

Chapter 11

International Trade In Forest Products

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The 21st century continues a trend of rapid growth in both international trade of forest products and a concern for forests. These two trends are connected. Forces causing trade growth are linked to the loss of native forest resources in some countries and the accumulation of nonnative forest resources in other countries. Factors increasing trade include relaxation of trade barriers, income growth, and improvements in wood growing, harvest, and manufacturing technologies. But environmental concerns are increasing as consumer preferences change, and as native forests recede and plantation forests become more prominent.

Efforts to address environmental concerns often involve changes in trade policies. The effects of these changes can be evaluated with trade models. In this chapter, we describe the context of forest products trade and major policy issues, explain three approaches to policy modeling, and present three applications of partial equilibrium modeling of trade policies.

1. FOREST PRODUCTS TRADE TODAY

World forest products trade has grown rapidly in volume and value, fuelled by both world economic growth and falling trade barriers. Tariffs on forest products have been decreasing as a result of consecutive rounds of the General Agreement on Tariffs and Trade (GATT) and World Trade Organization (WTO). The last round of GATT resulted in agreements to significantly reduce average worldwide tariffs on forest products (Barbier

1996), although these reductions may be matched by an increase in nontariff barriers.

Tariffs are declining mainly because of the creation of new multilateral trade liberalization accords and through modification of existing agreements, including the WTO and other multilateral regional accords. Principal among the regional accords are the North American Free Trade Agreement (NAFTA), the European Union, and the European Free Trade Association (Frankel et al. 1997). As of June 2000, there were 134 regional trade agreements (World Trade Organization 2001).

Trade liberalization, growing trade volumes, and the rise in concern for the environment have created ample subject matter for trade policy analysis. Major issues arising from the growing importance of trade include effects on import-competing domestic industries, biodiversity protection, global warming, forest sustainability, and the hardening of trade blocs. When governments negotiate freer trade, certain sectors are harmed and others benefit. Freer trade's effects on long-protected domestic industries can create political turmoil and lead to efforts to erect trade barriers to limit negative effects on them. Depending on the mix of ownership, tenure enforcement, and whether a country is a net importer or exporter of forest products, trade policies can encourage or discourage forest loss (Prestemon 2000) and have uncertain influences on biodiversity and carbon balances. Active forestry and efforts to preserve forests may be partial solutions to global warming, as some of the tropical forest loss is matched by temperate forest gains (e.g., Reddy and Price 1999, Sohngen and Sedjo 2000). In many countries, efforts to slow deforestation through trade instruments could even have some perverse effects on forests.

A country's environmental protection policies and related laws can have effects on trade and on global welfare as well. One set of policies and laws concerns timber or forest certification. Certification is the formal affirmation by an objective party that forest management and harvesting on a forested tract are done in environmentally, economically, and socially sustainable ways. Certification may have the effect of increasing timber production costs, leading to lower outputs and, presumably, less trade. The potential economic costs of reduced trade resulting from realignment and output decreases merit quantification (Sedjo et al. 1998).

Many of the multilateral and bilateral trade arrangements negotiated in the last 50 years conflict with the WTO and threaten to segment world markets for forest products. Such segmentation—resulting in groups of regions with freer trade among members than with nonmember nations—could ultimately be harmful from a global perspective (Frankel 1998, Frankel et al. 1997, Ito and Krueger 1997, Shiells 1995). These trade blocs

may have far-reaching implications for producers and consumers if such blocs serve as barriers to greater world growth and economic efficiency.

2. INTERNATIONAL TRADE THEORY AND TRADE MODELING

2.1 Comparative Advantage

The magnitude and direction of forest product flows are determined by geography (distance), size of economies (demand), character of forest endowments (supply), and government policies (interventions and historical relationships). Classical trade theory prescribes that trade occurs because there are differences among trading partners in their relative costs of production. In forest products, empirical research based on theoretical and applied work done by Vanek (1959) and Learner (1984) suggests that the principal factor determining the direction and magnitude of net trade is the size of a country's forest endowment relative to the size of its economy (Bonnetfoi and Buongiorno 1990, Prestemon and Buongiorno 1997). But people can change a country's forest endowment by planting and creating faster-growing forests, improve transport networks to lower the cost of product movement, invent and acquire better machines and technologies to more efficiently use raw materials, and train workers to facilitate technology development and implementation. Examples of human efforts to affect comparative advantage are large-scale softwood plantation establishment in New Zealand and Chile, countries without substantial marketable native softwood endowments but which today have a comparative advantage in softwood forest products.

Governments, through unilateral and cooperative actions, affect how completely comparative advantages are expressed. Government interventions and cooperative actions designed to encourage certain outcomes therefore have effects important to understand and quantify. Economic analyses can quantify tradeoffs with far-reaching implications for welfare, industry structure and competitiveness, tariff revenues, and the environment.

2.2 Trade Modeling

A focus of trade policy analysis has been on the economic consequences of restricting trade-i.e., quantifying the costs of government interventions in markets of tradable products. The literature developed from this describes how governments can set tariffs to maximize domestic welfare and to

promote infant industries. Much of the earlier theoretical and applied trade policy analyses assumed perfect industry competition (e.g., Corden 1974, Dixit and Kyle 1985, Krugman and Obstfeld 1988). In some commodity markets and small economies, however, imperfect competition may be common, hence the development of trade theory describing best and second-best policies in that context. The perfect competition model has also been enriched by considering negative and positive externalities of production and consumption, strategic trade policy (Helpman and Krugman 1989), and trading blocs (Frankel 1998, Frankel et al. 1997, Ito and Krueger 1997, Shiells 1995).

Trade modeling approaches for evaluating effects of policies fall into three categories: computable general equilibrium, spatial partial equilibrium, and nonspatial partial equilibrium. Each approach has its own particular uses, advantages, and disadvantages.

Computable general equilibrium (CGE) models provide answers to questions about policies at the level of whole sectors and economies. These models are systems of many equations relating key components of an economy to each other and to other economies through commodity trade, currency exchange rates, and capital flows. CGE models are built from functional relationships between supply and demand for all products and aggregate supplies and demands for inputs to production. A strength of CGE models is that, because all sectors are allowed to be affected by all other sectors, effects of a policy on prices and quantities of outputs and inputs of all affected markets can be measured most completely. Second, the effects of trade policy changes can be measured in terms of aggregate national economic welfare. The primary weakness of CGE models is their lack of model resolution. Because of tradeoffs between model accuracy and size on the one hand and model resolution on the other, the effects of trade policies at the subsector levels are usually not revealed. This means that it is difficult to evaluate the effects of policies on specific products. Simpler models, which treat a particular sector in detail and other sectors in more aggregate terms, are possible (e.g., Yúnez-Naude 1992) and perhaps a direction for further development in forest product sector trade modeling.

Partial equilibrium models assume that the feedbacks from sectoral changes to aggregate macro variables (gross domestic product [GDP] growth, national investment, wages, etc.) are negligible, and that assumption allows modelers to quantify the detailed effects of a policy on specific commodity markets. In partial equilibrium models, macro variables affect the sector, but are not affected significantly by it. One example is the spatial partial equilibrium model (Samuelson 1952, Takayama and Judge 1964), which exploits concepts of market spatial distribution and transportation and transaction costs to observe spatial reallocations of production and

consumption given a policy change. Spatial partial equilibrium models have been used to study the effects of trade policies on forest product trade levels (e.g., Frankel 1998, Boyd and Krutilla 1992, Boyd et al. 1993, Buongiorno and Gilless 1984, Gilless and Buongiorno 1987).

Nonspatial partial equilibrium models of trade (e.g., Olechowski 1987) remain the most widely used means of studying the effects of changes in trade policies on specific commodities. These models rely on estimates of the elasticity of import demand and export supply with respect to prices and with respect to other variables in order to measure the effects of an exogenous economic shock (e.g., a policy change) on markets. Therefore, the key element of partial equilibrium analysis is the estimate of the import demand equation for the product(s) of interest. The transportation and transaction costs of trade are left out of nonspatial partial equilibrium analysis. Presumably, empirical elasticity estimates contain the effects of these costs, but a consequence of ignoring spatial distribution is the inability of such models to anticipate the appearance of wholly new trade flows between two points of production and consumption.

3. EMPIRICAL STUDIES OF THE EFFECTS OF GOVERNMENT POLICIES ON FOREST PRODUCT TRADE

3.1 Case 1: The U.S.-Canada Memorandum of Understanding on Softwood Lumber Trade

The longest running trade dispute in the U.S. forest products sector concerns softwood lumber production and imports from Canada. Here we address one episode in this debate. The crux of the dispute is that U.S. producers view Canadian producers' long-term forest management contracts with Provincial governments as a subsidy. The U.S. firms successfully argued for relief in the form of a countervailing duty on imports of softwood lumber from Canada. Subsequent negotiations resulted in a Memorandum of Understanding (MOU) that allowed Canadian authorities to collect an export tax equivalent to the countervailing duty from the beginning of 1987 to October of 1991.

This study (details are contained in Wear and Lee 1993) estimated the influence of the MOU on softwood lumber trade and lumber markets in the United States. The study faced an issue common in applied policy analysis: evaluation of a recent policy-relevant event with few data.

3.1.1 An Impact Model

The first step was to model the share of Canadian lumber in the softwood lumber market in the United States as a function of supply and demand factors for the U.S. market and a set of variables that recognized imports from Canada as an excess supply (i.e., Canada's home market variables). We hypothesized that these variables would predict variation in market share before and after the imposition of the MOU and that the MOU would shift this relationship.

The impact model was defined as follows:

$$m^c = g(HS, GNP, t, CLUM, XLUM, XLOG, XCH, M) \quad 11.1$$

where m^c is the ratio of Canadian imports in the United States to total U.S. consumption. U.S. demand factors include housing starts (HS), gross national product (GNP, a proxy for nonhousing uses of lumber), and a time index (t), which allows for a changing relationship between demand factors and lumber consumption. U.S. supply factors include domestic export of comparable lumber ($XLUM$) and logs ($XLOG$). Additional variables are the Canadian-U.S. exchange rate (XCH), Canadian lumber consumption ($CLUM$), and a vector of impact variables (M), used to test for changes in market share coincident with the period of the MOU. All righthand-side variables were assumed to be exogenous, and equation 1 I. 1 was estimated by ordinary least squares.

The vector of impact variables (M) consisted of six separate dummy variables ($M_{85}, M_{86}, M_{87}, M_{88}, M_{89}, M_{90}$), to allow for different impacts in each year. Coefficients for the dummy variables for 1985 and 1986 capture unexplained variation in import share in years prior to the policy.

Equation 11.1 was estimated with annual data from 1960 to 1990. The model explained most of the variation in import share (adjusted $R^2 = 0.96$). All variables affected the share significantly, except M_{85} . The significant effect of M_{86} reflected a strong anticipatory response by Canadian producers in the fourth quarter, after a countervailing duty had been announced and would have been retroactively applied to fourth-quarter exports. The effects of M_{86} to M_{90} were not statistically different, so they were replaced by a single dummy variable. The value of the coefficient for this dummy variable was -0.048, indicating that the MOU reduced market share by about 4.8%.

3.1.2 Price-Quantity Analysis

The next step was to translate the results of the impact model into effects on lumber quantities and prices. The method for estimating market impacts

is summarized in figure 11.1, which describes the U.S. softwood lumber market with an aggregate demand function for lumber (D) and a two-part lumber supply with total supply (Q) equal to the sum of Canadian supply (S^C) and other supply (almost exclusively domestic, S^O). The subscripts 0 and 1 refer to supply before and after the policy, respectively. P is price.

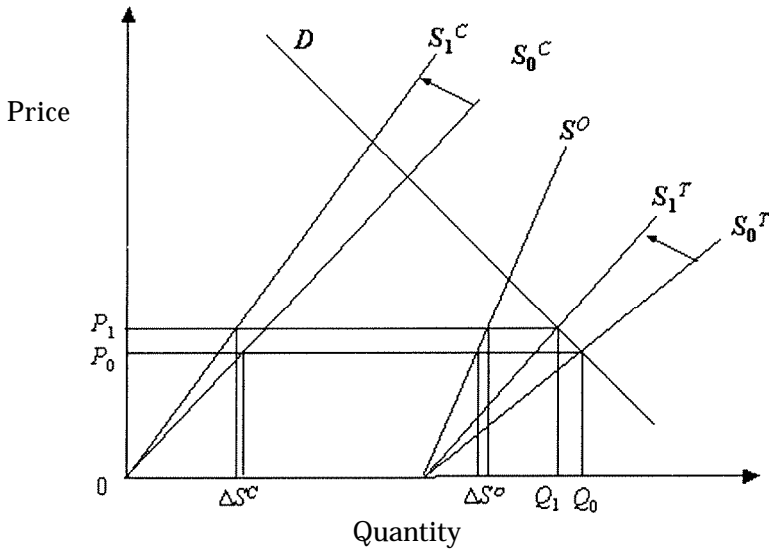


Figure 11.1. Structure of the U.S. softwood lumber market

The export tax is implemented as a proportional assessment on lumber price, so the policy results in a pivotal inward shift in Canadian supply (ΔS^C) analogous to the implementation of an ad valorem tax, and a consequent shift in total supply from S_0^T to S_1^T . The shift in total supply lowers the equilibrium quantity, $\Delta Q = Q_1 - Q_0$, and raises the equilibrium price, $\Delta P = P_1 - P_0$. These shifts cause a movement along the other supply curve (S^O). The policy can be evaluated through its impact on four variables: ΔS^O , ΔS^C , ΔQ , and ΔP as follows. First, movement along the lumber demand curve (ΔQ) and the 'other lumber supply' curve (S^O) is defined by their own price elasticities of η and δ , resulting in two linear equations.

$$\Delta Q = \eta \frac{Q_0}{P_0} \Delta P$$

$$\Delta S^O = \delta \frac{S_0^O}{P_0} \Delta P \quad 11.3$$

The policy impact on market share is modeled by the differential of Canadian market share:

$$dm^C = d \left[\frac{S^C}{Q} \right] = \frac{Q_0 \Delta S^C - S_0^C \Delta Q}{Q_0^2} \quad 11.4$$

Because the shares must sum to one, a symmetrical result holds for the other market share:

$$-dm^C = dm^O = d \left[\frac{S^O}{Q} \right] = \frac{Q_0 d S^O - S_0^O d Q}{Q_0^2} \quad 11.5$$

By setting dm^C equal to the impact on share estimated by the impact model (-4.8 percent), and imposing the market identity, we have four linear equations and four unknowns which can be solved with estimates of the two elasticities (δ and η), determined from the literature to be $\eta = -0.17$, $\delta^O = 0.4$, and $\delta^C = 1$.

Applying the four-equation model (11.2- 11 .5) to production, consumption, and price data for the years 1987-1990, the MOU resulted in a 2.6 billion board-feet (bbf) annual reduction of imports from Canada to the United States (table 11. 1).

Table 11. 1. Estimated total policy impacts for the years 1987 to 1990

	Total Change	Annual Change
<i>Market impacts</i>		
U.S. lumber consumption (bbf)	-3.06	-0.76
U.S. lumber production (bbf)	+7.32	+1.83
Lumber imports from Canada (bbf)	-10.43	-2.61
Lumber price (1982 US\$/mbf)	—	+19.91
<i>Welfare impacts</i>		
U.S. producer surplus (millions of 1982 US\$)	2632.4	658.1
U.S. consumer surplus (millions of 1982 US\$)	-3789.5	-947.4
U.S. total impact (millions of 1982 US\$)	-1157.0	-289.3

In response, U.S. lumber production increased by 1.8 bbf, and price increased by roughly \$20 per thousand board-feet (mbf). U.S. lumber consumption was reduced by about 0.8% over this period.

3.1.3 Welfare Analysis

To calculate consumer surplus, we describe total supply by the import and domestic supply elasticities and base year observations:

$$P = b_T + \beta_T Q; \quad \beta_T = \frac{P}{\delta^T Q}; \quad b_T = P_0 - \beta_T S_0^T \quad 11.6$$

where δ^T is the own price elasticity of total supply, equal to

$$\delta^T = \frac{\delta^C S^C + \delta^O S^O}{S^T} \quad 11.7$$

Consumer surplus, the area under the demand curve and above the price line, defines consumer benefits and is altered by shifts in the price-quantity equilibrium. Change in consumer surplus is defined by the total quantity and price changes as shown in figure 11.1:

$$\Delta CS = - \left[(P_1 - P_0) Q_1 + \frac{1}{2} (Q_0 - Q_1) (P_1 - P_0) \right] \quad 11.8$$

Producer surplus, the area above the supply curve and under the price line, defines producer profits. Change in domestic producer surplus is:

$$\Delta PS^O = (P_1 - P_0) S_0^O + \frac{1}{2} (P_1 - P_0) (S_1^O - S_0^O) \quad 11.9$$

The computation of change in producer surplus for Canadian firms following the policy is based on treating the shifted supply curve as an effective supply, and defining producer costs using the prepolicy supply curve.

$$\Delta PS^C = (1 - \alpha) P_1 S_1^C - \frac{1}{2} P_1' S_1^C - \frac{1}{2} P_0 S_0^C \quad 11.10$$

$$P_1' = P_0 S_1^C$$

where α is the export tax rate and P_1' is the price defined by the prepolicy supply curve at S_1^C . The tax revenue is defined as $R = \alpha P_1 S_1^C$.

We estimated total quantity and price changes from the 4.8% reduction in Canada's market share for the years 1988 to 1990 by simulating removal of

the policy impact ($S^C = 4.8\%$) from market results (P_o, Q_o) in each of these years, using the equations and elasticities given above. The total as well as the average annual impacts of the policy are listed in table 11.1. Over the full course of the MOU, U.S. producers gained about US\$2.6 billion (in 1982 dollars), while consumers lost about \$3.8 billion. Thus, the net U.S. cost is approximately \$1.2 billion over this 4-year period.

3.1.4 Discussion

The estimated welfare impacts reflect effective rent seeking by domestic lumber producers. Large positive returns accrued to domestic firms but also to the exporting country, and they are accounted for by increased consumer and efficiency costs. However, Canada's termination of the MOU indicates that these benefits, complicated by the MOU's prohibition on the redistribution of export tax revenue to wood products firms, were not adequate compensation for infringing on its resource sovereignty.

In the quantity terms of the original countervailing duty complaint, the MOU succeeded. Our analysis indicates that imports fell by about 2.6 bbf per year, while U.S. production increased by about 1.8 bbf per year. This, coupled with the consequent change in lumber price, led to considerable improvement in the competitive position of domestic producers in home markets. This improved competitiveness provided significant economic benefits to U.S. firms, even as domestic environmental issues caused available softwood timber inventories to contract.

3.2 Case 2: The Long-Run Effects of NAFTA

NAFTA took effect on January 1, 1994, after much debate and critical analysis of its potential impacts on North American economies. NAFTA created the world's largest free-trading zone: Canada, the United States, and Mexico. After a 15-year phase-in period, most commodity tariffs (including forest products) and nontariff barriers will be eliminated, affecting trade in a region of 400 million consumers and aggregate output of over 7 trillion dollars. United States-Canada-Mexico trade in forest products accounts for most forest products trade in all three, so NAFTA may have important implications for the forest sectors of each. In order for producers and consumers of traded forest products in each country to make informed decisions on investments in new plants and equipment, projections of the effects of NAFTA on trade in individual product categories will be useful.

Much modeling of NAFTA prior to its implementation was with CGE models (e.g., Francois et al. 1992). These models provided estimates of the net effects of NAFTA on exchange rates, price levels, aggregate economic

output, wages, and interest rates or capital flows. However, CGE models provided results for large sectors, not commodities. Prestemon and Buongiorno (1996) described a method for calculating the disaggregated effects of NAFTA on U.S. and Canadian exports to Mexico using these CGE models and a system of partial equilibrium models. Their approach was to (1) estimate partial equilibrium demand equations for Mexico's imports of forest products by product class, equations that made imports a function of import prices, Mexican forest product-consuming sector outputs, and Mexican production input prices; (2) estimate reduced-form price equations for each product class, which were functions of Mexican, U.S., and Canadian input prices and output levels; and (3) predict changes in Mexico's forest product import prices and quantities using CGE models' estimates of the effects of NAFTA on tariffs, output levels, and input prices.

The Mexican import demand function for each product is:

$$M_d = M_d(Y, P_M, \mathbf{w}) \quad 11.11$$

where M_d is the quantity imported by Mexico, Y is domestic output of the forest product-consuming industries in Mexico, P_M is the import price of the product, \mathbf{w} is a vector of input prices relevant to wood product producers and consumers. The total derivative of equation 11.11 shows the effects of changes in each variable on imports of each product, other things being equal:

$$dM_d(Y, P_M, \mathbf{w}) = \frac{\partial M_d}{\partial P_M} dP_M + \frac{\partial M_d}{\partial Y} dY + \sum_{i=1}^I \frac{\partial M_d}{\partial w_i} dw_i \quad 11.12$$

In relative terms,

$$\frac{dM_d(Y, P_M, \mathbf{w})}{M_d} = \beta_{P_M} \frac{dP_M}{P_M} + \beta_Y \frac{dY}{Y} + \sum_{i=1}^I \beta_i \frac{dw_i}{w_i} \quad 11.13$$

where β is the elasticity of import demand for the product with respect to the subscripted variable. Hence, counterfactual estimates of the trade agreement on individual products can be made by inserting estimates of import demand equations and price equations, which are functions of driving sector- and economy-wide variables, whose estimates can derive from CGE studies.

Estimation of output price changes deriving from NAFTA start by specifying the price function for each product, in pesos, as:

$$P_M = \theta EP(\mathbf{z}) \quad 11.14$$

where $\theta = I + \tau$, τ is the ad valorem tariff applied by Mexico to U.S. or Canadian forest product imports, and z are exogenous factors affecting the price. Predictions of the effects of NAFTA on the final price of forest products imports are obtained by taking the total derivative of equation 11.14 with respect to each variable and then converting the resulting equation into elasticities and proportional changes in the righthand-side variables:

$$\frac{dP_M}{P_M} = \alpha_E \frac{dE}{E} + \alpha_\theta \frac{d\theta}{\theta} + \sum_{j=1}^J \alpha_j \frac{dz_j}{z_j} \quad 11.15$$

where α is the elasticity of import price with respect to the subscripted variable.

The effect of NAFTA on trade quantity comes from substituting equation 11.15 into the first term on the righthand side of equation 11.13. The result is a model of the effect of NAFTA on the product import quantity:

$$\frac{dM_d(Y, P_M, w)}{M_d} = \beta_{P_M} \left[\alpha_E \frac{dE}{E} + \alpha_\theta \frac{d\theta}{\theta} + \sum_{j=1}^J \alpha_j \frac{dz_j}{z_j} \right] + \beta_Y \frac{dY}{Y} + \sum_{i=1}^I \beta_i \frac{dw_i}{w_i} \quad 11.16$$

Prestemon and Buongiorno (1996) estimated import demand equations (11.11) and price equations (11.14) for six categories of lumber, four categories of wood panels, newsprint, scrap plus waste paper, and seven kinds of wood pulp imported by Mexico from the United States. Similar equations were estimated for newsprint and three kinds of wood pulp imported by Mexico from Canada.

Three alternative scenarios of NAFTA's impacts on sector- and economy-wide variables were evaluated. These scenarios made alternative assumptions regarding the effects of the agreement on intraindustry competition, capital markets, and labor markets. Together, they provided a range of possible long-run effects of NAFTA on macroeconomic indicators in the United States, Canada, and Mexico.

Results are summarized in table 11.2. Minimum and maximum change estimates of the three scenarios are reported. Results show that impacts differ widely by product. NAFTA's net effect is to increase lumber, plywood, and scrap and waste paper imports from the United States and newsprint imports from the United States and Canada by large percentages relative to those observed in 1992. Effects on other products (other panels

and wood pulp) would have been small, reflecting their inelastic import responsiveness imports to prices.

Table 11.2. The long-run percentage change in value of NAFTA on U.S. and Canadian exports to Mexico, by selected forest product

Product	1992 Import quantity ^a	1992 Import value (1994 US\$ m)	Minimum change (%)	Maximum change %
<i>U.S. forest products</i>				
Douglas fir lumber	101 Mm ³	15	73	207
Ponderosa pine lumber	312 Mm ³	9.5	17	47
Southern pine lumber	93 Mm ³	16	10	77
Other softwood lumber	457 Mm ³	83	10	77
Oak lumber	72 Mm ³	26	19	58
Other hardwood lumber	56 Mm ³	17	74	247
Hardwood veneer	3,576 Mm ²	5.0	4	2.5
Softwood plywood	181 Mm ³	37	89	266
Hardwood plywood	76 Mm ³	15	26	72
Particle board	81 Mm ³	22	0	0
Bleached sulfate pulp	285 Mmt	126		43
Semibleached sulphate pulp	25.8 Mmt	10	0	3
Unbleached sulphate pulp	6.6 Mmt	22	0	2
Bleached + semibleached sulphite pulp	8.5 Mmt	2.8	0	15
Unbleached sulphite pulp	4.6 Mmt	1.1	0	0
Dissolving grades of pulp	79.9 Mmt	38	0	0
Mechanical + semichemical pulp	11.5 Mmt	4.2	9	50
Scrap + Waste paper	828 Mmt	110		20
Newsprint	119 Mmt	63	47	136
<i>Canadian forest products</i>				
Bleached + semibleached sulphate pulp	7.3 Mmt	0.4	2	41
Unbleached sulphate pulp	1.0 Mmt	13	2	14
Mechanical + semichemical pulp	36 Mmt	16	3	20
Newsprint	46 Mmt	23	12	44
<i>Total, US</i> ^b		686	21	83
<i>Total, Canada</i> ^c		39	21	117

^a Mm³ = 1000 m³, Mm² = 1000 m², Mmt = 1000 metric tonnes

^b Excluding 1992 imports of paper and paperboard worth US\$283 million and logs and panels worth US\$40 million

^c Excluding 1992 imports of paper and paperboard worth US\$3 million and pulp worth less than US\$1 million in 1992

3.2.1 Discussion

This model of trade analyzed what would have been the effect of NAFTA had the agreement been fully implemented in 1994. The partial equilibrium modeling was a simple way of obtaining disaggregated, product-specific assessments of the net effects of the trade agreement. The approach also took into account the general equilibrium effects of the agreement on industry-relevant cost factors and output levels. Although these estimates of trade effects were not projections of the future (i.e., they were counterfactual), the empirical models of import demands and prices could have been used to project. To project trade volumes by product into the future, the analyst would insert projected values of the macroeconomic variables for selected future years and then calculate the quantities and prices of forest product imports that would result in those years.

The policy implications of the modeling on the forest sectors complement the predicted net effects of NAFTA on economy-wide variables. First, NAFTA's effects on exports from the U.S. will be concentrated in solidwood products, especially lumber. U.S. lumber exporters to Mexico could use this finding to ready themselves for greater exports there. Second, U.S. and Canadian newsprint exporters should find NAFTA expanding their export opportunities to Mexico; exporters of paper products that were not analyzed here might expect a similar effect from NAFTA. Third, NAFTA will have little effect on pulp exports to Mexico, indicating that the agreement should have little effect on their pulp prices, implying ultimate benefits for the North American paper industry.

3.3 Case 3: Freer Global Trade and the WTO

The 1994 Uruguay Round of GATT, incorporated into the 1994 Marrakech agreement establishing the WTO, was intended to further the goal of worldwide free trade. Part of this WTO round involved significant reductions in forest products tariffs. Because U.S. tariffs on most forest products were already low before the agreement, the substantial reduction in tariffs by other countries benefited the U.S. forest industry (Wisdom 1995).

Nevertheless, in spite of the free trade advances of the Uruguay Round, tariffs remain a significant barrier to trade for forest products worldwide (Bourke and Leitch 1998). At the urging of the United States, Canada, Indonesia, and New Zealand, in 1998 the Asia Pacific Economic Cooperation (APEC) countries proposed the forest sector for accelerated tariff liberalization (ATL). The effects of this agreement were analyzed with a variant of the global forest products model (GFPM) developed at the University of Wisconsin-Madison in collaboration with the Food and

Agriculture Organization (FAO) of the United Nations and the USDA Forest Service (Zhu et al. 2001). After reviewing the GATT and WTO agreements, this section describes the application of the GFPM to predict the impacts of accelerated tariff liberalization on the global forest sector.

3.3.1 The Uruguay Round of GATT and Accelerated Tariff Liberalization

Barbier (1996) summarized the 1994 Uruguay Round agreements for forest products, which served as the base scenario for this application of the GFPM. The tariffs on most forest products would be reduced 33% on a trade-weighted basis. Most major importers agreed to tariff elimination on pulp and paper by 2004. The major developed countries were also committed to reducing tariffs by 50% on solid wood products over 5 years starting in 1995. For developed countries, the average tariff of forest products (wood, pulp, paper, and furniture) would be reduced from 3.5% to 1.1%. In the United States, average tariffs would be cut from about 3.1% to 1.8%. The tariff escalation for processed products in developed country markets would be reduced significantly. For wood, the reduction ranged from 30% to 67%; for paper and paperboard, tariff escalation would be eliminated. The Uruguay Round agreement committed all major developed countries and a high proportion of developing countries to bind forest product tariff rates, thus reducing the market risk greatly.

The implications of the agreement for nontariff barriers are less clear, although the Agreement on the Application of Sanitary and Phytosanitary Measures and the Agreement on Technical Barriers to Trade would improve the market access (Barbier 1999). Barbier (1996, 1997) and Brown (1997) found that the impact of these provisions resulting from the Uruguay Round on trade in forest products would be small. This is partly because tariffs in Organization for Economic Cooperation and Development (OECD) countries would remain high for some products, such as wood-based panels. In other countries, tariffs between 10% and 20% are common, and they can reach 40%. The ATL proposal covered all forest products, such as logs and wood products, pulp, paper, and paper products. Parties to the Uruguay Round of GATT “zero-for-zero” agreement (i.e., a market access agreement where all the participating countries eliminate the same tariff and [sometimes] nontariff barriers on the same products) meant to move up the elimination of tariffs on pulp, paper, and paper products from January 1, 2004, to January 1, 2000. Others would attempt to remove tariffs by the same date, but could delay removal until January 1, 2002. The proposal called for the elimination of tariffs on all other products by January 1, 2002.

This is the alternative scenario modeled with the GFPM, with all tariffs set to zero beginning in 2000.

3.3.2 The Global Forest Products Model

The GFPM uses price-endogenous linear programming (Zhang *et al.* 1993), which is based on the technique of solving for a spatial equilibrium in competitive markets (Samuelson 1952). The GFPM integrates the classical four major components of forest sector models (Kallio *et al.* 1987): timber supply, processing industries, product demand, and trade. The GFPM shows how production, consumption, imports, exports, and prices are likely to change in response to changes such as economic growth, tariffs, or technology.

The GFPM works by optimizing the short-run allocation of resources in global product markets. Long-run resource allocation is partly governed by market forces (e.g., capacity expansion and trade) and political forces. The latter include wood supply shifts determined by forest policy, waste paper recovery rates mandated by environmental policy, tariffs, and technology. The GFPM solves a sequence of annual global equilibria by maximizing the value of the products minus the cost of their production, subject to material balance and capacity constraints in all countries. In each projection year, for each country and commodity, net supply (domestic production plus imports) is equal to net 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 fiber in each country is price responsive. The supply of recycled paper is constrained by the waste paper supply, which itself depends on past paper consumption and the recycling rate. Each country exports to the world market and imports from it. Imports and exports for each country are constrained to simulate inertia in yearly changes in trade (Buongiorno and Gilless 1984, Kallio *et al.* 1987). The shadow prices of the material balance constraints are the market-clearing prices at which demand equals supply for all countries and commodities (Hazell and Norton 1986).

From one year to the next, demand changes in each country due to changes in GDP. Wood supply shifts exogenously according to a chosen scenario. The rate of fiber recycling depends on technology and recycling policy. Capacity changes depend on past production and the shadow price of capacity in different countries. 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.

The GFPM models 180 countries separately. Disaggregation to the national level is useful because political power on matters of international trade rests largely at national levels. It also facilitates data verification and enhances modeling flexibility. Lastly, it facilitates review and evaluation of results, because expert knowledge is more available at the country level than at more aggregate levels. Fourteen commodities are considered in the model: from fuelwood to paper and paperboard, covering all the forest products in the FAO statistical yearbook (FAO 1999).

The GFPM uses econometric demand equations for end products, summarized by elasticities with respect to national income (measured by real GDP) and real product price, in constant U.S. dollars (Baudin and Lundberg 1987, Buongiorno 1978). The assumptions on the GDP growth rate of each country were those used in the 1999 FAO Global Forest Products Outlook study (Zhu et al. 1998).

In any given year and country, the supply of industrial roundwood is a function of its price. The supply also shifts over time, reflecting estimates of change at constant prices. The shift rates vary by country and are based on past production, forest area and stock, growth rates, extent of plantations, and policy. The shift rates used here were the annual percentage changes in the commercially available wood supply projected by the Global Fiber Supply Model (Bull et al. 1998). The price elasticities were also estimated by the participants of the GFPM study, based on their knowledge of countries and on existing literature. The waste paper supply curves were horizontal, with upper bounds determined by the previous year's paper consumption. Waste paper recovery rates were assumed to increase over time (Ince 1994, Mabee 1998).

Manufacturing is represented in the GFPM by input/output coefficients and associated manufacturing costs. The estimation procedure was such that the implied consumption, production, and trade was as close as possible to the national statistics, while the input-output coefficients were within a plausible range, given prior knowledge of the technology. The manufacturing cost (capital, wages, energy, etc.), excluding the cost of raw materials explicit in the model, was estimated as the unit value of output minus the cost of all inputs, all expressed at world prices. So, net profits were constrained to equal zero, consistent with a competitive equilibrium. The technology was held constant at the 1997 level, except for the paper industry. There, it was assumed that the amount of recycled paper input would increase gradually between 1997 and 2010, to reach levels predicted by other studies (Ince 1994, Mabee 199X).

In the GFPM, each country imports from and exports to the world market. The world price was calculated as the average of import (cost, insurance, freight) and export (free on board) unit values. In the base year,

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. In this way, the solution of the model in the base year was almost identical to the observed quantities and prices.

The model was calibrated for 1997 and used to project prices and quantities to 2010. The parameters were estimated econometrically when possible and taken from other studies when not, and some had to be determined by judgment. The import tariffs were simulated as decreases in transportation costs. The tariff data for 1997 were obtained from the U.S. Department of Commerce, International Trade Administration. Tariffs were ad valorem, so the effect of a change in tariff changed with the price level. The tariff changes for each commodity and each country were based on Barbier (1996).

3.3.3 Effects of Tariff Liberalization to the Year 2010

With or without tariff elimination, the model projected changes between 1998 and 2010. Results show that wood consumption would continue to rise, especially in Asia. Worldwide, it would reach 4.4 billion m³ by 2010, 29% more than in 1997. Still, the real price of products would increase only slightly. North and Central America, a net exporter in 1997, would become a net importer by the year 2010, with or without tariff elimination. This would be due, in part, to timber harvest restrictions in the United States and Canada. Europe and Asia would remain major importers, while Oceania, South America, and South America would increase their exports.

Table 11.3 summarizes the effects of eliminating the tariffs, other things being equal, from 1998 to 2010, for selected products and regions and for the United States. The predicted effects of freeing trade on world production were quite small, totalling less than 0.5% average increases in yearly production. In fact, tariff elimination would cause industrial roundwood production to decrease slightly in Asia and Europe. In the United States, the main effects on production would be an average 1.2% increase in annual sawnwood output, and it would be negligible for other products.

Accelerated liberalization would have a larger relative effect on trade than on production. World imports of industrial roundwood would decrease by about 2% under free trade. The main decrease (4%) would take place in Asia, mostly in Japan. The U.S. imports of industrial roundwood would be unaffected. World imports of manufactured products would increase with free trade, by 2% for sawnwood and by 1% for pulp and paper. U.S. imports of sawnwood would decrease by about 3%, and those of pulp would decrease by 2%. Instead, U.S. imports of wood-based panels and papers would increase.

Table 11.3. Predicted effects of tariff reductions on production and trade quantities, 1998 to 2010, for selected regions and products

Region	Industrial roundwood			Sawnwood		
	Production	Import	Export	Production	Import	Export
	%yr ⁻¹	%yr ⁻¹	%yr ⁻¹	%yr ⁻¹	%yr ⁻¹	%yr ⁻¹
Africa	0.6	3.1	1.0	1.0	-0.4	7.6
North and Central America	0.0	3.2	-15.5	0.8	-2.9	0.3
United States	0.4	0.3	6.3	1.2	-3.4	1.4
South America	1.1	0.9	0.0	1.0	5.9	11.5
Asia	-0.3	-3.7	-0.3	-1.3	6.4	3.9
Oceania	0.4	1.0	1.0	0.0	0.5	0.4
Europe	-0.1	-0.1	-2.8	-0.3	4.8	5.0
Former USSR	0.5	-0.3	2.0	0.0	1.1	0.2
World	0.1	-1.7	-1.9	0.0	2.0	2.0
		Wood pulp		Paper and paperboard		
Africa	1.4	-1.0	3.5	0.4	0.0	2.5
North and Central America	0.1	-1.5	1.7	-0.3	2.0	-0.1
United States	0.0	-1.8	2.6	-0.4	3.3	0.5
South America	0.4	-0.5	2.6	-0.4	-1.1	-1.3
Asia	-1.3	3.4	-4.3	0.8	0.7	0.7
Oceania	-1.1	-3.7	0.3	-1.4	2.5	-0.7
Europe	0.3	0.2	-0.7	0.2	0.8	1.6
Former USSR	-1.0	2.2	0.8	-1.5	3.0	1.4
World	-0.1	0.7	0.7	0.1	0.9	0.9

While U.S. imports of industrial roundwood were almost unchanged by tariff elimination, exports decreased by 6%. Instead, U.S. exports of sawnwood and panels would increase by 1% to 1.5%. U.S. exports of wood pulp would increase by 3%, while exports of paper and paperboard would remain nearly unchanged. The main gains in exports, in relative terms, would occur in South America for sawnwood and panels.

3.3.4 Discussion

With or without freer global trade, world consumption of forest products projected with the GFPM continued to grow along the historical trends, and real world prices increased moderately. Eliminating tariffs caused only small changes in world production and consumption, but the trade shifted toward more processed products. Exports increased from northern Europe, Oceania, South America (Chile), and Asia (Indonesia and Malaysia). For the United States, the production and consumption was barely affected, but the trade quantity changed more. The U.S. exports of logs decreased while exports of most processed products increased.

Based on GFPM projections, global timber harvest would increase little due to tariff elimination. Projected timber harvesting would increase most in South America (by about 1% per year) but decrease slightly in Asia and Europe. The increase in harvest, where it occurs, is likely to come in large part from plantations (Tomberlin and Buongiorno 2001). Thus, at a broad scale, further tariff liberalization should have little effect on harvesting in primary forests.

We caution, finally, that these results depend on arguable assumptions and model parameters, which are estimates, so improvements in baseline data and methods would reduce uncertainties. Furthermore, tariff elimination in forest products is only a part of a broader set of reductions in other trade barriers. Those other reductions may contribute to increasing income and rising standards of living in poor countries, accompanied by decreases in fuelwood use and increases in demand for forest amenities (Raunikar and Buongiorno 1999).

4. CONCLUSION

Rapid growth in international trade of forest products has been observed at least partly because countries have reduced trade barriers, especially tariffs and quotas. In spite of this, significant additional barriers to trade remain, and there is growing evidence of largely negative economic and environmental outcomes from such trade constraints. Policy makers and economists have held out competitive pricing and free trade policies as the best means of promoting the efficient allocation of scarce forest resources. Barriers to trade distort market signals and may result in inefficient utilization of timber and nontimber forest resources. This is a common outcome in countries where competitive markets do not exist, but this also happens in countries with reasonably competitive forest products markets. Remaining barriers range from persistent tariffs and export quotas to trade-limiting new and existing technical, environmental, and sanitary standards. Timber trade restrictions are usually used as tools to (1) protect (subsidize) or develop domestic wood processing industries so that they generate employment, value added, and export revenues; and (or) (2) better fund forest management and protect forest resources. These policies have mixed results. While they may succeed in generating employment or value added, they also may be associated with high overall economic and environmental costs. These shortcomings are clearly recognized in the Forest Principles (1992 Earth Summit in Rio de Janeiro), which call for trade barrier reductions to achieve sustainable forest management.

Forest product trade liberalization and trade agreements have several documented economic advantages, including providing a framework for more effective institutions to protect, manage, and profit from forests and strengthening the economy. Trade models can help to quantify the effects of such changes. Nevertheless, trade policies and trade barriers can be surprisingly immovable. The persistence of forest products trade barriers may arise out of reluctance by governments to relinquish control over trade, or it may arise because these governments see trade restrictions as effective means of achieving important economic development goals. Modeling the effects of the status quo in comparison to what could be, however, can help policy makers better assess whether to chart a new economic course.

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