Effects of the Free Trade Area of the Americas on Forest Resources

James A. Turner, Joseph Buongiorno, and Shushuai Zhu

The effects of the Free Trade Area of the Americas (FTAA) agreement on the forest sectors and resources of member countries are investigated. A model of wood supply within the spatial partial-equilibrium Global Forest Products Model is developed to link international trade and deforestation. The direct effects of tariff changes and the indirect effects of income changes induced by trade liberalization are considered. The FTAA has a small positive impact on the region's forest resources. Higher harvests of industrial roundwood in most countries are offset by increased afforestation due to the income effect of trade liberalization (captured by the environmental Kuznets curve).

Key Words: trade liberalization, international trade, forest resources, forest sector trade model

Deforestation, particularly in the tropics, is of considerable importance with regards to the health of the global environment. The global forest area decreased between 1990 and 2000 by 9.4 million hectares per year, the result of 14.6 million hectares per year of deforestation, and 5.2 million hectares per year of afforestation (Food and Agriculture Organization [FAO] 2001a). The cumulative net loss during the 1990s was four times the area of Michigan. Environmental problems associated with deforestation include increased erosion, decreases in the global carbon sink, and loss of biodiversity (Nordström and Vaughan 1999).

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Concerns about the role of freer trade in deforestation have been raised during negotiations of the Free Trade Area of the Americas (FTAA) agreement (American Lands Alliance 2001). Ratification and implementation of the agreement is set for December 31, 2005, with obligations likely to be phased in over a decade or more (Schott and Hufbauer 1999). For agricultural and forest products, tariff and non-tariff barriers will be progressively reduced, and agricultural export subsidies eliminated (Burfisher and Link 2000). The agreement will also reconcile current sub-regional trade pacts.

There are over 40 regional trade agreements (RTAs) already in force in the Americas, and more than a dozen under negotiation (Stout and Ugaz-Pereda 1998, U.S. International Trade Commission 1999, O'Keefe 2002). Significant existing RTAs are the Andean Community (Colombia, Ecuador, Bolivia, Peru, Venezuela), the Caribbean Community (Antigua, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, St. Kitts–Nevis, St. Lucia, St. Vincent, Suriname), the Central American Integration System (Costa Rica, Guatemala, Honduras, Nicaragua, El Salvador, Panama), the Southern Common Market (MERCOSUR) (Brazil, Argentina, Uruguay, Paraguay), and the North American Free Trade Agreement (Mexico, Canada, and the United States). The large number of RTAs in effect in the Americas means that tariffs on forest products in the Americas are relatively low (Table 1).

Diao, Somwaru, and Raney (1998), U.S. Department of Agriculture (1998), Diao, Díaz-Bonilla, and Robinson (2003), and Mattson and Koo (2003) have investigated the potential impact of the FTAA on member country agriculture sectors, and their economies in general. These studies suggest that the FTAA will benefit all member countries in terms of increased incomes and trade. With the exception of Mattson and Koo (2003), these studies consider the benefits of technological spillovers and economies of scale from trade liberalization. The largest gains were predicted for developing countries, which are more likely to capture technological spillovers embodied in trade and capital flows from Canada and the United States (Diao, Somwaru, and Raney 1998). While there has been considerable work analyzing the potential impact of the FTAA on the agriculture sector, the impact on the forest industry and forest resources remains unknown.

Whether or not trade liberalization under the FTAA will increase or decrease forest resources depends on the net impact of three conflicting environmental effects of freer trade: composition, scale, and technique (Fredriksson 1998, Nordström and Vaughan 1999). The composition effect is the change in the mix of products that countries produce. Production of some goods, such as industrial roundwood, increases deforestation, while production of other goods decreases it. This composition effect depends on each country's comparative advantage. The scale effect is due to trade-liberalization–induced increases in income resulting in higher consumption, and associated increases in production. The scale effect unambiguously increases deforestation. But citizens' increased incomes result in greater demand for the conservation and extension of forests, enforced through tighter environmental regulations. This is the technique effect of trade liberalization. The net impact of the composition, scale, and technique effects on forest resources depends on their relative strength; therefore, empirical analysis is necessary to determine their effects in different countries.

Table 1. Import Weighted Average Tariffs on Forest Product Trade Among FTAA Member Countries

Commodity	Trade Weighted Tariff (%)
Industrial roundwood	0.2
Sawnwood	0.5
Plywood and veneer	4.1
Particleboard	1.2
Fiberboard	1.9
Mechanical pulp	0.1
Chemical pulp	0.8
Waste paper	2.1
Newsprint	1.0
Printing and writing paper	2.6
Other paper and paperboard	3.3

Source: Turner (2004).

Trade influences forest resources, and as well, forest resources influence trade. Trade-induced increases in wood supply may lead to over-exploitation and degradation of forests, resulting in long-run comparative disadvantage (Sedjo and Lyon 1983; Brander and Taylor 1997, 1998). Forest sector models provide a framework for determining the changes in trade and wood supply due to trade liberalization.

This study investigates the potential effects of the FTAA on the forest resources of the agreement's members. A modified version of the Global Forest Products Model (Buongiorno et al. 2003) was used to carry out the analysis. The modification consisted mainly in linking wood supply to forest stock and area in order to predict the effect of trade liberalization on forest resources.

Methods and Materials

The Global Forest Products Model

This paper outlines the Global Forest Products Model (GFPM); a more detailed description, including its mathematical formulation, is in Buongiorno et al. (2003). Turner (2004) contains details of GFPM assumptions related to the current study.[1] The GFPM has previously been used to analyze policy issues such as the global effects of accelerated tariff liberalization (Zhu, Buongiorno, and Brooks 2001), U.S. waste paper recycling (Zhu and Buongiorno 2002), U.S. timber harvest restrictions (Tomberlin 1999), and regional trade agreements involving New Zealand (Turner et al. 2001).

The GFPM is a spatial partial-equilibrium model of the global forest sector, which in this version gives forecasts for 180 countries (Table 2) and 14 forest commodity categories (Table 3)

[1] Model data are available from the authors upon request.

Table 2. Countries in the Global Forest Products Model

AFRICA	NORTH AND CENTRAL AMERICA	ASIA	EUROPE
Algeria*	Bahamas	Afghanistan*	Albania
Angola*	Barbados	Bahrain*	Austria
Benin*	Belize	Bangladesh	Belgium
Botswana*	Canada	Bhutan	Bosnia
Burkina Faso*	Cayman Islands	Brunei Darussalam	Bulgaria
Burundi*	Costa Rica	Cambodia	Croatia
Cameroon*	Cuba	China	Czech Republic
Cape Verde*	Dominica	Cyprus	Denmark
Central African Republic*	Dominican Republic	Hong Kong	Finland
Chad*	El Salvador	India	France
Congo*	Guatemala	Indonesia	Germany
Côte d'Ivoire*	Haiti*	Iran	Greece
Djibouti*	Honduras	Iraq*	Hungary
Egypt*	Jamaica	Israel*	Iceland
Equatorial Guinea*	Martinique	Japan	Ireland
Ethiopia*	Mexico	Jordan*	Italy
Gabon*	Netherlands Antilles	Korea, DPR	Macedonia
Gambia*	Nicaragua	Korea, REP	Malta
Ghana*	Panama	Kuwait*	Netherlands
Guinea*	Saint Vincent	Laos	Norway
Guinea-Bissau*	Trinidad	Lebanon*	Poland
Kenya*	United States	Macau	Portugal
Lesotho*		Malaysia	Romania
Liberia*	**SOUTH AMERICA**	Mongolia	Slovakia
Libya*	Argentina	Myanmar	Slovenia
Madagascar*	Bolivia	Nepal*	Spain
Malawi*	Brazil	Oman*	Sweden
Mali*	Chile	Pakistan*	Switzerland
Mauritania*	Colombia	Philippines	United Kingdom
Mauritius*	Ecuador	Qatar*	Yugoslav Fed. Rep.
Morocco*	French Guiana	Saudi Arabia*	
Mozambique*	Guyana	Singapore	**FORMER USSR**
Niger*	Paraguay	Sri Lanka	Armenia
Nigeria*	Peru	Syria*	Azerbaijan
Reunion*	Suriname	Thailand	Belarus
Rwanda*	Uruguay	Turkey	Estonia
Sao Tome*	Venezuela	United Arab Emirates*	Georgia
Senegal*		Vietnam	Kazakhstan
Sierra Leone*	**OCEANIA**	Yemen*	Kyrgyzstan
Somalia*	Australia		Latvia
South Africa*	Cook Island		Lithuania
Sudan*	Fiji		Moldova
Swaziland*	French Polynesia		Russian Federation
Tanzania*	New Caledonia		Tajikistan
Togo*	New Zealand		Turkmenistan
Tunisia*	Papua New Guinea		Ukraine
Uganda*	Samoa		Uzbekistan
Zaire*	Soloman Islands		
Zambia*	Tonga		
Zimbabwe*	Vanuatu		

* Countries where harvest of 1 m^3 of fuelwood leads to less than 1 m^3 loss of forest stock.

from 2000 to 2030. Base year production, consumption, trade, and prices by country and commodity are from FAO (2001b). Base year forest stock and forest area are from FAO (2001a).

The GFPM determines consumption, production, trade, and prices in the forest sector, in accordance

Table 3. Commodities in the Global Forest Products Model

Commodity Aggregate (used in the GFPM)	Constituent Commodities
Fuelwood and charcoal	Wood fuel
	Wood charcoal
Industrial roundwood	Chips and particles (imports and exports only)
	Pulpwood
	Sawlogs
Other industrial roundwood	Other industrial roundwood
Sawnwood	Sawnwood
Plywood	Plywood
	Veneer sheets
Particleboard	Particleboard
Fiberboard	Fiberboard
Mechanical pulp	Mechanical wood pulp
Chemical pulp	Chemical wood pulp
	Semi-chemical wood pulp
Other fiber pulp	Other fiber pulp
Waste paper	Recovered paper
Newsprint	Newsprint
Printing and writing paper	Printing and writing paper
Other paper and paperboard	Other paper and paperboard

with economic equilibrium theory. It solves for market equilibrium by mathematical programming, based on the theory of spatial equilibrium in competitive markets (Samuelson 1952, Takayama and Judge 1971). The equilibrium is found 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) is equal to demand (final consumption, plus input into other processes, plus exports). Final demand is represented by demand equations, while demand for wood and intermediate products is derived from the demand for final products through input-output coefficients that describe technologies in each country. The supply of raw wood and non-wood fibers in each country is represented by supply equations. The supply of intermediate and final products represented with input-output coefficients is constrained by capacity. The supply of recycled paper is constrained by the waste paper supply, which itself depends on past paper consumption and the recycling rate.

The GFPM predicts trade flows for all commodities except fuelwood, for which trade volumes are small,[2] and other industrial roundwood, for which trade flows are not recorded (FAO 2001b). Most trade flows in the GFPM are between each country and the world market. For this study bilateral trade flows were added for trade among the member countries of the FTAA. This was done to maintain a reasonable model size, while allowing analysis of the FTAA.

From one year to the next, demand changes in each country due to exogenous changes in income. The wood supply shifts endogenously due to changes in the forest stock and forest area. The amount of recycled fiber used in making paper and paperboard changes exogenously 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. Trade changes with inertia tied to past trade and the income of importing countries.

A new equilibrium is then computed subject to the new demand and supply conditions, new technology, new capacity, and new tariffs. The general principle of the GFPM is, then, that global markets optimize the allocation of resources in the short run (within one year). Long-run resource allocation is partly governed by market forces, as in capacity expansion and trade, by policy changes such as the waste paper recovery rates and the trade tariffs on imports, by exogenous progress that changes the techniques of production, and by forest resource changes that affect wood supply.

A Model of International Wood Supply

The theory underlying the wood supply model implemented in this version of the GFPM is sufficiently general to cover the economic situations in different countries, while it is simple enough to implement empirically with the scarce international data available. It predicts for each country the yearly roundwood harvest, forest stock, and forest area using equations that describe (i) the short-term supply of wood conditional on forest stock and forest area, (ii) the annual rate of growth of forest stock, (iii) the annual rate of change in

[2] Total imports and exports of fuelwood were 0.73 percent of global production in 2000 (FAO 2001b).

forest area, and (iv) the evolution of forest stock and forest area over time, given initial conditions (Turner 2004). This model expands earlier formulations (Binkley and Dykstra 1987, Adams and Haynes 1996) by including afforestation and deforestation, represented with an environmental Kuznets curve (Grossman and Kreuger 1995).

As in earlier versions of the GFPM, the short-term wood supply (for a given level of forest stock and forest area, and other variables that may influence wood supply) is represented by a Cobb-Douglas function linking supply to price (Binkley 1987). In any given year and country, the supply of fuelwood and industrial roundwood is a function of its price, with an upper bound reflecting the amount of forest stock available for harvest.

Wood supply decisions for public forests differ from supply decisions for private forests (Adams and Haynes 1989, Wear and Flamm 1993). The elasticity of industrial roundwood supply with respect to price depends on the proportion of a country's forest area in public ownership. This is captured by the interaction of price and the proportion of forest area in public ownership in the industrial roundwood supply equation (Table 4). Under complete public ownership the price elasticity is 1.31, while the elasticity is 1.58 under full private ownership. Forest ownership data are from the United Nations Economic Commission for Europe (2000) and White and Martin (2002). Industrial roundwood supply equation elasticities (Table 4) were estimated by two-stage least squares using 91 observations from 59 countries for 1990 and 2000 (Turner 2004).

The fuelwood supply equation shifts over time with endogenous changes in forest stock (Table 4). Past studies (Amacher, Hyde, and Kanel 1996, Kanel et al. 2000, FAO forthcoming) suggest that national fuelwood supply is positively related to price and forest stock. The fuelwood supply equation elasticities were estimated by running the GFPM from 1980 to 2000, with various elasticities and choosing those that gave predicted trends most similar to observed trends. Industrial roundwood supply shifts over time due to endogenous changes in forest area and forest stock, and exogenous changes in GDP per capita (Table 4).

Year-to-year forest stock changes are described by a growth-drain equation (Brooks 1987). Stock losses occur due to harvests and deforestation, and stock gains due to growth and afforestation. Harvests are the sum of fuelwood and industrial roundwood supply. It was assumed that the harvest of 1 cubic meter of fuelwood reduced forest stock by less than 1 cubic meter in countries where significant fuelwood harvests come from outside of the forest (Chomitz, Griffiths, and Puri 1999, Table 2). For all other countries, fuelwood harvests came from forest stock alone.

The rate of growth of forest stock is a function of the ratio of forest stock to forest area, forest density:

$$g_{it}^{s} = (\beta_0 + \beta_1 Z_i)\left(\frac{S_{it}}{A_{it}}\right)^{\alpha}, \quad (1)$$

where g_{it}^{s} is the growth of forest stock in country i between year t and $t + 1$, in percent; α, β_0, and β_1 are constants (Table 4); S_{it} is forest stock; A_{it} is forest area; and Z_i is the proportion of a country's forest area that is plantation forest.

Relating forest stock growth to density follows the behavior of growth in forests over large areas (Oliver and Larson 1996, Smith et al. 1996). Mature forests have a high volume per unit area and little percent net growth in volume; young forests have a low volume per unit area and high percent net volume growth. The greater productivity of plantation forests, compared with natural forests, is one reason for increased production from plantation forests (Sedjo and Lyon 1990, Brown 2000). This suggests that the greater the proportion of forest area in plantations, the higher the growth rate for a given forest density.

Equation (1) was estimated with data, for 1990 and 2000, from 129 countries on forest stock, forest area, forest harvest, and the proportion of each country's forest that is made up of plantation forests. The parameters of equation (1) were estimated by nonlinear least squares (Turner 2004).

Forest stock changes due to deforestation and afforestation, and forest area change, were predicted with an environmental Kuznets curve (Table 4 and Figure 1):

$$\left(\frac{\Delta A_{it}}{A_{it}}\right) = \alpha_0 + \alpha_1 (Y_{it}/N_{it}) + \alpha_2 (Y_{it}/N_{it})^2, \quad (2)$$

where

$$\left(\frac{\Delta A_{it}}{A_{it}}\right)$$

is the percentage change in forest area in country i between year t and $t + 1$, and (Y_{it}/N_{it}) is country GDP per capita in year t.

Table 4. Equation Parameters for Fuelwood Supply, Industrial Roundwood Supply, Forest Stock Growth, and Forest Area Change in the GFPM

	Fuelwood Supply	Industrial Roundwood Supply	Stock Growth	Area Change
Price	0.40	1.58 (0.50)***		
Price × Ownership		-0.27 (0.12)**		
GDP per capita		1.31 (0.25)***		0.1868 (0.0504)***
(GDP per capita)^2				-0.0045 (0.0015)***
Forest stock	1.50	1.10 (0.26)***	-0.81 (0.11)**	
Forest area		-0.27 (0.32)	0.81 (0.11)**	
Intercept			0.69 (0.22)**	-1.2776 (0.2483)***
Plantation area/ forest area			1.70 (0.69)**	

Notes: Standard errors are in parentheses. ***, **, and * indicate statistical significance at the 1 percent, 5 percent, and 10 percent level, respectively.

Source: Turner (2004).

Equation (2) was estimated with 114 observations from 58 countries for 1980, 1990, and 2000 (Turner 2004). The full model, equation (3), was based on Antweiler, Copeland, and Taylor (2001). It includes variables to capture scale, technique, and composition effects (Fredriksson 1998, Nordström and Vaughan 1999), as well as the effect of trade liberalization:

$$(3)\left(\frac{\Delta A}{A}\right)_{it} = \gamma_0 + \alpha_1 (Y/N)_{it} + \gamma_2 (Y/N)^2_{it} + \gamma_3 SCALE_{it} + \gamma_4 (L/A)_{it} + \gamma_5 (K/A)_{it} + \gamma_6 \left[(L/A)_{it} \times (K/A)_{it}\right] + \gamma_7 \psi_{it} TI_{it} + \varepsilon_{it} \ ,$$

with

$$\psi_{it} \cong \psi_0 + \psi_1 (Y/N)_{it} + \psi_2 (Y/N)^2_{it} + \psi_3 (L/A)_{it} + \psi_4 (K/A)_{it} + \psi_5 [(L/A)_{it} \times (K/A)_{it}] \ ,$$

where $SCALE_{it}$ is a measure of the scale of forest use, rural population density; $(L/A)_{it}$ is the ratio of the labor force to forest area; $(K/A)_{it}$ is the ratio of capital to forest area; TI_{it} is trade intensity in country i at time t, the ratio of the value of exports plus imports to GDP; and Ψ_{it} is a linear approximation used to describe the partial effect of an increase in trade intensity on deforestation.

The technique effect was represented by country income per capita and its square. The ratio of labor to forest area and capital to forest area represented the composition effect. The effect of trade liberalization on country forest area change depended on country characteristics, which influence the country's comparative advantage in sectors utilizing forest resources. To capture this effect, the measure of trade intensity was interacted with variables representing technique and composition effects.

Equation (3) was estimated by pooled ordinary least squares (Turner 2004). Keeping all variables in equation (3), except GDP per capita (the technique effect), at their sample mean values gave equation (2). The parameters of equation (2) imply that an increase in country income per capita results in a declining rate of deforestation for incomes below $8,700 per person. Above this income an increase in country income results in an increasing rate of afforestation until an income of $20,800 per person, after which the rate of afforestation declines until it is zero at $32,900 per person (Figure 1).

The Free Trade Area of the Americas

With the wood supply model, the GFPM was used to make projections of forest resources and forest product consumption, production, and trade from 1999 to 2030, with and without the Free Trade Area of the Americas agreement. Both the direct effects of FTAA tariff reductions and the

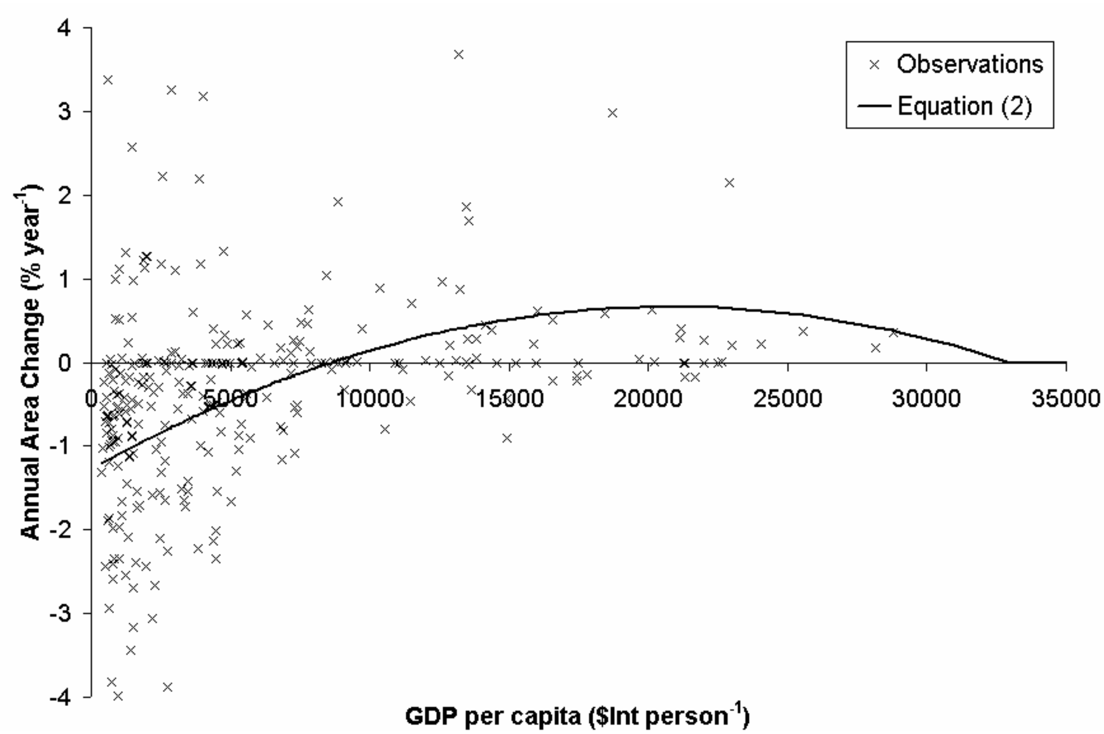

Figure 1. Relationship Between Forest Area Change and Income per Capita [Equation (2)], and Observed Forest Area Change (1980–1990, 1990–2000)

indirect effects of income changes induced by trade liberalization were considered.

The timing of tariff reductions is uncertain. Here, we simulated a complete removal of tariffs in 2006 on all forest products traded among FTAA member countries. This is an extreme policy, likely to have the largest effect on forest resources. It was assumed that trade liberalization would increase the GDP per capita growth rates of FTAA member countries. The assumed cumulative changes in level of GDP were those obtained by Diao, Díaz-Bonilla, and Robinson (2003).

To convert the changes in GDP levels to changes in GDP growth rates, we assumed that GDP would not change in the first year after liberalization, and that 15.0 percent of the total change would occur in the second year, 42.0 percent in the third, 19.0 percent in the fourth, 11.5 percent in the fifth, 7.7 percent in the sixth, and 3.8 percent in the seventh (Greenaway, Morgan, and Wright 2002). These estimates were used to apportion the static GDP change predicted by Diao, Díaz-Bonilla, and Robinson (2003) to GDP growth rates from 2008 to 2013 (Table 5).

Results

In our model, the FTAA has little effect on forest resources outside of the Americas (Table 6); forest stock changes less than 26 million m^3 in all countries in 2030 under the FTAA, with and without an income effect. Forest area changes less than 260,000 hectares.

The impact of the FTAA, without the income effect, on forest stock in member countries is small (Table 6). There is no effect on forest area as it depends only on GDP per capita (Equation 2), which is unchanged under this scenario. By 2030, forest stock in North and Central America is 74 million m^3 lower, and that in South America 28 million m^3 lower. This is a relatively small decrease on the 66.7 billion m^3 and 110.7 billion m^3 of forest stock in North and Central America, and in South America, respectively, in 2000 (FAO 2001a).

The negligible effect of the FTAA, without the income effect, on forest stock reflects the small impact of the agreement on industrial roundwood harvests (Table 7). Industrial roundwood production is 2.5 million m^3 per year (0.3 percent) higher

Table 5. Estimated Increase in GDP Growth Rate Due to FTAA, 2008 to 2013

	Increase in GDP Growth Rate (%)						
Region/Country	2007–2013[a,b]	2008	2009	2010	2011	2012	2013
USA	0.77	0.12	0.32	0.15	0.09	0.06	0.03
Canada	0.51	0.08	0.21	0.10	0.06	0.04	0.02
Mexico	0.60	0.09	0.25	0.11	0.07	0.05	0.02
Central America and the Caribbean	6.21	0.93	2.61	1.18	0.71	0.48	0.24
Colombia	5.48	0.82	2.30	1.04	0.63	0.42	0.21
Peru	3.14	0.47	1.32	0.60	0.36	0.24	0.12
Venezuela	3.61	0.54	1.52	0.69	0.42	0.28	0.14
Rest of Andean Pact	4.16	0.62	1.75	0.79	0.48	0.32	0.16
Argentina	3.32	0.50	1.39	0.63	0.38	0.26	0.13
Brazil	2.80	0.42	1.18	0.53	0.32	0.22	0.11
Chile	1.82	0.27	0.76	0.35	0.21	0.14	0.07
Uruguay	1.26	0.19	0.53	0.24	0.14	0.10	0.05
Rest of South America	5.07	0.76	2.13	0.96	0.58	0.39	0.19

[a] Cumulative inter-equilibrium percentage change in GDP due to the FTAA.
[b] Diao, Díaz-Bonilla, and Robinson (2003).

Table 6. Effects of the FTAA on Forest Stock and Forest Area in 2030

	FTAA without Income Effect				FTAA with Income Effect			
	Stock		Area		Stock		Area	
Region/Country	10^6 m^3	%	10^3 ha	%	10^6 m^3	%	10^3 ha	%
Canada	-75	-0.2	0	0.0	30	-0.1	-563	-0.1
Mexico	-3	-0.1	0	0.0	12	0.1	148	0.1
United States	4	0.0	0	0.0	-146	-0.1	0	0.0
Brazil	-24	0.0	0	0.0	514	0.2	3546	0.2
Chile	-9	-0.4	0	0.0	-11	-0.1	68	0.1
CAN	3	0.0	0	0.0	162	0.2	1002	0.2
CARICOM[a]	0	0.0	0	0.0	24	0.1	109	0.1
SICA[b]	0	0.0	0	0.0	6	0.1	101	0.2
Rest of MERCOSUR	3	0.1	0	0.0	17	0.1	326	0.2
Total FTAA	**-101**	**0.0**	**0**	**0.0**	**608**	**0.1**	**4735**	**0.1**
Africa	-6	0.0	0	0.0	2	0.0	133	0.0
North and Central America	-74	-0.1	0	0.0	-92	0.1	-281	0.0
South America	-28	0.0	0	0.0	718	0.2	5124	0.2
Asia	-15	0.0	0	0.0	5	0.0	260	0.0
Oceania	2	0.0	0	0.0	-13	0.0	-116	0.0
Europe	-10	-0.1	0	0.0	-6	0.0	-47	0.0
Former USSR	18	0.0	0	0.0	26	0.0	123	0.0
World	**-113**	**0.0**	**0**	**0.0**	**640**	**0.0**	**5195**	**0.0**

[a] Includes the Dominican Republic.
[b] Includes Panama.

Notes:
"CAN" is the Andean Community/Pact, consisting of Colombia, Ecuador, Bolivia, Peru, and Venezuela.
"CARICOM" is the Caribbean Community, consisting of Antigua, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, St. Kitts–Nevis, St. Lucia, St. Vincent, and Suriname.
"SICA" is the Central American Integration System, consisting of Costa Rica, Guatemala, Honduras, Nicaragua, and El Salvador.
"Rest of MERCOSUR" is the Southern Common Market, consisting of Argentina, Uruguay, and Paraguay.

in North and Central America, and 1.1 million m^3 per year (0.4 percent) higher in South America. Given the small impact of the FTAA without the income effect, the rest of this section will focus on the impact of the FTAA when the effect of trade liberalization on country income is included.

The impact of the FTAA, with the income effect, on forest stock and area is small, though

Table 7. Effects of the FTAA on Average Annual Production and Trade of Industrial Roundwood (1999–2030)

	FTAA without Income Effect						FTAA with Income Effect					
	Production		Imports		Exports		Production		Imports		Exports	
Region/Country	10^3 m^3	%	10^3 m^3	%	10^3 m^3	%	10^3 m^3	%	10^3 m^3	%	10^3 m^3	%
Canada	2344	1.0	-3	0.0	2	0.1	-15425	-1.8	285	0.3	-3	0.2
Mexico	81	0.6	2	1.1	2	11.3	-518	-0.8	-7	0.1	-2	0.6
United States	124	0.0	6	0.6	14	0.0	19060	0.9	5	0.6	149	0.2
Brazil	963	0.5	4	11.6	-1	0.0	7169	1.2	-4	2.5	5	0.0
Chile	333	0.7	1	6.3	-102	-4.1	818	1.6	-1	2.2	529	19.2
CAN	-100	-0.6	14	18.1	-30	-5.5	576	2.0	-14	2.9	158	17.5
CARICOM[a]	7	0.5	27	11.7	6	1.7	-2	-0.1	32	12.8	0	0.4
SICA[b]	-36	-0.8	-7	-2.1	7	15.2	198	2.6	-89	-1.1	-4	-4.8
Rest of MERCOSUR	-85	-0.5	10	11.2	8	0.4	-440	0.0	-20	-5.6	-1	0.0
Total FTAA	**3631**	**0.3**	**54**	**0.1**	**-94**	**-0.1**	**4537**	**0.4**	**122**	**0.4**	**703**	**0.9**
Africa	175	0.3	10	0.6	-11	-0.1	1483	0.7	-4	0.3	88	1.1
North and Central America	2504	0.3	26	0.1	29	0.0	3293	0.2	223	0.4	141	0.2
South America	1129	0.4	29	13.9	-123	-1.3	8178	1.2	-40	-0.2	689	6.2
Asia	524	0.2	-197	-0.1	14	0.0	-458	0.1	-1838	-0.6	975	0.2
Oceania	-60	-0.1	2	9.6	73	0.1	117	0.0	-3	-1.7	305	0.2
Europe	378	0.1	156	0.1	64	0.4	1178	0.0	4210	1.4	441	1.4
Former USSR	-619	-0.3	3	0.2	-17	0.0	444	0.1	0	0.0	-92	-0.1
World	**4031**	**0.2**	**29**	**0.0**	**29**	**0.0**	**14235**	**0.2**	**2546**	**0.4**	**2546**	**0.4**

[a] Includes the Dominican Republic.
[b] Includes Panama.

Notes:
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"CARICOM" is the Caribbean Community, consisting of Antigua, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, St. Kitts–Nevis, St. Lucia, St. Vincent, and Suriname.
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larger than that predicted under the FTAA without the income effect (Table 6). South America's forest area is predicted to be 0.2 percent higher in 2030 under the FTAA. This is an additional 5.1 million hectares. Brazil and the Central American Integration System (SICA) economies have the largest relative increases in forest area (0.2 percent higher in 2030), due to the stronger income effect of the FTAA in these countries (Table 5). Brazil has an additional 3.5 million hectares of forest, slightly larger than the area of Maryland, and SICA an additional 101,000 hectares. The Andean Community/Pact (CAN) economies also experience a large increase in forest area, 1.0 million hectares in 2030. Canada's forest area is lower under the FTAA, despite an increase in income. This is due to Canada being on the portion of the environmental Kuznets curve where the rate of afforestation declines with an increase in income (Figure 1).

Implementation of the FTAA leads to an increase in forest stock in 2030 in most member countries (Table 6). This is due to lower industrial roundwood harvests in some cases, such as Canada and Mexico, or increased afforestation offsetting increased harvests in others, such as Brazil and the CAN economies. The United States and Chile are the only countries to experience a decline in forest stock. This is due to increased harvests in these countries not being offset by increased afforestation. The U.S. income per capita is high enough that predicted forest area change is zero (Figure 1). Chile has only a small increase in income under the FTAA (Table 5), and as a result Chile's forest area changes little.

Industrial roundwood harvests in both Canada and Mexico are lower under the FTAA, by 15.4 million m^3 per year and 518,000 m^3 per year, respectively (Table 7). Smaller Canadian harvests are due to lower production of all commodities, particularly sawnwood (4.0 percent lower annual production, Table 8) and wood-based panels (5.3 percent lower annual production, Table 9), and associated lower exports. Mexico's production

Table 8. Effects of the FTAA, with Income Effect, on Average Annual Production and Trade of Sawnwood (1999–2030)

	Production		Imports		Exports	
Region/Country	10^3 m^3	%	10^3 m^3	%	10^3 m^3	%
Canada	-11538	-4.0	673	22.8	-10853	-4.2
Mexico	-35	0.2	98	1.6	91	1.3
United States	9943	3.2	-8922	-2.3	754	9.0
Brazil	412	0.4	3	4.1	-330	-0.7
Chile	-314	-1.1	1	3.7	-341	-2.9
CAN	-1	0.7	86	23.6	10	0.7
CARICOM[a]	-10	-1.0	210	8.3	13	6.3
SICA[b]	112	2.8	22	6.4	51	7.3
Rest of MERCOSUR	61	1.0	96	5.0	67	4.4
TOTAL FTAA	**105**	**0.1**	**1266**	**1.2**	**1767**	**2.0**
Africa	6	0.5	134	0.1	114	2.1
North and Central America	-1528	0.0	-7906	-1.4	-9948	-2.4
South America	164	0.2	185	6.8	-592	-1.1
Asia	-869	-0.2	129	0.3	-340	-1.1
Oceania	196	0.7	-21	0.0	184	4.2
Europe	1808	0.1	-2333	-0.1	-225	0.2
Former USSR	2010	0.9	-9	0.0	986	1.6
WORLD	**1788**	**0.1**	**-9821**	**-0.4**	**-9821**	**-0.5**

[a] Includes the Dominican Republic.
[b] Includes Panama.

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"SICA" is the Central American Integration System, consisting of Costa Rica, Guatemala, Honduras, Nicaragua, and El Salvador.
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and trade (Tables 7–11) are little changed by the FTAA, presumably due to the small effect of the agreement on Mexico's income (Table 5).

Brazil has a large increase in industrial roundwood production under the FTAA, 7.2 million m^3 per year (Table 7). These increased harvests are utilized in the production and export of processed products, particularly wood-based panels (Table 9) and paper and paperboard (Table 11). Despite increased harvests, Brazil's forest stock is 514 million m^3 higher in 2030. This is the result of increased afforestation, due to higher income, offsetting the increased harvests. Brazil harvests an additional 110 million m^3 of total roundwood between 1999 and 2030 under the FTAA. Higher growth adds an additional 62 million m^3 to forest stock. Reduced deforestation and increased afforestation adds 437 million m^3.

The CAN economies also increase forest stock and industrial roundwood harvests under the FTAA (Table 6 and Table 7). Their industrial roundwood production is 576,000 m^3 per year higher, and forest stock is 162 million m^3 higher in 2030. Again, this suggests that afforestation, due to higher incomes, offsets the effect of increased harvests. The CAN economies utilize the increased harvests in the production of wood-based panels (Table 9) and paper and paperboard (Table 11) for export.

Under the FTAA, forest stock in the United States and Chile is lower in 2030—by 146 million m^3 and 11 million m^3, respectively (Table 6). This is due to increased harvests: an additional 7.9 million m^3 per year in the United States, and an additional 0.5 million m^3 per year in Chile. The United States' increased harvests are driven by domestic demand for wood to export processed forest products. Chile exports a large proportion (0.5 million m^3 per year) of its increased industrial roundwood harvest (Table 7).

The main effect of the FTAA on world forest commodity prices is a reduction in pulp prices and paper and paperboard prices. There is little change in the world prices of other commodities (Table 12). The reduction in the wood pulp price is due to increased production, particularly from Canada, the United States, and Brazil. Increased production of paper and paperboard from the

Table 9. Effects of the FTAA, with Income Effect, on Average Annual Production and Trade of Wood-Based Panels (1999–2030)

	Production		Imports		Exports	
Region/Country	10^3 m^3	%	10^3 m^3	%	10^3 m^3	%
Canada	-3096	-5.3	1199	38.2	-1928	-4.3
Mexico	-252	-9.1	9	0.6	-247	-3.9
United States	1356	1.0	-228	-0.3	799	15.9
Brazil	712	2.2	43	3.4	621	4.3
Chile	86	2.3	-6	0.5	59	4.5
CAN	255	6.5	24	4.6	249	12.5
CARICOM[a]	14	3.9	54	7.5	15	5.3
SICA[b]	-8	0.4	31	6.5	16	8.9
Rest of MERCOSUR	125	2.3	1	2.4	86	3.5
TOTAL FTAA	**224**	**0.2**	**594**	**2.4**	**41**	**0.3**
Africa	-14	-0.2	-17	-0.2	0	-0.7
North and Central America	-1981	-0.6	1069	2.4	-1361	-1.4
South America	1193	2.5	62	3.2	1030	4.8
Asia	454	0.3	-98	0.1	433	1.3
Oceania	-50	-0.2	-11	-0.2	-43	0.2
Europe	926	0.3	-1030	-1.6	56	-0.4
Former USSR	-177	-0.8	-23	-0.3	-164	-1.3
WORLD	**352**	**0.1**	**-48**	**0.3**	**-49**	**0.3**

[a] Includes the Dominican Republic.
[b] Includes Panama.

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United States and Brazil contributes to a reduction in that commodity's price. The reduction in the price of paper and paperboard is greater for the FTAA without the income effect (Table 12). For the FTAA with the income effect, the price reduction due to tariff removal is partly offset by increased consumption due to the income effect.

Discussion[3]

The limited effect of the FTAA, without the income effect, is due to the already low tariffs on forest products within the region (Table 1) and the large number of regional trade agreements already in effect in the Americas (U.S. International Trade Commission 1999, O'Keefe 2002). The impact of the FTAA with the income effect on forest stock and area is larger than that predicted without the income effect (Table 6). This highlights the importance of considering the indirect effect of general trade liberalization on country incomes, beyond the direct effect of tariff reductions on forest products only.

An important consideration in interpreting the predicted positive impact of the FTAA on forest area is that the estimation of afforestation from equation (2) does not distinguish between increases in forest area due to establishment of plantations and natural regeneration of natural forests. This is because estimates of forest area change (FAO 2001a) do not distinguish between natural regeneration or plantations. It is not possible, therefore, to draw conclusions from this study about the types of forest that will increase under the FTAA.

An additional consideration is that coniferous and non-coniferous species are not separated in the industrial roundwood aggregate in the GFPM (Table 3). This distinction influences interpretation of the effects of the FTAA on forest stock and area. For example, Brazilian production of sawnwood increases under the FTAA. Just over 60 percent of Brazil's industrial roundwood and

[3] The authors thank an anonymous referee for raising a number of issues discussed in this section.

Table 10. Effects of the FTAA, with Income Effect, on Average Annual Production and Trade of Wood Pulp (1999–2030)

	Production		Imports		Exports	
Region/Country	10^3 t	%	10^3 t	%	10^3 t	%
Canada	2872	2.3	23	1.5	3570	5.1
Mexico	6	14.5	-35	0.4	-56	-7.6
United States	1963	0.5	2603	10.2	-367	0.4
Brazil	816	1.8	7	7.2	-14	-0.5
Chile	158	1.0	-1	-0.9	140	1.0
CAN	-46	-1.2	120	3.8	1	5.0
CARICOM[a]	6	10.4	9	2.7	0	10.0
SICA[b]	-11	-2.6	-13	-0.6	0	0.0
Rest of MERCOSUR	-261	-3.6	24	2.1	-86	-1.2
TOTAL FTAA	**1524**	**1.0**	**835**	**7.1**	**1020**	**2.3**
Africa	426	1.3	34	-0.4	367	3.1
North and Central America	4837	1.0	2588	7.9	3148	3.4
South America	668	1.1	150	4.7	41	0.0
Asia	-781	-1.0	893	0.8	119	0.2
Oceania	-171	-1.5	6	0.1	-191	-3.9
Europe	453	0.7	421	0.4	653	1.7
Former USSR	-661	-1.5	19	5.4	-28	-3.2
WORLD	**4771**	**0.6**	**4109**	**1.7**	**4109**	**1.7**

[a] Includes the Dominican Republic.
[b] Includes Panama.

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sawnwood production in 1999 was from coniferous species (FAO 2001b). As 90 percent of Brazil's natural forest is tropical moist or tropical rainforest, both of which are composed predominantly of non-coniferous species (FAO 2001a), Brazil's increased sawnwood production is unlikely to impact on its tropical forests. Incorporating coniferous and non-coniferous industrial roundwood supply and demand into the GFPM would require estimation of supply equations for these commodities, manufacturing coefficients for their use, and base year forest stock and area, and commodity production, consumption, trade, and prices. While data are available for coniferous and non-coniferous production and trade, there are no forest stock data distinguishing coniferous and non-coniferous species (FAO 2001a).

A surprising impact of the FTAA is that Canadian production and exports of sawnwood are lower, with the United States meeting its increased consumption of sawnwood through increased domestic production (Table 8). This is despite Canada's currently being the main source of U.S. sawnwood imports—36.8 million m^3 (67.3 percent of imports) in 1999 (FAO 2001b). There are two reasons for this result. First, this study does not consider the removal of the Canadian-U.S. softwood lumber agreement, which places a quota on sawnwood imports from Canada. As the softwood lumber agreement has persisted despite NAFTA, however, it is reasonable to assume that it would continue under the FTAA. Second, allowable annual cut (AAC) levels, established by provincial agencies, limit industrial roundwood harvests on public lands in Canada. In the GFPM the AAC was set at 240 million m^3 (Adams et al. 2003). This AAC prevents Canada from increasing its harvest to produce and export sawnwood to meet the United States' increased consumption under the FTAA. This suggests that there may be a trade-off in using harvest restrictions to preserve forest resources. Though potentially reducing the negative environmental effects of freer trade, they may also reduce the potential economic benefits to the forest sector.

That citizens increase their demand for forest protection with increased wealth, that is, that the environmental Kuznets curve for deforestation is

Table 11. Effects of the FTAA, with Income Effect, on Average Annual Production and Trade of Paper and Paperboard (1999–2030)

	Production		Imports		Exports	
Region/Country	10^3 t	%	10^3 t	%	10^3 t	%
Canada	-1129	-0.7	169	-1.2	-1181	1.8
Mexico	-810	0.2	1072	2.8	-9	3.6
United States	7920	1.4	-1461	4.0	4480	-1.4
Brazil	1234	3.8	35	11.2	792	2.8
Chile	46	1.2	30	-0.1	-6	1.9
CAN	194	2.4	161	3.5	25	7.7
CARICOM[a]	-110	-5.6	231	34.2	2	10.5
SICA[b]	-33	1.0	228	3.9	0	6.6
Rest of MERCOSUR	-257	-3.0	409	-0.1	-10	10.4
TOTAL FTAA	**2166**	**1.1**	**413**	**1.9**	**848**	**1.4**
Africa	176	0.3	12	0.2	29	0.4
North and Central America	5850	1.0	241	1.3	3291	0.5
South America	1216	2.7	636	8.2	800	6.1
Asia	-3539	-0.2	1072	-0.3	-446	0.6
Oceania	-17	-0.2	24	0.1	-29	1.2
Europe	-619	0.3	1708	0.6	15	0.7
Former USSR	-650	-0.4	9	-0.3	41	0.4
WORLD	**2416**	**0.3**	**3701**	**0.8**	**3702**	**0.8**

[a] Includes the Dominican Republic.
[b] Includes Panama.

Notes:
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valid, is critical to the findings of this study. Such a relationship is not guaranteed; therefore, including in trade agreements policies or provisions that contribute to forest protection would ensure that deforestation rates do not increase with trade liberalization.

Some economists argue that where trade liberalization results in increased environmental degradation, it is due to market and policy failures, and not to trade directly (Nordström and Vaughan 1999). In the case of deforestation, the problem is that there are as yet no markets for important services provided by forests, such as carbon sinks and biodiversity, and in some countries few property rights apply to forest resources (Brander and Taylor 1997, 1998).

Still, addressing deforestation by limiting trade could potentially have a negative effect. For example, placing import bans on tropical timber could lead to the conversion of forests to more lucrative uses, such as agriculture (Vincent 1992). Environmental problems are best addressed at their source by, in the case of forests, developing markets for services, such as carbon storage, and defining property rights (Vincent 1992, Nordström and Vaughan 1999).

Table 12. Effects of the FTAA on Average Annual World Forest Commodity Prices (1999–2030)

Commodity	FTAA Without Income Effect (%)	FTAA With Income Effect (%)
Industrial roundwood	-1.83	0.42
Sawnwood	-0.01	-0.27
Wood-based panels	0.24	0.39
Wood pulp	-5.28	-5.67
Paper and paperboard	-3.18	-1.89

Conclusions

If one considers only the direct impact of removing tariffs on forest products, the Free Trade Area of the Americas agreement would have a small effect on forest product production and trade, and forest resources. However, when the complete, multi-sector agreement's effect on country income was included in our analysis, the agreement had a stronger impact. This was due to the substantial increase in forest product consumption that would result from increases in national income, particularly in the Latin American economies. Thus, when dealing with a relatively small sector like forestry, it is essential to recognize both the direct tariff effects and indirect income effects of trade liberalization. This is not only to predict the effects on trade flows (Prestemon and Buongiorno 1996), but also to trace the effects of liberalization on forest harvest, stock, and area.

In our model, the United States and Brazil experienced the largest increase in production and exports of forest products under the FTAA, while Canada experienced the largest decline. Mexico's production and trade of forest products was largely unchanged under the FTAA. Chile increased its production and export of industrial roundwood, with little change in production of processed forest products.

Under the FTAA, forest area was higher in all countries due to reduced deforestation and increased afforestation associated with increased incomes. All countries, except the United States and Chile, had higher forest stock. A variety of forces contributed to this. In some countries, industrial roundwood harvests were lower, reducing the demand on forests. In other countries, harvests were higher, but increased afforestation offset these losses. These results rely critically on afforestation rates being positively related to country income.

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