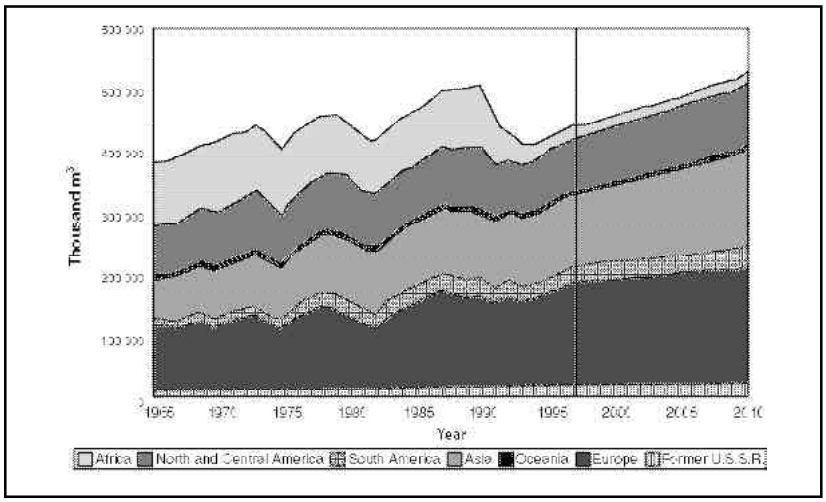

Figure 7—Consumption of sawnwood.

Sawnwood

Sawnwood and sleepers (sawnwood in short) includes coniferous and nonconiferous species. The world sawnwood consumption rose slightly, from 383 million m^3 in 1965 to 441 million m^3 in 1997. In 1990, it reached its peak, 508 million m^3, and then dropped sharply until 1994 (fig. 7). This was largely due to the decrease in the consumption of the former U.S.S.R, which consumed only about one-fourth of its 1990 consumption in 1994. From 1997 to 2010, global sawnwood consumption is projected to grow from 441 to 532 million m^3.

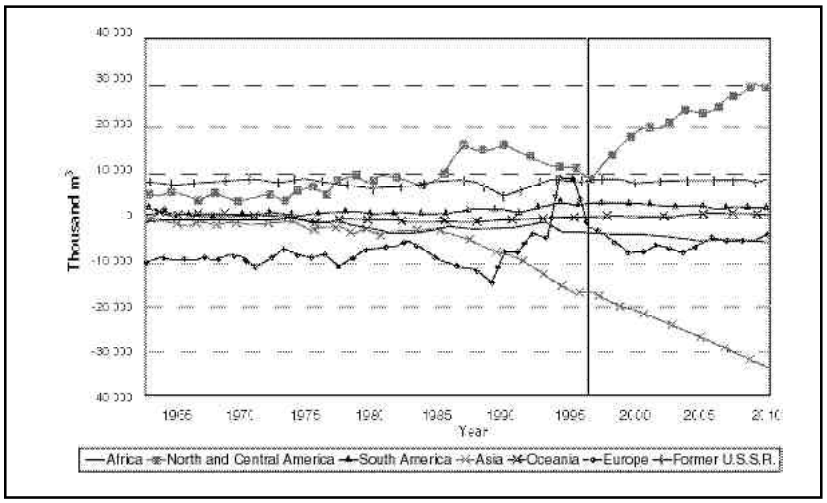

Figure 8—Net trade of sawnwood.

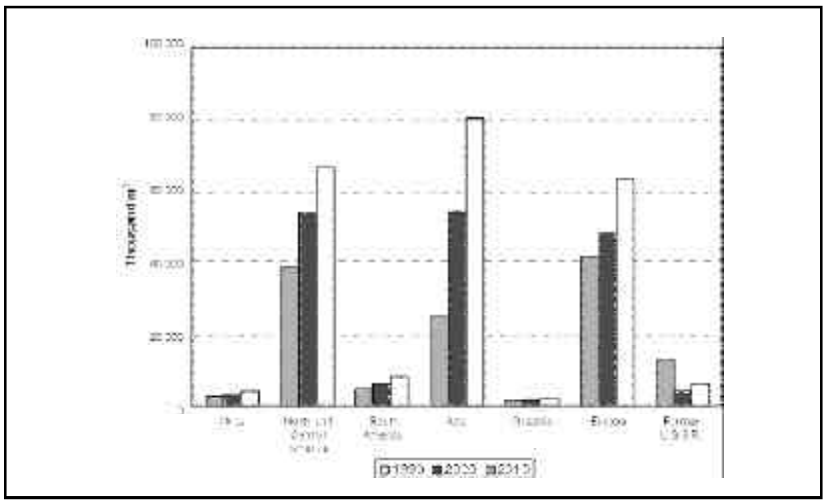

Figure 9—Consumption of wood-based panels.

In 1997, the three net exporting regions were the former U.S.S.R., North and Central America, South America, and Oceania, respectively. They are projected to continue to be net exporters by 2010 (fig. 8). By 2010, North and Central America is projected to increase its surplus with 29 million m^3 of net exports. Net exports of Oceania will almost double, whereas the former U.S.S.R. and South America would stay at about their 1997 level. Symmetrically, the largest net importer is projected to continue to be Asia whose net imports would reach 33 million m^3 by 2010, followed by Africa at 5.5 million m^3.

Wood-based panels—From 1965 to 1997, the demand for wood-based panels grew faster than for any other forest product. World consumption went from 42 million m^3 to 154 million m^3, with an average growth of 4.1 percent per year. The 1997 distribution of the world's consumption by panel type was plywood and veneer, 40 percent; particle board, 45 percent; and fiberboard, 15 percent. Wood-based panels consumption was expected to grow during the next 13 years to 231 million m^3 in 2010 (fig. 9).

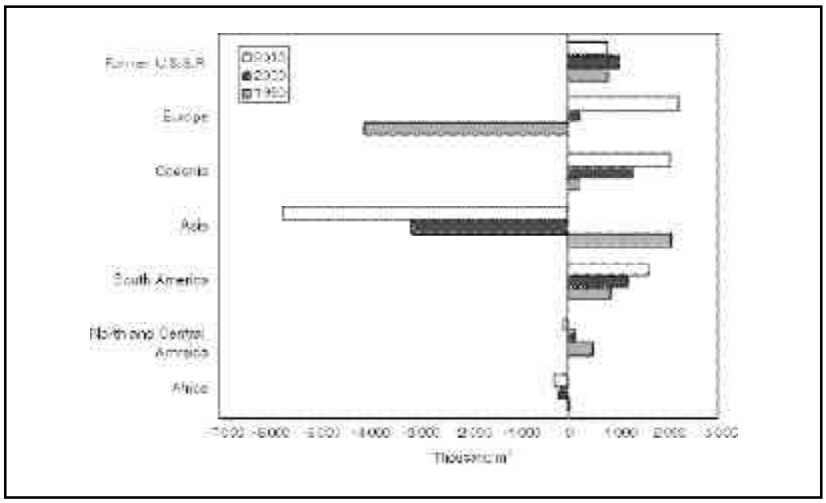

Figure 10—Net trade of wood-based panels.

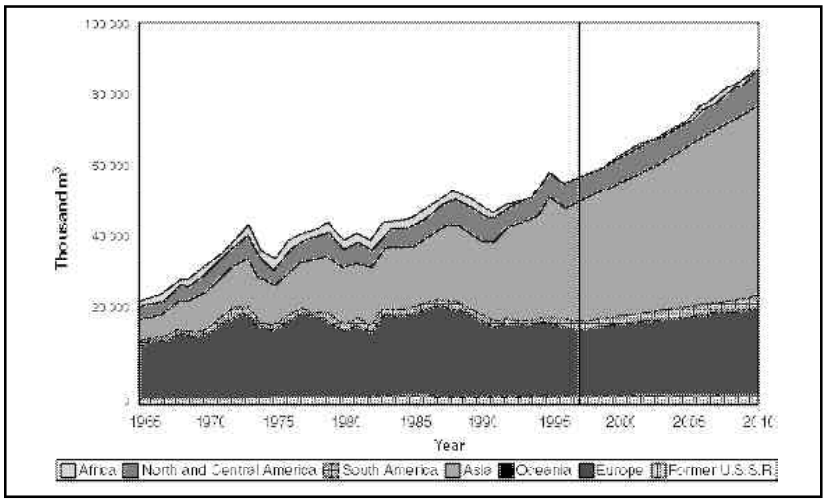

Figure 11—Consumption of veneer and plywood.

From 1965 to 1993, Asia, the former U.S.S.R., and South America were net exporters, but Asia became a net importer after 1993. The projections are that by the year 2010, Europe and Oceania will become the largest and the second net exporters, respectively, whereas South America and the former U.S.S.R. would still be net exporters. Asia would become by far the largest net importer, reaching 5.8 million m^3 by 2010, whereas North and Central America would nearly balance its trade (fig. 10).

Veneer sheets and plywood—The world consumption of veneer sheets and plywood increased from 27 million m^3 in 1965 to 60 million m^3 in 1997. It is projected that world consumption would increase from 60 million m^3 in 1997 to 89 million m^3 in 2010, for an average annual growth rate of 3 percent (fig. 11). Although in 1997, Asia was the largest net exporter and Europe the largest net importer, by 2010, South America is projected to be the largest net exporter of plywood and veneer, and Europe would continue to be the largest net importer (fig. 12).

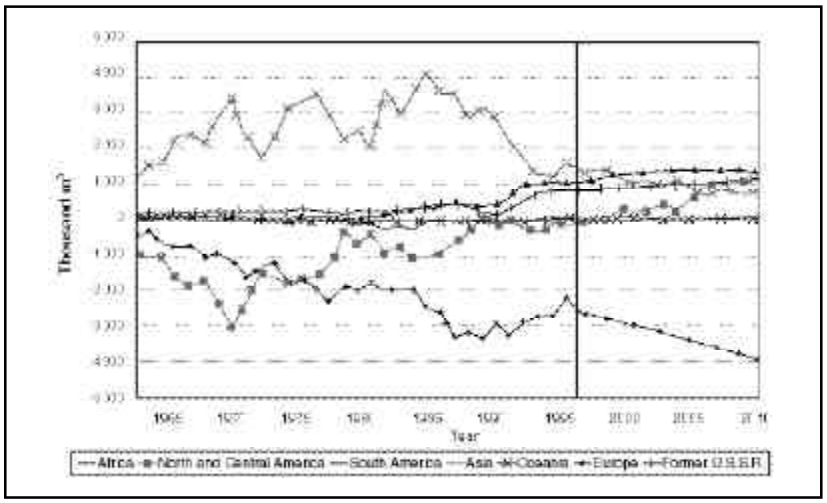

Figure 12—Net trade of veneer and plywood.

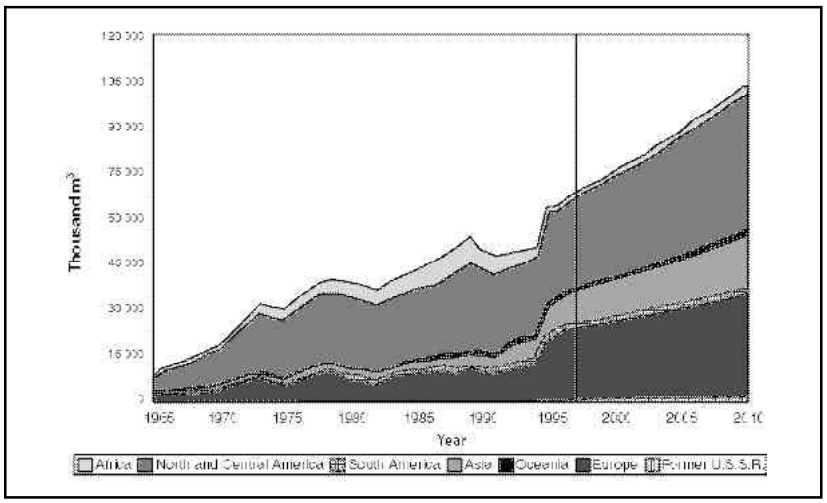

Figure 13—Consumption of particle board.

Particle board—The world consumption of particle board grew fast, from 9 million m^3 in 1965 to 70 million m^3 in 1997. Meanwhile, it is projected that the world particle board consumption would continue to increase to 105 million m^3 in 2010 (fig. 13). Europe switched from being the largest net importer of particle board in 1989 to the largest net exporter in 1994. In 1997, Asia was the largest net importer of particle board (fig. 14). The 2010 projections show Europe to still be the largest net exporter, at a slightly higher level than in 1997. Asia would continue to be the largest net importer, and its net imports of particle board would increase steadily, reaching 2224 thousand m^3 by 2010.

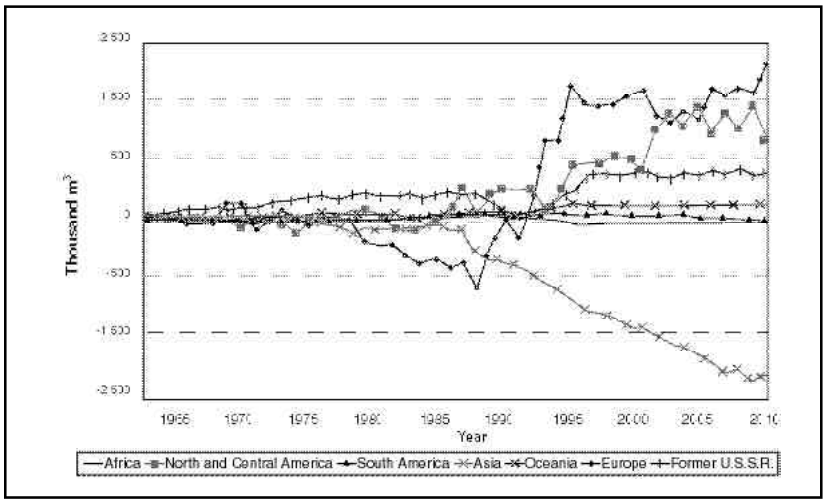

Figure 14—Net trade of particle board.

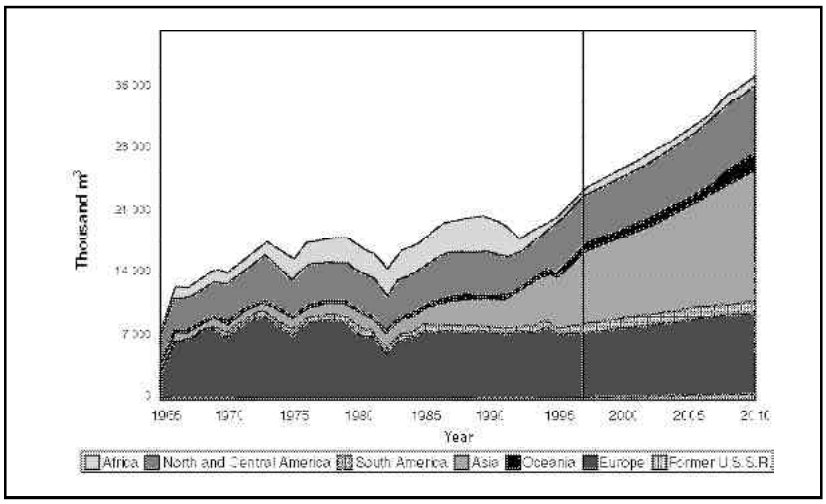

Figure 15—Consumption of fiberboard.

Fiberboard—The world consumption of fiberboard increased from 6.4 million m^3 in 1965 to 23 million m^3 in 1997. (Asia had the largest consumption of fiberboard amoung the regions.) The projections suggest that the world fiberboard consumption will continue increasing from 23 million m^3 in 1997 to 36 million m^3 in 2010 (fig. 15). By 2010, Asia, North and Central America, and Europe will be the three main consuming regions, respectively. The net exporting regions in 1997 (South America, North and Central America, Oceania, Europe, and the former U.S.S.R.) are projected to still be net exporters in 2010 (fig. 16). The main net importing region would still be Asia by 2010, its deficit in fiberboard trade increasing to about 3918 thousand M.T. in 13 years.

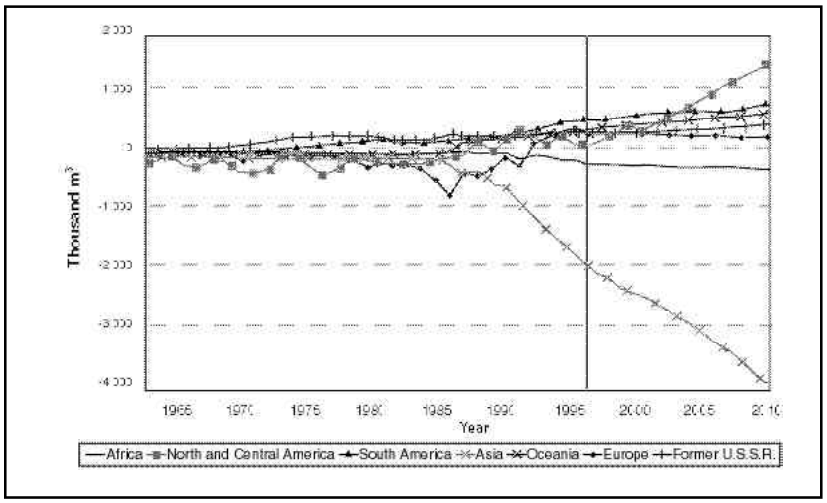

Figure 16—Net trade of fiberboard.

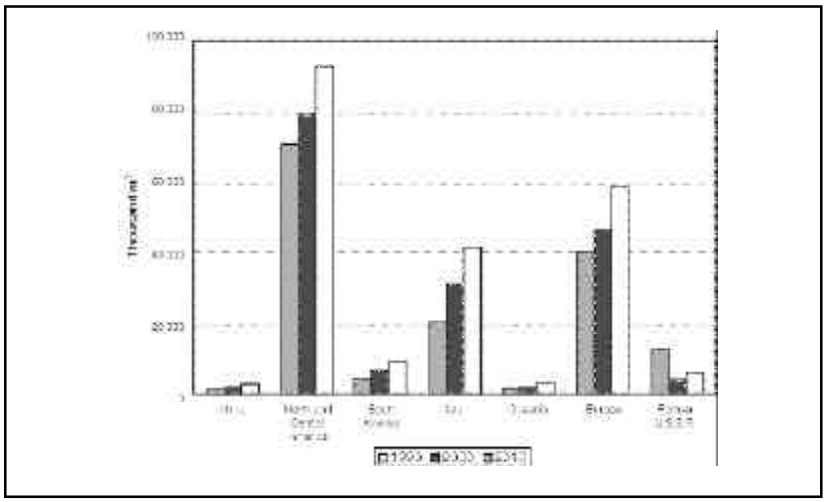

Figure 17—Consumption of wood pulp.

Fiber furnish—Total fiber furnish includes all wood pulp, waste paper, and other fiber pulps. The world consumption of fiber furnish, which almost tripled from 1965 to 1997, is projected to reach 490 million M.T. by 2010, from 289 million M.T. in 1997.

Wood pulp—Wood pulp includes mechanical pulp and chemical pulp. Wood pulp consumption was expected to grow to 216 million m^3 by 2010, from 158 million m^3 in 1997 (fig. 17). In 1997, Asia was the largest net importer and North and Central America the largest net exporter. The projections show the same rankings for 2010 (fig. 18).

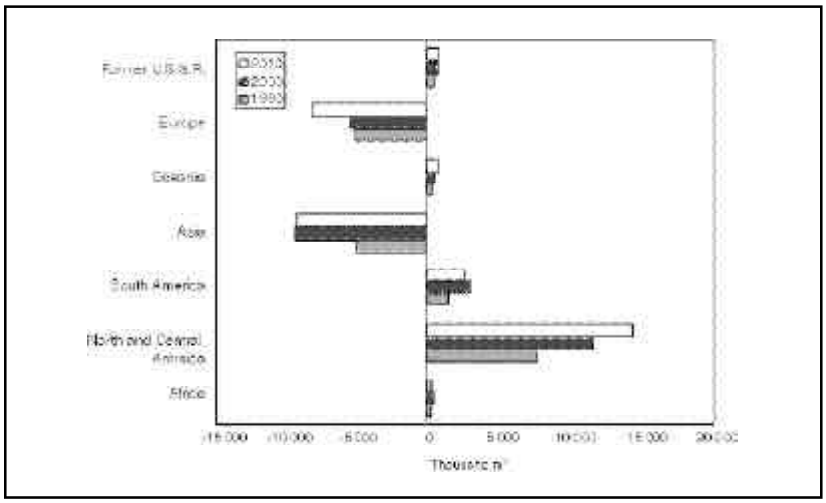

Figure 18—Net trade of wood pulp.

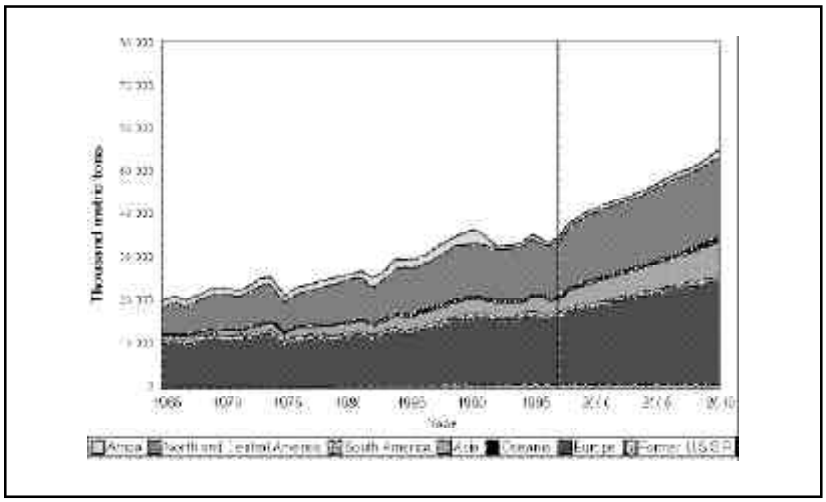

Figure 19—Consumption of mechanical wood pulp.

Mechanical pulp—From 1997 to 2010, consumption of mechanical pulp is projected to grow fastest in Asia and Africa, and slower in other regions (fig. 19). Oceania, the largest net exporter in 1997, would continue to expand its world market share and be the largest exporter by 2010 (fig. 20). North and Central America would be the second largest net exporter, and Europe would still be a small net exporter by 2010, with little change. Asia would continue to be the major importer and would increase its net imports by 2010 to about 980,000 M. T.

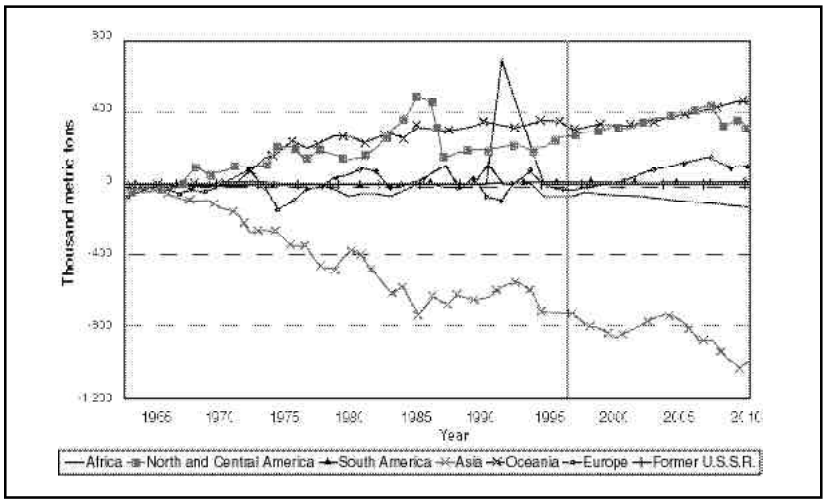

Figure 20—Net trade of mechanical wood pulp.

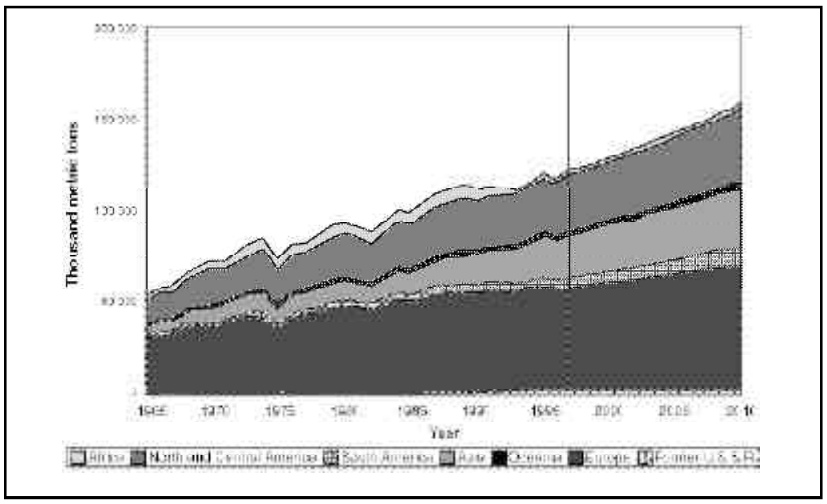

Figure 21—Consumption of chemical/semichemical wood pulp.

Chemical pulp—Chemical pulp consumption is projected to increase the most in Africa and Oceania, and least in North and Central America (fig. 21). North and Central America would remain the largest net exporter of chemical pulp, and Europe would exceed Asia to be the largest net importer (fig. 22). Net exports for South America are projected to decrease slowly until 2010.

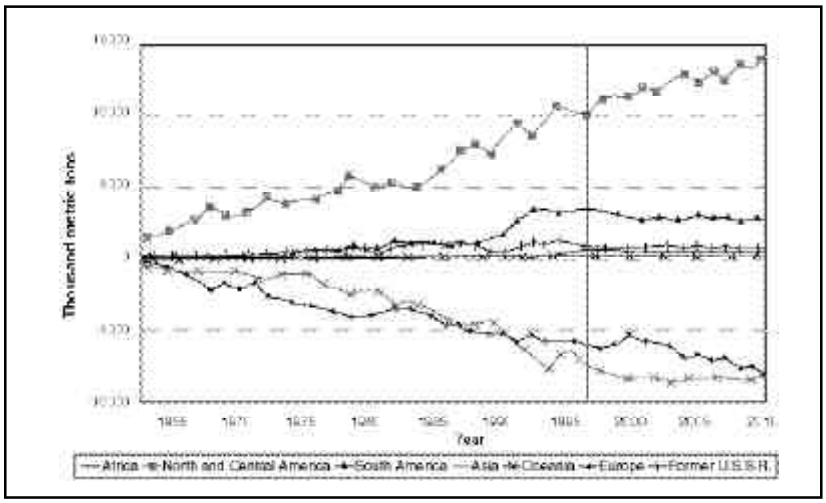

Figure 22—Net trade of chemical/semichemical wood pulp.

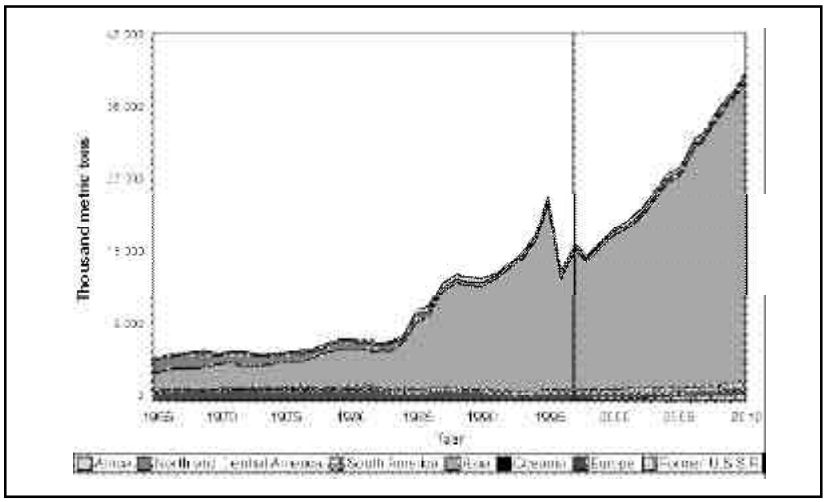

Figure 23—Consumption of other fiber pulp.

Other fiber pulp—Figure 23 indicates that consumption of other fiber pulp has increased rapidly in Asia after 1984 because of large fiber needs caused by quick development in the economy and limited wood fibers of the region. Other fiber pulp consumption in Asia is projected to approach 38 million M.T. by 2010, larger than the sum of mechanical and chemical pulp consumption.

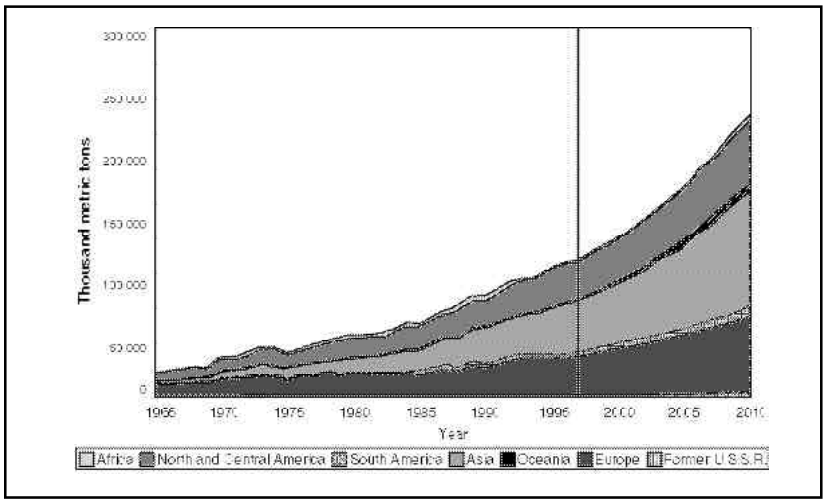

Figure 24—Consumption of wastepaper.

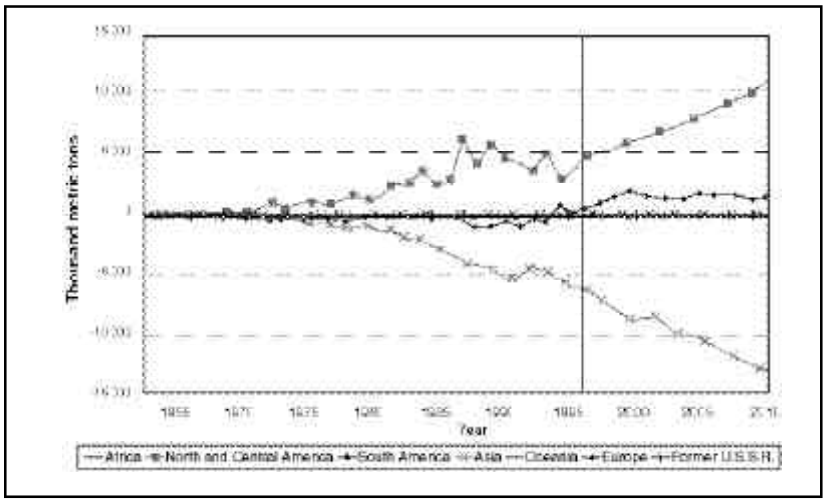

Figure 25—Net trade of wastepaper.

Waste paper—According to the projection, consumption and production of wastepaper would increase fast in Asia and South America (fig. 24). Asia would remain the largest net importer, whereas North and Central America would remain the major net exporter. The projections suggest that exports from the region will continue to increase fast (fig. 25). Net imports for Asia would increase by 50 percent by 2010. The net surplus of Europe also would continue to increase steadily.

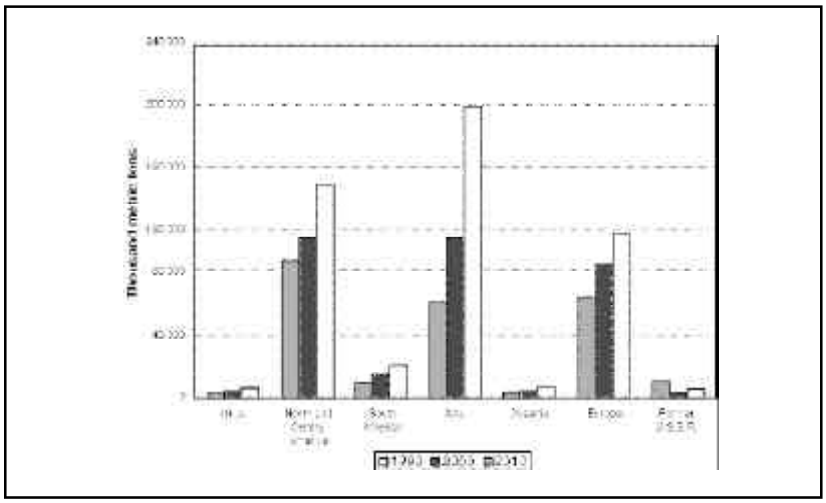

Figure 26—Consumption of paper and paperboard.

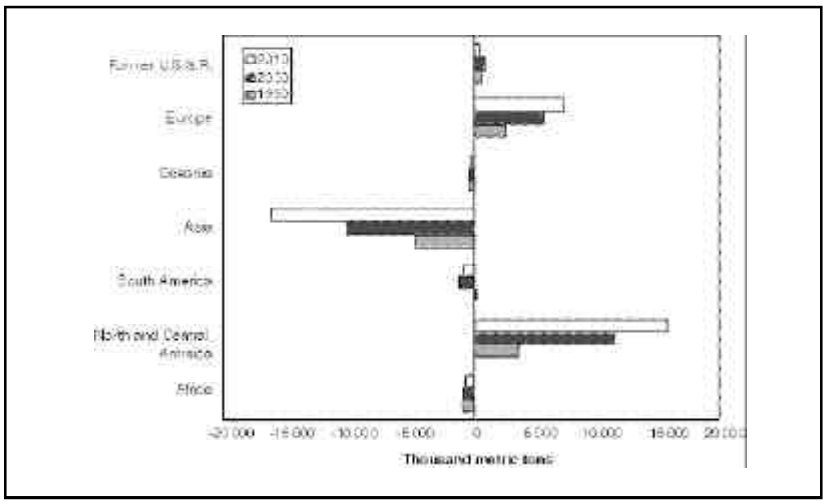

Figure 27—Net trade of paper and paperboard.

Paper and Paperboard

The paper and paperboard group includes newsprint, printing and writing paper, and other paper and paperboard. Figure 26 shows that according to projections, Asian consumption would exceed that of North and Central America by 2000. This is due essentially to the faster rate of GDP growth for Asia presumed in the scenario. Figure 26 also shows the world consumption of paper and paperboard would be 500 million M.T. by 2010, from 294 million M.T. in 1997. Figure 27 suggests that North and Central America would exceed Europe to become the largest net exporter of paper and paperboard by 2010, reaching 15 million M.T. Net imports for Asia would almost double in 13 years.

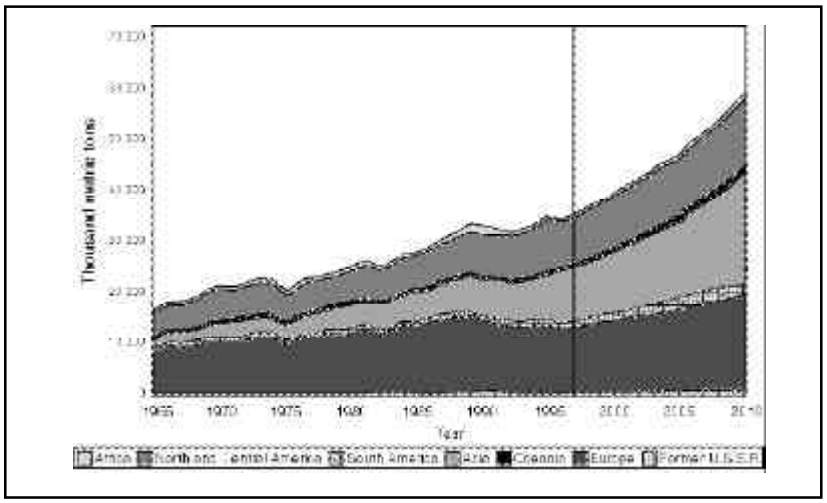

Figure 28—Consumption of newsprint.

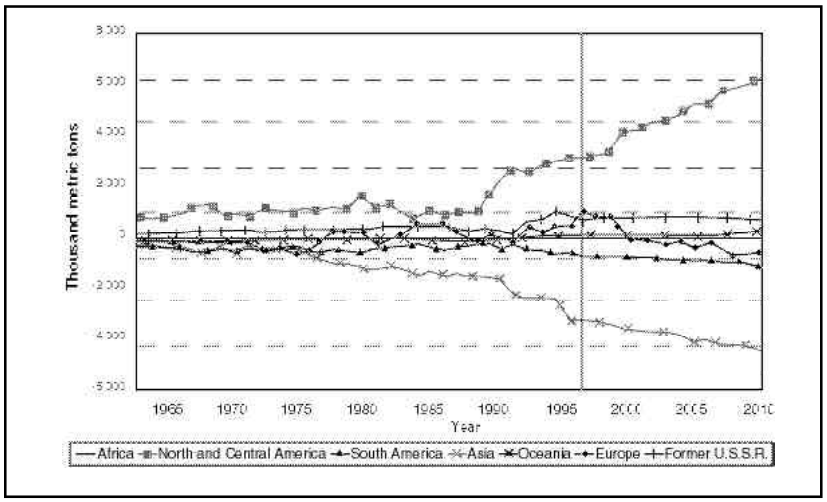

Figure 29—Net trade of newsprint.

Newsprint—The growth of newsprint consumption would be faster than that of the 1990s in all regions, especially in Asia and the former U.S.S.R. (fig. 28). World newsprint consumption would increase from 35 million M.T. in 1997 to 60 million tons in 2010. The largest net exporter would still be North and Central America, followed by the former U.S.S.R. (fig. 29). Asia would remain the largest net importer and is projected to increase its net imports by 37 percent from 1997 to 2010.

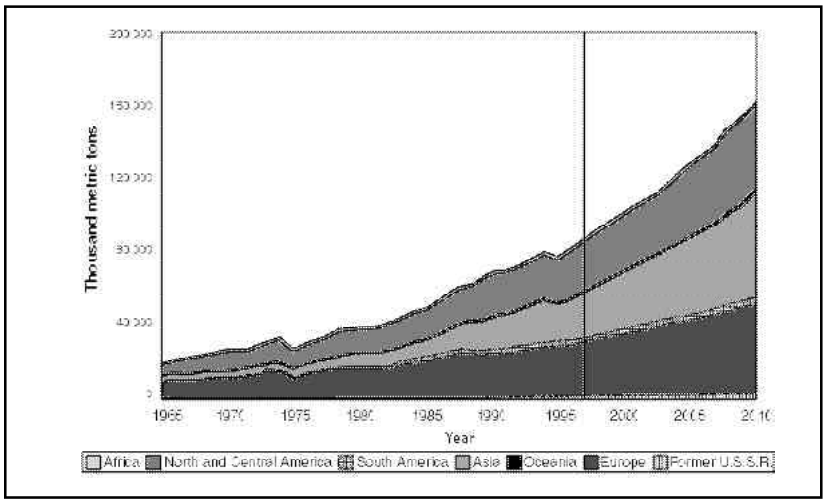

Figure 30—Consumption of printing and writing paper.

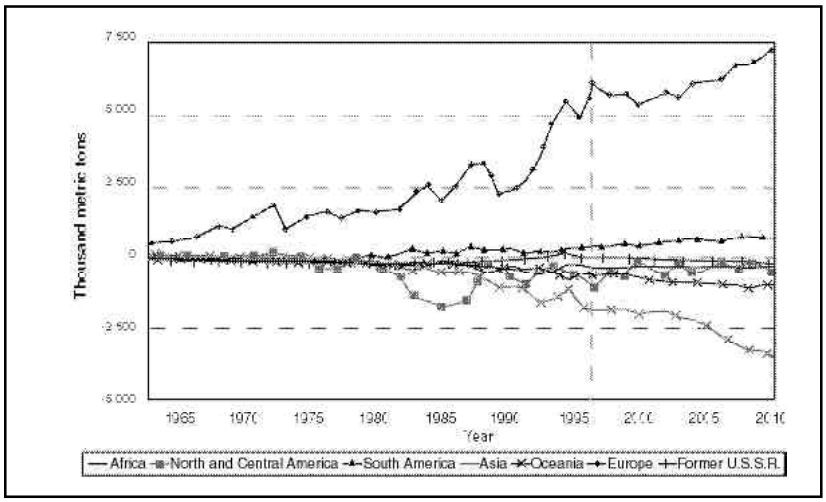

Figure 31—Net trade of printing and writing paper.

Printing and writing paper—Consumption of printing and writing paper is projected to grow fastest in the former U.S.S.R. and Oceania. World printing and writing paper consumption would increase from 88 million M.T. in 1997 to 163 million M.T. in 2010, almost double in 13 years (fig. 30). The positions of Europe and South America as net exporters would strengthen, though net exports would grow at a slower rate. The trade deficit in printing and writing paper in Asia would reach nearly 3.6 million M.T. in 2010 (fig. 31).

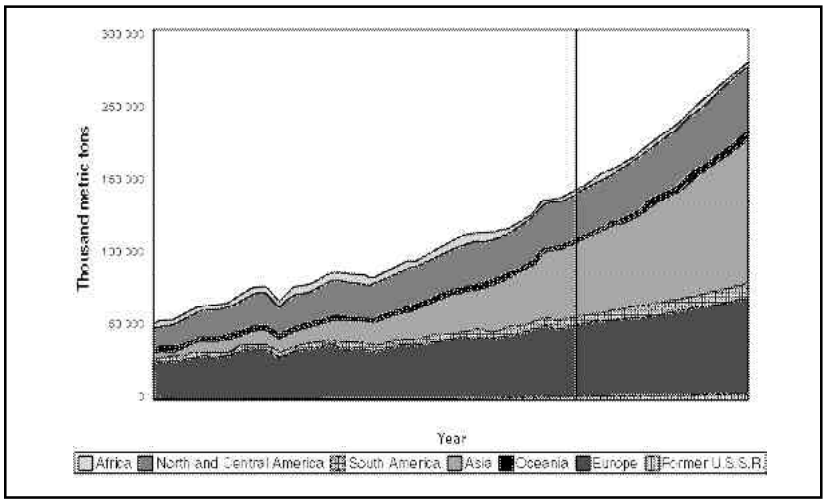

Figure 32—Consumption of other paper and paperboard.

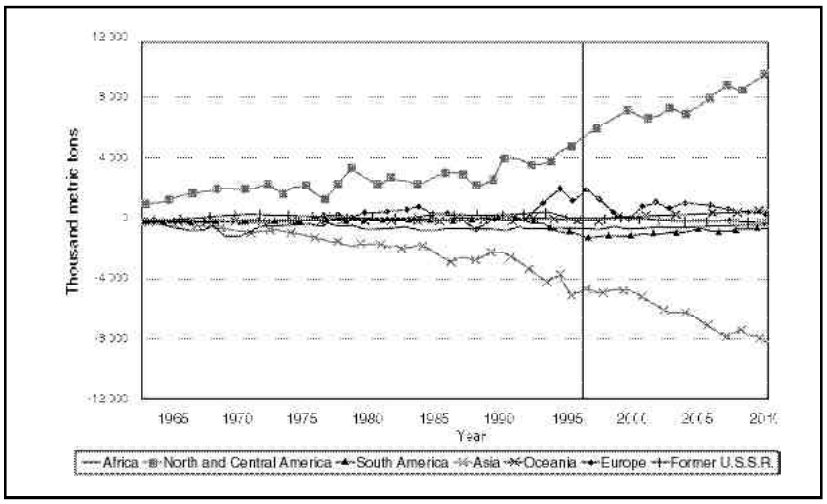

Figure 33—Net trade of other paper and paperboard.

Other paper and paperboard—Other paper and paperboard consumption is projected to grow slower than printing and writing paper and newsprint. Asia would experience the most increase (fig. 32). World consumption other paper and paperboard would increase from 170 million M.T. in 1997 to 277 million M.T. in 2010. Asia would nearly double its net imports by 2010. Net exports from North and Central America would continue to grow almost linearly, whereas net exports from Europe would decrease to one-fifth of their 1997 level (fig. 33).

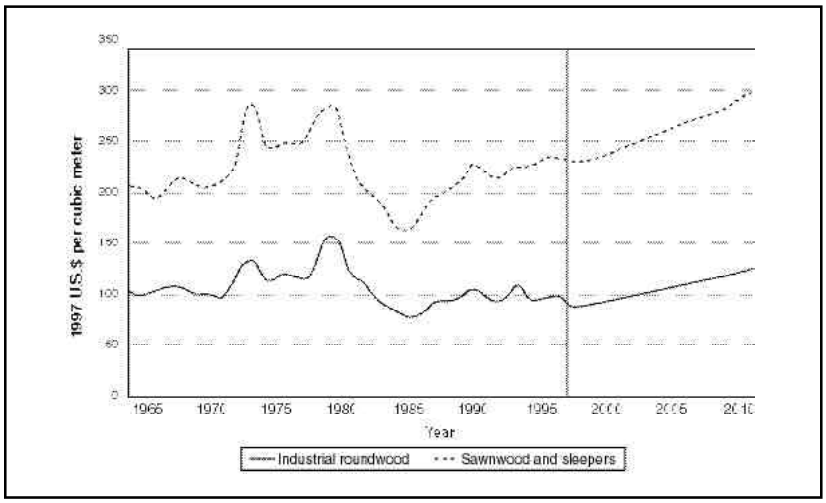

Figure 34—Real world prices of solid wood products.

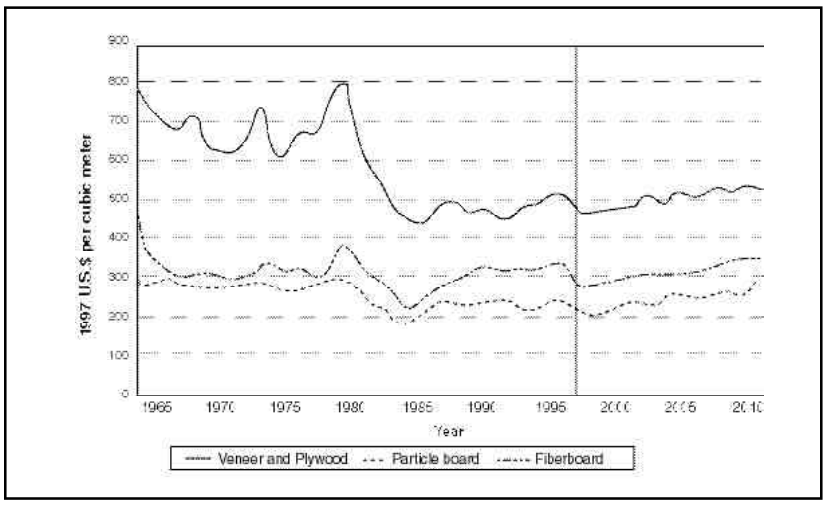

Figure 35—Real world prices of wood-based panels.

Price Trends with Accelerated Tariff Liberalization

In market economies, prices determine, in part, the demand and supply of forest products. Price levels are also critical in determining the feasibility of forestry and industry projects. It is, therefore, useful that the method to predict consumption, production, and trade also gives projections of the market clearing prices.

Industrial roundwood and sawnwood—Figure 34 presents historical trends and projections for industrial roundwood and sawnwood prices in 1997 U.S. $ at the world level. Historically, the price of sawnwood paralleled the price of industrial roundwood, mainly because roundwood is a major part of the total cost of sawmilling, reaching as high as 60 to 70 percent. The projections show that the relation between the two prices will remain strong over the next 13 years.

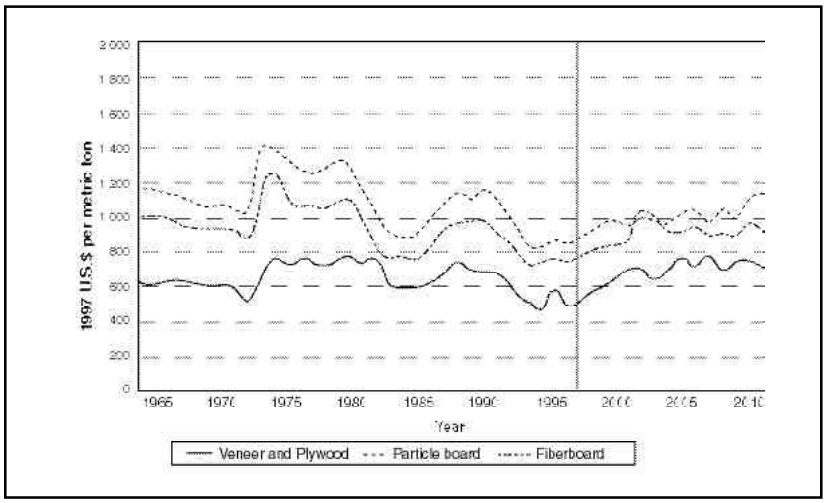

Figure 36—Real world prices of paper and paperboard.

The price projections suggest that the real price of industrial roundwood worldwide would increase by $27 per m^3 over the next decade, and would rise to about $130 per m^3 by 2010. Because of the rising price of raw material, the price of sawnwood would increase by $50 per m^3. The price of sawnwood is projected to reach about $300 per m^3 in 2010.

Wood-based panels—The price for wood-based panels fell between 1965 and 1997, as shown in figure 35. This steady fall in price was made possible mostly by a reduction in costs of production (new processes, economies of scale, cheaper raw material from sawmill residues, for example). Among all panel products, the real price of veneer and plywood declined more than that of particle board or fiberboard.

The projections show that the real prices of veneer and plywood, particle board, and fiberboard should increase slightly during the next 13 years, almost in parallel with the increasing price of industrial roundwood (fig. 34).

Paper and paperboard—For the pulp and paper sector, wood costs account for a smaller share of total costs, notably because of high capital costs. Because the technology is broadly similar throughout the world, however, wood cost is one of the means whereby individual companies seek to gain a comparative advantage. To some extent, therefore, the price trend of paper and paperboard also followed that of industrial roundwood during the last three decades of the 20th century (fig. 36). The strong rise after 1973 was due to high energy costs that declined subsequently.

The prices of paper and paperboard projected with the GFPM and under the ATL agreement remain stable or increase slightly from 1997 to 2010. The price trend corresponds to the raw material price trend, dampened by the increased use of waste paper and other fiber pulp in paper and paperboard production worldwide and in Asia particularly.

Effects of Accelerated Tariff Liberalization Agreement, 1997-2010

Table 7—Consumption of industrial roundwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	45 607	59 368	59 645	68 554	59 668	68 240	-0.5
North and Central America	472 122	603 287	668 147	772 411	669 264	776 478	0.5
United States	307 817	399 868	452 820	512 839	452 629	518 406	1.1
South America	84 432	121 134	127 437	151 138	127 444	152 703	1.0
Asia	270 609	333 458	398 565	527 799	398 626	523 054	-0.9
Oceania	18 837	24 205	25 190	31 048	25 201	32 662	5.2
Europe	235 898	317 445	342 345	399 352	341 592	405 281	1.5
Former U.S.S.R.	263 120	77 939	83 565	93 914	83 565	94 934	1.1
Developed, all	1 077 492	1 094 509	1 188 693	1 385 998	1 188 796	1 386 726	0.1
Developing, all	313 133	442 327	516 201	658 217	516 563	666 628	1.3
World	1 390 625	1 536 836	1 704 894	2 044 215	1 705 359	2 053 353	0.4

Table 8—Consumption of sawnwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	9 917	12 017	12 646	14 930	12 646	14 940	0.1
North and Central America	123 139	172 833	177 158	192 431	177 159	192 431	0.0
United States	101 196	148 259	151 755	163 692	151 755	163 692	0.0
South America	20 895	27 470	28 897	34 782	28 897	34 858	0.2
Asia	98 201	113 623	122 106	156 728	122 106	158 041	0.8
Oceania	6 104	6 580	6 787	7 550	6 787	7 546	-0.1
Europe	73 465	91 722	94 072	102 956	94 072	102 956	0.0
Former U.S.S.R.	91 314	17 307	17 563	20 941	17 563	20 924	-0.1
Developed, all	332 848	318 180	326 060	356 520	326 060	356 501	0.0
Developing, all	90 187	123 372	133 169	173 798	133 169	175 197	0.8
World	423 035	441 552	459 230	530 318	459 230	531 697	0.3

Table 9—Consumption of wood-based panels (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	1 634	2 081	2 291	3 121	2 287	3 095	-0.8
North and Central America	32 021	49 865	53 470	67 158	53 469	67 258	0.1
United States	27 399	44 121	47 260	58 943	47 260	59 035	0.2
South America	3 239	4 571	4 952	6 708	4 952	6 714	0.1
Asia	17 011	47 830	54 069	81 185	54 070	80 748	-0.5
Oceania	1 148	1 972	2 163	2 940	2 163	3 806	29.5
Europe	23 132	44 318	48 118	64 623	48 118	63 795	-1.3
Former U.S.S.R.	9 849	3 023	3 161	5 272	3 161	5 347	1.4
Developed, all	76 118	112 835	121 653	158 750	121 653	158 911	0.1
Developing, all	11 916	40 825	46 570	72 256	46 567	71 852	-0.6
World	88 034	153 660	168 223	231 006	168 220	230 763	-0.1

Table 10—Consumption of woodpulp (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	932	1 782	1 986	3 086	1 988	3 121	1.1
North and Central America	58 994	74 185	79 960	94 119	79 971	93 884	-0.2
United States	45 539	59 285	61 481	70 800	61 481	70 879	0.1
South America	3 367	5 971	6 620	9 549	6 620	9 635	0.9
Asia	14 935	27 717	31 396	42 145	31 376	41 994	-0.4
Oceania	1 623	1 952	2 117	2 834	2 116	2 999	5.8
Europe	26 840	43 598	47 113	58 954	47 172	59 744	1.3
Former U.S.S.R.	7 463	3 000	3 309	4 890	3 309	4 852	-0.8
Developed, all	106 181	138 070	148 078	180 247	148 146	180 813	0.3
Developing, all	7 973	20 135	24 423	35 330	24 405	35 416	0.2
World	114 154	158 205	172 501	215 578	172 551	216 229	0.3

Table 11—Consumption of total paper and paperboard (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	2 452	4 183	4 661	6 798	4 661	6 862	0.9
North and Central America	68 104	101 423	110 809	147 779	110 809	147 717	0.0
United States	60 706	89 502	97 598	127 786	97 598	127 525	-0.2
South America	6 417	11 382	12 567	18 025	12 567	18 641	3.4
Asia	32 665	95 050	113 190	199 913	113 203	198 634	-0.6
Oceania	2 449	3 853	4 329	6 290	4 329	6 574	4.5
Europe	35 054	74 595	81 706	114 967	81 706	115 305	0.3
Former U.S.S.R.	8 603	3 239	3 375	6 354	3 375	6 289	-1.0
Developed, all	130 307	212 098	232 904	321 481	232 904	321 351	0.0
Developing, all	25 437	81 627	97 733	17 645	97 745	178 671	0.0
World	155 744	293 725	330 637	500 127	330 650	500 022	0.0

Table 12—Production of industrial roundwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	50 801	66 366	67 242	79 230	67 265	78 496	-0.9
North and Central America	492 415	613 534	675 936	772 261	677 053	769 403	-0.4
United States	327 095	416 092	467 872	524 504	467 681	525 018	0.1
South America	85 487	130 085	137 566	166 878	137 572	168 458	0.9
Asia	233 821	277 153	341 261	450 016	341 474	454 992	1.1
Oceania	27 930	41 285	43 665	57 561	43 653	60 874	5.8
Europe	217 168	291 482	314 855	376 814	313 973	383 151	1.7
Former U.S.S.R.	277 700	103 019	110 458	127 544	110 458	124 068	-2.7
Developed, all	1 047 723	1 072 919	1 166 592	1 361 907	1 166 821	1 363 013	0.1
Developing, all	337 599	450 005	524 390	668 396	524 627	676 428	1.2
World	1 385 322	1 522 924	1 690 983	2 030 303	1 691 448	2 039 441	0.5

Table 13—Production of sawnwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	7 650	8 350	8 565	9 364	8 564	9 425	0.7
North and Central America	132 302	181 091	194 210	217 211	195 094	221 358	1.9
United States	84 112	111 425	122 568	131 624	122 568	135 751	3.1
South America	21 993	30 285	31 696	37 098	31 690	36 961	-0.4
Asia	94 718	96 531	101 625	129 154	101 630	124 519	-3.6
Oceania	5 801	6 981	7 238	8 287	7 231	8 283	0.0
Europe	68 433	89 529	87 398	96 829	86 543	98 968	2.2
Former U.S.S.R.	98 200	25 819	25 533	29 410	25 512	29 218	-0.7
Developed, all	339 068	321 426	331 581	371 918	331 583	371 573	-0.1
Developing, all	90 029	117 160	124 683	155 434	124 681	157 158	1.1
World	429 097	438 586	456 264	527 352	456 264	528 731	0.3

Table 14—Production of wood-based panels (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	1 361	1 805	2 006	2 732	2 018	2 793	2.3
North and Central America	31 756	50 756	55 180	72 429	55 039	71 084	-1.9
United States	26 224	38 502	41 608	53 953	41 465	52 649	-2.4
South America	3 574	6 306	6 879	8 134	6 896	8 852	8.8
Asia	19 005	45 837	51 197	75 369	51 197	75 364	0.0
Oceania	1 197	2 607	2 880	3 809	2 888	4 766	25.1
Europe	22 582	43 629	47 126	63 552	47 203	62 273	-2.0
Former U.S.S.R.	10 618	4 783	5 018	7 043	5 041	7 692	9.2
Developed, all	76 190	108 160	116 966	156 071	116 727	153 687	-1.5
Developing, all	13 903	47 563	53 319	76 996	53 555	79 137	2.8
World	90 093	155 723	170 286	233 067	170 283	232 824	-0.1

Table 15—Production of woodpulp (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	1 013	2 253	2 374	3 480	2 374	3 336	-4.1
North and Central America	64 894	84 550	91 507	108 653	91 449	108 218	-0.4
United States	44 819	59 394	62 211	73 278	62 210	73 441	0.2
South America	4 237	9 375	9 493	12 132	9 489	12 203	0.6
Asia	11 893	19 431	21 994	32 581	21 991	32 818	0.7
Oceania	1 819	2 324	2 508	3 581	2 508	3 628	1.3
Europe	25 289	37 458	41 648	50 938	41 763	51 613	1.3
Former U.S.S.R.	8 063	3 879	4 042	5 404	4 041	5 478	1.4
Developed, all	109 727	140 979	152 228	185 884	152 291	186 009	0.1
Developing, all	7 481	18 291	21 338	30 885	21 324	31 285	1.3
World	117 208	159 270	173 565	216 768	173 615	217 294	0.2

Table 16—Production of total paper and paperboard (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	1 713	3 162	3 646	5 942	3 649	6 005	1.1
North and Central America	72 379	109 037	122 216	163 438	122 229	163 144	-0.2
United States	56 839	86 274	97 110	128 219	97 110	128 528	0.2
South America	5 579	9 842	11 156	17 603	11 156	17 705	0.6
Asia	29 651	85 235	102 908	184 263	102 793	182 194	-1.1
Oceania	2 104	3 291	3 766	5 821	3 765	6 291	8.1
Europe	39 001	83 729	87 147	120 751	87 259	122 466	1.4
Former U.S.S.R.	8 733	3 823	4 192	6 704	4 192	6 611	-1.4
Developed, all	139 461	229 718	250 588	344 119	250 713	345 690	0.5
Developing, all	19 699	68 401	84 443	160 402	84 331	158 725	-1.0
World	159 160	298 119	335 031	504 521	335 044	504 415	0.2

Table 17—Import of industrial roundwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	793	904	902	903	902	965	6.9
North and Central America	6 297	10 563	11 925	15 816	11 925	16 745	5.9
United States	3 021	2 019	2 214	2 536	2 214	2 543	0.3
South America	99	29	133	163	133	164	0.9
Asia	70 574	69 549	70 648	92 770	70 437	83 058	-10.5
Oceania	8	11	38	49	38	52	7.2
Europe	33 756	52 485	54 912	55 035	54 692	54 605	-0.8
Former U.S.S.R.	255	815	801	662	801	659	-0.4
Developed, all	94 288	111 185	114 762	131 981	114 264	122 759	-7.0
Developing, all	17 494	23 171	24 596	33 417	24 663	33 489	0.2
World	111 782	134 356	139 358	165 397	138 927	156 248	-5.5

Table 18—Import of sawnwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	3 169	4 950	5 286	6 385	5 287	6 387	0.0
North and Central America	26 303	47 814	41 723	48 699	41 723	45 113	-7.4
United States	22 918	43 610	37 093	42 420	37 093	38 846	-8.4
South America	1 453	702	808	1 182	808	1 142	-3.4
Asia	10 727	23 218	26 203	31 625	26 204	37 946	20.0
Oceania	1 075	847	970	1 364	977	1 373	0.7
Europe	27 412	37 498	40 555	39 703	41 447	42 861	8.0
Former U.S.S.R.	356	632	684	888	684	866	-2.5
Developed, all	59 397	97 945	96 738	102 932	97 637	108 856	5.8
Developing, all	11 098	17 716	19 491	26 915	19 493	26 832	-0.3
World	70 495	115 661	116 229	129 847	117 130	135 688	4.5

Table 19—Import of wood-based panels (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	532	709	754	1 005	741	961	-4.4
North and Central America	2 636	10 472	11 165	11 872	11 307	13 383	12.7
United States	2 145	8 845	9 360	9 762	9 504	11 207	14.8
South America	231	460	490	644	492	644	0.0
Asia	2 034	18 926	21 256	30 210	21 403	31 140	3.1
Oceania	107	254	288	417	280	409	-1.8
Europe	7 429	16 565	18 721	23 860	18 702	25 882	8.5
Former U.S.S.R.	187	469	487	695	486	629	-9.6
Developed, all	10 469	34 968	38 601	46 400	38 922	51 112	10.2
Developing, all	2 687	12 887	14 559	22 302	14 489	21 935	-1.6
World	13 156	47 855	53 160	68 702	53 410	73 047	6.3

Table 20—Import of woodpulp (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	319	306	325	460	327	497	8.1
North and Central America	3 804	6 291	6 840	7 094	6 841	7 015	-1.1
United States	3 414	5 704	6 184	6 188	6 185	6 015	-2.8
South America	437	783	886	1 046	891	1 084	3.6
Asia	3 176	9 786	11 086	11 478	11 079	11 327	-1.3
Oceania	279	214	246	246	246	293	19.1
Europe	8 079	15 169	15 186	18 584	15 155	19 100	2.8
Former U.S.S.R.	221	69	74	82	74	91	11.0
Developed, all	14 256	24 826	25 854	28 676	25 818	29 148	1.6
Developing, all	2 059	7 792	8 789	10 313	8 796	10 260	-0.5
World	16 315	32 618	34 643	38 989	34 614	39 408	1.1

Table 21—Import of total paper and paperboard (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	897	1 504	1 515	1 515	1 512	1 531	1.1
North and Central America	9 531	18 285	17 415	20 475	17 415	20 395	-0.4
United States	8 054	14 381	13 315	15 682	13 315	15 085	-3.8
South America	1 175	3 382	3 355	3 249	3 355	3 669	12.9
Asia	4 253	18 971	19 136	26 522	19 284	27 644	4.2
Oceania	763	1 390	1 491	1 766	1 492	1 609	-8.9
Europe	11 970	38 681	43 157	59 383	43 304	59 993	1.0
Former U.S.S.R.	905	1 005	979	1 350	979	1 414	4.8
Developed, all	22 867	59 827	63 615	83 095	63 764	83 186	0.1
Developing, all	6 627	23 391	23 433	31 164	23 579	33 070	6.1
World	29 494	83 218	87 048	114 59	87 342	116 256	1.7

Table 22—Export of industrial roundwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	6 182	7 902	8 500	11 579	8 500	11 221	-3.1
North and Central America	26 590	20 810	19 714	15 666	19 714	9 669	-38.3
United States	22 299	18 243	17 266	14 200	17 266	9 155	-35.5
South America	1 154	8 980	10 261	15 903	10 261	15 919	0.1
Asia	33 786	13 244	13 344	14 987	13 286	14 995	0.1
Oceania	9 101	17 091	18 514	26 561	18 490	28 264	6.4
Europe	15 026	26 522	27 422	32 497	27 073	32 475	-0.1
Former U.S.S.R.	14 835	25 895	27 693	34 292	27 693	29 793	-13.1
Developed, all	64 519	89 595	92 661	107 890	92 288	99 047	-8.2
Developing, all	42 155	30 849	32 785	43 595	32 727	43 289	-0.7
World	106 674	120 444	125 446	151 485	125 015	142 336	-6.0

Table 23—Export of sawnwood (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	902	1 283	1 205	819	1 205	872	6.5
North and Central America	35 466	56 072	58 775	73 479	59 659	74 040	0.8
United States	5 834	6 776	7 905	10 353	7 905	10 905	5.3
South America	2 551	3 517	3 607	3 499	3 601	3 244	-7.3
Asia	7 244	6 126	5 721	4 051	5 728	4 424	9.2
Oceania	772	1 248	1 421	2 101	1 421	2 110	0.4
Europe	22 380	35 305	33 880	33 575	33 918	38 873	15.8
Former U.S.S.R.	7 242	9 144	8 654	9 358	8 632	9 160	-2.1
Developed, all	65 617	101 191	102 259	118 330	103 159	123 928	4.7
Developing, all	10 940	11 504	11 004	8 551	11 005	8 794	2.8
World	76 557	112 695	113 263	126 880	114 164	132 722	4.6

Table 24—Export of wood-based panels (thousand CUM)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	259	433	469	616	471	659	7.0
North and Central America	2 371	11 363	12 876	17 143	12 877	17 208	0.4
United States	970	3 226	3 708	4 772	3 708	4 821	1.0
South America	566	2 195	2 417	2 070	2 437	2 782	34.4
Asia	4 028	16 933	18 383	24 394	18 530	25 757	5.6
Oceania	156	889	1 006	1 286	1 006	1 369	6.5
Europe	6 879	15 876	17 730	22 789	17 787	24 360	6.9
Former U.S.S.R.	956	2 229	2 343	2 466	2 366	2 974	20.6
Developed, all	10 541	30 293	33 915	43 721	33 996	45 888	5.0
Developing, all	4 674	19 625	21 309	27 043	21 477	29 220	8.1
World	15 215	49 918	55 224	70 764	55 473	75 108	6.1

Table 25—Export of woodpulp (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	400	777	712	854	712	712	-16.5
North and Central America	9 704	16 656	18 388	21 627	18 320	21 349	-1.3
United States	2 694	5 813	6 914	8 665	6 914	8 577	-1.0
South America	1 307	4 187	3 759	3 630	3 761	3 652	0.6
Asia	134	1 500	1 684	1 914	1 694	2 152	12.5
Oceania	475	586	637	992	638	921	-7.1
Europe	6 528	9 029	9 721	10 567	9 747	10 969	3.8
Former U.S.S.R.	821	948	807	597	807	717	20.3
Developed, all	17 802	27 735	30 004	34 313	29 963	34 344	0.1
Developing, all	1 567	5 948	5 703	5 867	5 716	6 129	4.5
World	19 369	33 683	35 707	40 180	35 678	40 473	0.7

Table 26—Export of total paper and paperboard (thousand MT)

	Actual		Projection				
			Base		ATL		Change (%)
Region	1980	1997	2000	2010	2000	2010	2010
Africa	158	483	500	658	500	674	2.4
North and Central America	13 806	25 899	28 822	36 134	28 835	35 822	-0.9
United States	4 187	11 153	12 827	16 115	12 827	16 087	-0.2
South America	337	1 842	1 945	2 827	1 945	2 732	-3.3
Asia	1 239	9 156	8 853	10 872	8 874	11 204	3.1
Oceania	418	828	929	1 297	929	1 326	2.3
Europe	15 917	47 815	48 598	65 167	48 857	67 155	3.1
Former U.S.S.R.	1 035	1 589	1 796	1 700	1 796	1 737	2.1
Developed, all	32 021	77 447	81 299	105 733	81 572	107 525	1.7
Developing, all	889	10 165	10 143	12 921	10 164	13 123	1.6
World	32 910	87 612	91 443	118 654	91 736	120 649	1.7

The detailed effects of the ATL agreement, by individual product and country are in the appendixes (see footnote 1). Tables 7 through 26 summarize the effects for the world, its main regions, and the developed and developing group of countries.

Consumption

As shown in tables 7 through 11, the world consumption of forest products would change little because of the ATL agreement. The largest relative change at world level would be in industrial roundwood, a 0.4-percent increase. This would be tied, in part, to an increase of industrial roundwood consumption of about 1 percent in the United States. Changes in the United States would be negligible for all other products.

Production

The effects of the ATL on world production are the same as on world consumption, as they should (see tables 12 through 16). The slight discrepancies between world production and consumption are due to errors in trade statistics, which are maintained constant throughout the projections. In the United States, there would be practically no effect on production. The main changes in the United States would be a 3-percent increase in sawnwood production under ATL, and a decrease of 2 percent in panel production. Production of other products in the United States would be unchanged.

Imports

The effects of the ATL agreement would be much more important on trade, in relative terms than on consumption and production. As shown in tables 17 through 21, world imports of industrial roundwood would decrease by about 5.5 percent under ATL. The main decrease (10 percent) would occur in Asia, mostly in Japan as shown by data in the appendixes. The United States imports of industrial roundwood would be unaffected by the agreement. World imports of all manufacture products would increase under the ATL. World sawnwood and panels imports would rise by 5 to 6 percent, and those of pulp and paper by 1 to 2 percent. United States imports of sawnwood would decrease by about 8 percent, whereas those of pulp and paper would decrease by 3 to 4 percent. The only increase in U.S. imports would be in wood-based panels, but it would be substantial at nearly 15 percent.

Exports

At the world level, the effects of the ATL agreement on exports would be the same as on imports, as they should, after adjustment for the discrepancies in import and export statistics. The distribution of the changes by region, however, considerably differs. In particular, whereas U.S. exports of industrial roundwood were unaffected by the ATL, exports decreased by 35 percent. The major roundwood exporter, the former U.S.S.R., also would see its exports of industrial roundwood decrease by about 13 percent. Instead, exports of sawnwood and panels from the U.S. would increase by 5 percent and 1 percent, respectively. Uunited States. exports of wood pulp would drop by 1 percent, whereas exports of paper and paperboard would remain unchanged. The main gains in exports, in relative terms, would occur in Asia, and to a lesser extent in Europe.

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English Equivalents

When you know:	Multiply by:	To find:
Cubic meters (m^3)	35.315	Cubic feet
Metric tons (M.T.)	1.102	Short tons

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Web site	http://www.fs.fed.us/pnw
Telephone	(503) 808-2592
Publication requests	(503) 808-2138
FAX	(503) 808-2130
E-mail	desmith@fs.fed.us
Mailing address	Publications Distribution Pacific Northwest Research Station P.O. Box 3890 Portland, OR 97208-3890