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The Effect of a Tariff Elimination Policy on the Forest Sector: A Global Perspective

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EXECUTIVE SUMMARY

Current tariffs on wood products act as a barrier to trade. They restrict market access to more efficient producers. When a multilateral tariff elimination policy is simulated with a global trade model the results project greater trade activity in softwood lumber and plywood, and a greater market share for the US, Canada and European producers. Smaller but similar effects are found in the hardwood sector.

The scenario analysis also suggests the possibility that, in the short term, tariff elimination may not lead to increase global consumption. A tariff elimination policy may result in a strong demand effect in the North American market, and, as a result, may lead to higher prices. Supply tightness may come from either stronger than expected demand growth and restrictions on supply availability in North America. Demand rigidity in Asian economies for lumber and plywood lead to positive, but small consumption gains with tariff liberalization.

Initial changes in softwood lumber trade flows reach 20% from baseline dropping to 13% by 2010. The result suggests that tariffs in softwood lumber have restricted markets mostly for North American and European producers. Because the North American, particularly the US market, and Europe are also the major consumers of softwood lumber, a tariff elimination scenario results in greater international demand for their products raising domestic prices and lowering domestic consumption. This reduction in North American and European domestic consumption outweighs consumption gains in Japan, Australia and Mexico, regions where tariff elimination occurs.

The current economic outlook for Asia is likely having a strong influence on the above result. Baseline results suggest a strong demand in the US while Asian consumption has fallen. The current global market condition has raised product prices in the US and lowered prices in Asia, an effect expected from lowering tariffs, but due to different forces. With an expanding US domestic markets and little consumption growth in Asian, the tariff elimination policy places further upward price pressure on US consumers as US and other producers shift some production from domestic to international markets. A further strengthening of foreign demand through a tariff elimination scenario reinforces upward price pressures affecting consumers in the US. Hence, the simulation suggests a global consumption decline in the short term with a price rise in the North American and European markets. This result suggests low cost producers are constrained from meeting expanded demand from tariff liberalization in the short run.

A dominant North American market characterizes the global softwood plywood sector. The simulation results suggest that tariff elimination in the softwood plywood sector increases trade activity as well as global consumption and production. The US, a major consumer and producer of softwood plywood, acts as an exporter reducing its consumption and increasing output. As such the US dominates the response from a tariff elimination scenario in the model. Since many of the producing sectors outside the US have exogenous behavior for this sector, production changes in the model are limited. The limited production capacity outside North America for softwood plywood is likely to lessen the importance from these exogenous production constraints. Tariff effects on plywood trade are substantial percentage-wise; they reach 8% immediately and attain 14% by 2010.

Softwood plywood is viewed as a mature product in decline being replaced by alternative engineered materials. Production capacity expansion in these engineered materials outside the U.S. are more likely to lessen the expanded production and consumption associated with the simulated tariff elimination policy in softwood plywood. Currently, fiberboard and reconstituted products are projected exogenously in CGTM.

Tariff elimination in the softwood lumber and plywood sectors has a direct impact on the sawlog and pulpwood sectors. There is little evidence of any substantial effect from a tariff elimination policy in the softwood sawlog sector and no recorded changes in the pulpwood sector due to tariff elimination. This is because tariffs currently exist in countries with limited market behavior, such as China, or with small trade flows such as Mexico. Hence, changes observed in the log sector are driven primarily by the softwood lumber tariff elimination. Softwood log trade is lower under the tariff elimination policy. Changes in trade activity in the softwood log sector reach 8% from baseline due to lumber and plywood tariff elimination.

Hardwood sector results are smaller than the softwood sector impacts. Assumptions regarding China's consumptive behavior have a strong influence on the results. Sensitivity analysis with higher Chinese consumption projects greater imports originating from nearby Asian countries. Otherwise, much of the increase in production would come from the US.

The above results suggests the major part of increased softwood harvests would involve Canadian forests which are mostly natural followed by secondary forests in the US and Europe. Depending on Chinese consumption changes, the major increase in hardwood harvests would originate from Southeast Asian producers under high Chinese consumption growth. Otherwise, the increase in hardwood consumption would flow from US forests.

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1 INTRODUCTION

Trade policy is a foremost concern for the global village. Globalization has lead to greater factor mobility and the need to understand the effect trade policies have on economic development and the environment. Globalization of the forest sector has grown as barriers to trade in forest products have come down. Forest trade policy takes on added importance due to its explicit relationship with environmental resources. As globalization and environmental concerns continue to grow so will the need to understand forest sector trade policy effects.

Economic trade theory dictates that the removal of existing tariffs will have consequences for the allocation of resources across sectors. Our interest in the present study is to examine the effect a reduction in tariffs in the forest sector has on wood and its use in forest products sectors around the globe. Also, understanding the changes in the production, consumption and trade activity in the forest sector for wood inputs and intermediate products of lumber and plywood associated with any tariff reduction in the forest sector has important regional and global consequences on the labor, capital and environmental sectors. This study examines the effect from a tariff elimination policy on production, consumption, trade and prices for the forest sector. Secondary effects on the labor, capital and environmental sectors may be extracted using information gathered on the primary forest sector results. Only a brief discussion on which forest and where is included in the present analysis, however.

The report details the following in subsequent sections. Section 2 describes the objectives of the work as described in the terms of reference. Section 3 explains the methods employed to analyze changes in the tariffs using the CINTRAFOR Global Trade Model (CGTM). The model description is provided in Section 4. This section also presents expected results from a tariff elimination policy from the perspective of a spatial equilibrium model. Section 5 introduces the baseline reference case, highlighting those trends most influential in determining the effect of tariff liberalization. Section 6 provides a summary of the effect of the accelerated tariff liberalization in terms of changes in production, consumption and trade. Section 7 lists shortcomings and how they may affect the results. A discussion of these limitations and a description of the underlying assumptions including structural parameters in the CGTM follow with an assessment of their effect on the study results. Section 8 briefly concludes the study by discussing results with respect to likely changes in sources of supplies and an indication of the type of forest that may be affected.

2 OBJECTIVES

The present work has two objectives.

- Provide a baseline projection for development in world forest products production, consumption and trade to the year 2010, with annual data.

- Illustrate the probable effects of the proposed Accelerated Tariff Liberalization (ATL) for forest products using scenario analysis.

The following strategy is employed in the assessment work. We begin by constructing the multilateral trade liberalization case. To gain further insights into individual producer and consumer behavior in the forest sector, we employ sensitivity analyses using unilateral implementation of tariff liberalization. The study also employs a single product approach to isolate effects across products (i.e. sawlogs versus lumber and plywood). The sensitivity analysis seeks to isolate behavior that is not consistent with the multilateral approach. As such it provides information on how regional assumptions of production, consumption and trade may be influential in the multilateral case. Additional sensitivity runs are performed to determine the importance of various assumptions concerning the development of the business as usual base case.

3 CHANGING THE TARIFF STRUCTURE IN THE GLOBAL FOREST SECTOR

The CGTM characterizes trade in the global forest sector by constructing bilateral trade flows. There are 423 such flows for softwood and hardwood sawlogs, pulpwood, lumber and plywood. The cost associated with trade is included for each trade flow in the model. Trade cost changes associated with a tariff reduction are implement in the year 2000 by calculating the reduction in trade cost associated with an ad valorem tariff reduction. The ad valorem tariff reduction is calculated using the exporter's price plus trade costs (e.g. the CIF price) for the importing region. The resulting reduction in value is subtracted from the trade cost for each trade flow for which there exists a tariff reduction. Tariff rates used are those provided by Dr. David Brooks of the USDA Forest Service and prepared by Professor Joseph Buongiorno at the University of Wisconsin.

4 THE CGTM AND ATL

The CINTRAFOR Global Trade Model (CGTM) (Cardellichio et al. 1989) is a modified version of the International Institute for Applied Systems Analysis' global trade model (Kallio, Dystra and Binkley 1987). It is an economic simulation model used to analyze forest products trade patterns and competitiveness of U.S. industry in domestic and international markets.

The CGTM is a spatial equilibrium model of the global forest sector. The CGTM simulates the effect of changes in regional supply and demand around the world, their cost structure or trading costs associated with meeting global demand. The principle outputs are production, consumption, price, trade flows from which revenues for standing timber, logs, and primary products may be calculated. The model characterizes the effect of changes on three stages of production and consumption: the timber producer, the processor and the intermediate or final product consumer. The CGTM determines the set of prices that minimizes costs while maximizing consumer's and producer's surplus by using an optimization program (Samuelson 1952). Its structure is described in greater detail in Cardellichio et al., (1988, 1989) and Kallio, Dystra and Binkley (1987).

The CGTM computes market equilibria for regional forest products sectors considering constraints on processing capacity and available wood resources. It solves for equilibrating prices, production, consumption and trade levels for each region period by period. It increases (decreases) future processing capacity when profit (costs) increase and past utilization is above (below) the historical trend level for capacity utilization. It emulates multi-product and market behavior for the timber resource and intermediate wood products sector.

The logic of the model is as follows. The demand for forest products in each region may be met by its own domestic production or by imports from other regions. A region will import some or all of its consumption needs if the price of the domestic product is higher than the cost associated with purchasing it outside of the region and transporting it home, including trade-related costs. More imports force down domestic prices until market prices are in equilibrium: the price in the importing region is equal to the price in the exporting region plus all trade costs (including tariffs). The competitive market structure imposed on the model assures that final demand is met employing the least costly producer after accounting for all trade costs.

Previous analyses with the CGTM have provided input into a wide variety of assessments. Economic impacts of climatic change on the global forest sector were measured with CGTM (Perez-Garcia et al., 1996). Impacts of U.S. carbon mitigation strategies on U.S. and global carbon accounts were also recently analyzed (Perez-Garcia in review). The CGTM was used to study impacts of timber supply shortages on land-use allocation (Perez-Garcia 1995). Trade policies in the U.S. (Perez-Garcia, Lippke and Baker 1996) and Canada (Perez-Garcia 1996a, 1992) were also analyzed. The model has been used to simulate the development of tropical hardwood markets. In 1992, the model was utilized in separate studies funded by Jaakko Poyry through the World Bank and the London Environmental Economics Centre through ITTO. The first study examined effective trade policies on tropical deforestation in Southeast Asia (World Bank 1992). The second study utilized the model to examine impacts of supply constraints and trade policies on global tropical forests (Perez-Garcia and Lippke 1992). The CGTM was also utilized to analyze market distortions and their impacts on the forest sector in Latin America, a region primarily possessing tropical hardwood resources for USAID (Perez-Garcia 1994). This brief summary of work with the CGTM illustrates the flexibility of the model to provide input into a variety of assessment processes.

Figure 4.1 illustrates the modeling approach used to estimate the effect of an accelerated tariff liberalization policy on the forest sector. Note that in the absence of trade costs, prices in both regions would be equal under spatial equilibrium. With trading costs, importer's price equals exporters price plus the trade costs. Trade costs are composed of several components that include transportation costs, adjustments for quality premiums and taxes or tariffs. Defining trade costs in the CGTM allows us to adjust them with new information on tariff reductions.

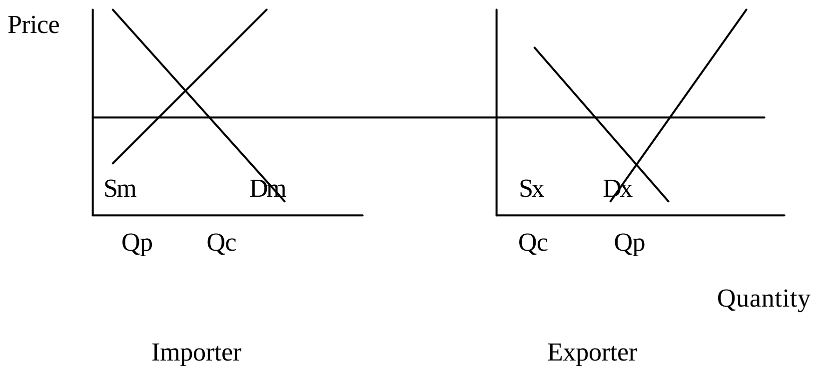

Figure 4.1. Spatial Price Equalization for Bilateral Trade Flow and Zero Tariffs.
For illustrative purposes, transportation costs are assumed zero in the above figure. A single price exists where markets clear; the amount consumed globally equals world production in this two-country economy. Differences in internal domestic prices stimulate trade until these internal domestic prices meet the international price.

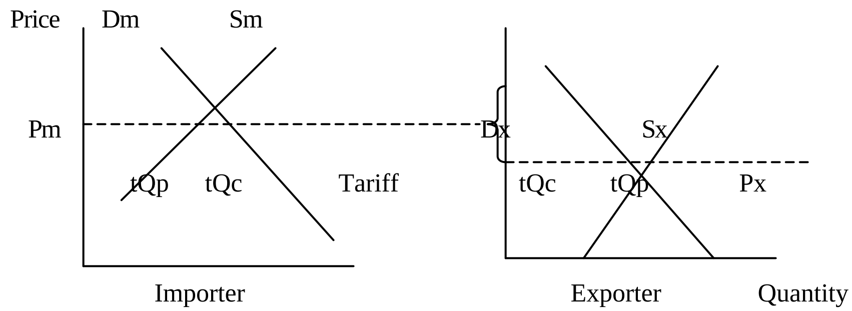

Figure 4.2. Price Equalization with the Existence of a Tariff.

Figure 4.2 illustrates the price equilibrium with a tariff in place. The effect a tariff has on production, consumption, trade and prices can be deduced by comparing figures 4.1 and 4.2. A tariff acts as a wedge between regional prices. As a result, under normal elasticity assumptions of demand and supply, the following results are expected.[1]

- Importer prices (Pm) are lower when a tariff is removed (Pm > Pe)
- Exporter prices (Px) are higher when a tariff is removed (Px < Pe)
- Importer's domestic production is lower when a tariff is removed (Qp < tQp for importer)
- Importer's domestic consumption is higher when a tariff is removed (Qc > tQc for importer)
- Imports and exports are higher when a tariff is removed (|Qc – Qp| > |tQc – tQp|)
- Exporter's domestic production is higher when a tariff is removed (Qp > tQp for exporter)
- Exporter's domestic consumption is lower when a tariff is removed (Qc < tQc for exporter).

The simplified two-country world model also suggests that globally, prices are lower and consumption increases.

[1] Demand and supply estimates for the CGTM are within range that would results in the results describe in Figure 4.2.

5 THE BASELINE CASE AND EXOGENOUS ASSUMPTIONS

Before proceeding with a presentation of the results, we present a short description of the baseline case and a note on the model assumptions. A summary of the baseline case follows. The baseline case and several scenarios regarding Asia's recovery from its current recession provide a description on current market behavior. We utilize this business-as-usual base case to report the effects of the tariff elimination policy by measuring the observed change associated with the tariff elimination policy from the base case.

The business as usual base case projects continued price growth in the North American softwood lumber market due to timber supply restrictions and sustained growth in demand in the US. Lower prices occur in Asia and Europe due to Asia's recession and slack demand in Europe. Asia's recession and continued growth in demand in North America diverts trade flows from Asian markets to the US. An Asian recovery scenario produces a redirection of trade from Southern Hemisphere and European producers to Asian markets. The recovery scenario projects rapid price increase in the Pacific Northwest region due to resource constraints in this region. Price increases follow in Chile and New Zealand once Pacific Northwest prices rise sufficiently to tighten supplies in the Southern Hemisphere under this recovery scenario.[2]

The following insights are drawn from the baseline results. Asia's recession has interrupted the process of reallocating capital from the Pacific Northwest to the U.S. South and elsewhere due to harvests restrictions implemented in the early 1990's in the Pacific Northwest region. Capital investments in processing capacity in Chile and New Zealand for the next several years are required to maintain the wood fiber supply in balance with demand. With lower prices from a decline in demand in Asia, capital expansion becomes more difficult. Excess supplies from New Zealand and Chile will lower product prices in the Pacific Rim until Asia's economies resume consumption of wood products and capital investments resume.

A consequence of Asia's recession is that North America has become the global price setter for softwood lumber during the Asian recession.[3] With a strong Asian demand for wood products creating excess demand conditions and dependence on imports during the last three decades, the recession has sufficiently decreased demand and prices so that the North American market represents the demand center attracting greater wood products imports.

Asia's recession has effectively lowered wood prices for an undetermined period of time in the Pacific Rim region.[4] When solidwood product prices increased, traditional forest products faced market competition from new wood products that utilize less wood and from non-wood substitutes. These engineered and non-wood products are now facing stronger competition from solid wood products through lower prices due to the Asian recession. Sensitivity analysis on resource availability in the U.S. western region suggests that the continued supply constraint on sawlogs availability in North America is likely to limit the retreat of product prices to any large extent. As a result, continued timber availability tightness will reduce the likelihood that solidwood products will recapture a substantial portion of their market share lost to other products.

Regionally, the lack of alternative, low cost supply sources for processors in the West indicates that tight log supply markets will likely to continue into the future. As a result, log supply constraints will contribute to upward price pressure in the national and international softwood lumber markets.

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[2] The timing of Asia's recovery in uncertain. Asia is still in the process of reorganization following drastic declines in stock market values and economic activity. Due to this uncertainty, alternative scenarios were employed where we project an Asian recovery in wood markets in the year 2000. This scenario defines our Base Case.

[3] At the national level the US imports more solid wood than it produces. Regionally, the US has important exporting regions, such as the coastal regions of Washington and Oregon. Without Asian demand for wood products, the model simulates the US as the most important demand center for wood products consumption, i.e. it attracts trade flows once destined for Asian markets, including historically exported wood from Washington and Oregon.

[4] Recent price data suggests prices have stabilized and may increase somewhat.

The outlook for log prices in Canada indicates a doubling of historical levels for the three major log producing regions prior to the Asian crisis. Asia's impact on Canada has been to lower product prices substantially. These low product prices and high resource costs indicate a likely restructuring in capacity to take place in western Canada.

Emerging areas of New Zealand and Chile will surpass industrial roundwood output from Western Washington and Oregon by 2010 under the baseline outlook. Annual cut for the two regions is estimated to be at 51 MMm^3 by 2010. The annual cut represents an 18% increase over Western Washington and Oregon. However, lack of demand in Asia presents a problem to these emerging regions. Large volumes of excess supplies with no demand push Chile and New Zealand products into U.S. markets. A quick recovery shifts the trade flows back to Asia.

The rise of log costs has change purchasing patterns in Japan and Korea and reduced their level of log imports. However, projections of China's inventory suggest it will have log supply problems in the near future and recent announcements indicate that a total ban on harvesting is likely to be implemented. Baseline projections indicate the log supply shortage will be imported mainly from New Zealand and Chile. However, other problems may exist in China that would substantially reduce its level of log imports, including sub optimal location of milling capacity currently in the traditionally wood-producing northeast provinces and away from ports. Capital expenditures must occur to relocate processing centers to utilize wood imports.

Assumptions about non-market behavior in the production and consumption sectors constrain the economic effect of a tariff liberalization policy. Non-market behavior, such as harvest and output targets, acts to increase the average demand elasticity for the region. These non-market behavioral assumptions are valid for a number of the regions represented in the model where planning processes rather than market mechanism dictate production decisions. Examples of such regions are China, the Former Soviet Union, Indochina, India and others. Further discussion is presented in Section 7.2, which lists the exogenous assumptions currently used by the CGTM. Section 7.2 also discusses the potential impact these assumptions have on the study results.

6 CHANGES IN THE PRODUCTION, CONSUMPTION AND TRADE ASSOCIATED WITH ATL

6.1 SOFTWOOD LUMBER

Tariff reductions range from 6.7% in Mexico to 1.3% in Europe (see Appendix A for output tables). Of the 85 trade flows identified in the model, 36 (42%) are affected by the tariff elimination. Nineteen percent (10 MM m^3) of the 54 MM m^3 trade volume activity represented by the model is affected directly by tariff elimination. Intra-national trade (within US, Canada and European Union) is not counted the trade volume number above[5]. With intra-national trade, total activity reaches 122 MM m^3. Over 30% is directly influenced by tariff elimination. Tariffs are reduced in Mexico (6.7%), (imposed in CAM region), China (6%), Japan (4.5%), Korea and Australia (3.3%), and West Europe (1.3%).

Trade activity increases as a result of the tariff elimination policy as expected. Globally, exports (imports) increase substantially, reaching 20% immediately and dropping to 13% by 2010. Exports increase in Chile, New Zealand, Finland and Sweden. Likewise for the WSV, where production is diverted from the domestic market to the export market, it increases exports. At the national aggregate level, the U.S. expands its exports overseas, as well as increasing imports from other nations. The change in exports is larger than imports making the U.S. act as an exporter of softwood lumber. Hence, we observe a decline in consumption, an increase in production, and greater exports with higher prices in the U.S. The European Union also increases exports to the non-EU countries. Exports increase slightly with no change in imports. Canada, traditionally an exporter of softwood lumber, sees its own export and production increase while consumption declines as a result of higher prices. The export behavior of these three, major softwood lumber-consuming regions dominate the global result.

The tariff elimination results in lower softwood lumber production and higher consumption for Japan, a key softwood lumber and log importing country. Other importing behavior in the softwood lumber sector is not straightforward to understand.

Korea, currently an importing country, acts as an exporting region, increases its domestic production since its price increase. This behavior is the result of the bilateral trade activity between Korea and Japan. Average trade cost data between Korea and Japan, New Zealand and Korea, and New Zealand and Japan allow Korea to import lumber from New Zealand and export it to Japan more efficiently than New Zealand can to Japan. A problem exists since quality is not differentiated in the model explicitly, only implicitly through ad hoc cost adjustments in trade. From the model's perspective New Zealand does not differentiate between the Korean and Japanese markets. In reality such differences in grades occur but are not captured efficiently in the trade model.

The effect of tariff liberalization in China is not adequately captured in the model primarily because its production level does not react to market forces, but rather to a planning process, which fixes production targets. The expectation is that China would behave as an importer, reducing its domestic production, increasing its consumption and imports of softwood lumber through price signals. The lack of these signals makes any measurement of tariff elimination in China difficult.

Tariff elimination reduces prices in importing countries of Mexico, Japan and Australia. Elsewhere, prices rise in exporting regions of softwood lumber. Prices decline by as much as 3% in Japan and rise by as much as 5% in New Zealand.

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[5] Throughout the analysis within-country trade activity - i.e. from US South to US North regions - is not discussed at any great length. Tariff elimination does cause regional price changes and influences regional trade patterns however.

6.2 SOFTWOOD PLYWOOD

Tariff reduction range from 10% in Mexico to 3.3% in Australia and the U.S. There are 32 trade flows in softwood plywood specified in the trade model. Trade costs on all thirty-two flows are lowered through tariff elimination, the most extensive tariff liberalization policy implemented with the trade model. Tariffs of 5.5% are removed in European countries. Japan's softwood plywood tariff elimination is 4.7%. Tariff elimination of 4% occurs in Canada.

Trade activity increases as a result of tariff elimination. Globally exports increase by 0.162 MM m^3 (8%) in 2000 to 0.258 MM m^3 (14%) in 2010. Volume changes in softwood plywood trade are small relative to softwood lumber since trade in softwood plywood mostly occurs intra-nationally. These intra-national trade patterns change more significantly. Japan, Mexico and Australia increase all imports and consumption under the ATL scenario. Production changes are limited due to exogenous assumptions regarding production behavior in the model (see Section 7.2 below).

Global consumption/production increases as a result of the trade policy implementation. In the U.S. consumption declines and production increases: It acts as an exporter of softwood plywood to the world. New Zealand and Brazil also expand plywood exports. Greater imports occur in Japan, Mexico, Australia and Europe.

6.3 SOFTWOOD SAWLOGS

There are two effects operating at the sawlog levels with a multilateral tariff elimination policy. The first effect is the elimination of tariffs on the trade of sawlogs themselves. The second effect is the change in the consumption of sawlogs due to changes in the production of intermediate products occasioned by the reduction in tariff in that sector.

Tariff reductions in the softwood sawlog sector are minimal. There are 59 trade flows for softwood sawlogs specified in the trade model. Of these flows, 17 (29%) have tariffs associated with them. Only three regions have tariffs that are eliminated in the policy scenario. China and Korea reduce their 1.3% tariff and Mexico reduces its 6.7% tariff. With the exception of Korea, softwood sawlog production in these three regions is exogenous, i.e. not determined by market forces. Trade flows to Mexico are currently a very small volume: It is not expected that the tariff reduction will lead to significantly greater flows into Mexico of softwood sawlogs. Nevertheless, there is a substantial change in trade flows associated with both the tariff reduction and changes in the demand for sawlogs from the multi-product trade policy implementation.

Trade activity increases slightly as a result of tariff elimination and changes in the demand for sawlogs from the intermediate product sector. Globally exports decline by nearly 2 MM m^3, an 8% decline over the baseline trade activity. Hence, the effect of tariff elimination in the sawlog sector is overshadowed by the changes in production, consumption and trade in the intermediate sector, primarily the softwood lumber sector.

The model projects an increase in Korea log imports of logs associated with higher production of softwood lumber while Japan's demand for logs declines. Japan's softwood lumber sector increases imports of lumber, expanding its consumption through less costly product rather than higher cost logs. These two changes ignore Japan's log purchases based on quality characteristics that are difficult to capture with the current trade model. Second, the model projects Korea's potential, rather than actual, low cost status to convert logs into lumber. Further study into Korea's cost structure is needed to determine the validity of these results.

Even though exports of logs fall in the U.S. by nearly 25%, log production and consumption increase. These results are consistent with the increase in softwood lumber and plywood observed previously.

6.4 SOFTWOOD PULPWOOD

Tariff elimination for softwood pulpwood affects only China in the policy scenario. Since imports to China of pulpwood are exogenously determined, there are no effects recorded from tariff elimination. However, the changes in production in lumber and plywood impact roundwood production and trade activity. With an exogenously determined pulp projection, changes in lumber and plywood production affect residual production. With higher residual production, there is less demand for roundwood production. Trade flows are also impacted.

Higher U.S. production of lumber and plywood reduces import demand for softwood pulpwood. However, greater imports of lumber by Japan in particular result in higher imports of softwood pulpwood. All changes are relatively minor ranging from less than one to only a few percentage points.

6.5 HARDWOOD LUMBER

As in softwood lumber, tariff reductions range from 6.7% in Mexico to 1.3% in Europe (see Appendix A). Of the 88 trade flows identified in the model, 41 (47%) are affected by the tariff elimination. Twenty-two percent (3.6 MM m^3) of the 16 MM m^3 trade volume activity represented by the model is affected directly by tariff elimination. Tariffs are reduced in Mexico (6.7%), (imposed in CAM region), China (6%), Japan (4.5%), Korea and Australia (3.3%), and West Europe (1.3%). Trade in hardwood lumber is significantly lower than trade in softwood lumber.

Trade activity increases as a result of the tariff elimination policy as expected. Globally, exports (imports) increase slightly, about 1% of the baseline trade flow. Export activity increases in the USA, Europe and the Asian producers of Malaysia, and Philippines. Modeling assumptions have a large effect on the above result. The difficulty measuring the production response to changes in product price in China results in the need to project alternative production scenarios for China. Sensitivity analysis with alternative Chinese production scenarios suggests greater imports of hardwood lumber from Asian producers. That is, lower planned production targets in China will increase imports from Asian producers, mostly Malaysia, Indonesia and the Philippines.

While tariff elimination also reduces prices in Mexico its effects appears small compared to China's and the softwood lumber effects we saw above. The elimination of tariffs results in less production in Mexico under a sensitivity analysis conducted with the model.

6.6 HARDWOOD PLYWOOD

Tariff reduction range from 26.7% in Malaysia to 3.3% in Australia and the U.S. There are 53 trade flows in hardwood plywood specified in the trade model. Trade costs on forth-one flows are lowered through tariff elimination. The study eliminates a 13% tariff in China. Tariffs of 10% in Mexico are removed. Tariffs of 5.5% and 5.3% are removed in European countries and Korea respectively. Japan's hardwood plywood tariff elimination is 4.7%. Tariff elimination of 4% occurs in Canada.

Trade activity increases as a result of tariff elimination. Globally exports increase by 0.124 MM m^3 (1%) in 2000 to 0.310 MM m^3 (2%) in 2010. While volume changes in hardwood plywood trade are similar to softwood, the respective percent change is lower due to a greater level of trade activity outside of North America. As was the case with hardwood lumber, key sensitivities to the above results depend on production changes that may occur in China. Should the elimination of the plywood tariff alter planned production targets in China, a greater amount of trade activity occurs, particularly by Asian producers.

Global consumption/production increases as a result of the trade policy implementation, although less than 1%. Lower production in Europe is offset with higher production in the Philippines, Indochina, Taiwan Hong Kong region, and Indonesia.

6.7 HARDWOOD SAWLOGS

As in the case of softwood sawlogs, there are two effects operating at the hardwood sawlog levels with a multilateral tariff elimination policy. The first effect is the elimination of tariffs on the trade of sawlogs themselves. The second effect is the change in consumption of sawlogs due to changes in the production of intermediate products occasioned by the reduction in tariff in that sector.

There are 47 trade f lows for hardwood sawlogs specified in the trade model. Of these flows, 19 (40%) have tariffs associated with them. Only three regions have tariffs that are eliminated in the policy scenario. China and Korea reduce their 1.3% tariff and Mexico reduces its 6.7% tariff. In Europe there is a reduction of 0.7%. Trade flows to Mexico are currently a very small volume. The results indicate no change in trade flows due to the reduction in tariffs to Mexico.

Non-tariff barriers are a significant difference between softwood and hardwood log trade. Major Asian producers of sawlogs have ban and quotas in place that prevent sawlog trade activity to occur freely. As a result, there is only limited change in sawlog exports. Indonesia is perhaps the region with the greatest ability to export logs—i.e. an excess economic supply condition exists—after the lifting of the log export ban. Sensitivity runs with alternative production schemes indicates higher log exports from Indonesia mainly to Japan, Korea and China.

6.8 HARDWOOD PULPWOOD

Tariff eliminations do not appear to change hardwood pulpwood trade significantly. Changes in the trade flows are directly related to changes in sawlog trade.

7 MODELING SHORTCOMINGS

The above results are highly conditioned by modeling assumptions. This section presents assumptions used in constructing the trade model and how they may affect the results reported above.

7.1 BILATERAL TRADE PREDICTIONS

Imprecise bilateral trade flows is a shortcoming of a spatial equilibrium model such as CGTM. This shortcoming is of particular interest in the present study because of the nature of the study; analyzing tariff elimination effects. Aggregate trade flows for the region—the sum of all bilateral trade flows—present a better measure of trade activity in spatial equilibrium models and are used in the present study. Bilateral trade results are analyzed to determine how they might affect the aggregate result. One example is the result associated with softwood lumber exports from Korea to Japan. While little research has been conducted to completely assess spatial equilibrium results, the approach appears to lead to a smaller number of trade flows, but not necessarily less trade activity. This may be the result of greater efficiency in the trade sector than data suggests.

The situation is illustrated using Figure 7.1. Spatial equilibrium operates by allocating the lowest cost producers to meet demand using trade activity as an equilibrating mechanism. While normal upward and downward sloping supply and demand functions respectively operate in CGTM, trade functions are best represented as in Figure 7.1. At each iteration, prices are evaluated to determine whether market-clearing conditions exist. At P1, all potential export quantity from Chile, Canada and U.S. may be imported. If this is the best solution, it defines the market clearing condition. However, if some excess production or consumption exists, then prices are changed (perhaps lowered) to P2. At P2 only potential export from Chile and Canada are importable, and in a similar vein at P3 only imports from Chile are exportable. For illustrative purposes we hold the potential export quantity the same for this two price evaluations whereas in actuality, the potential quantity would also change. What the figure illustrates is the nature of bilateral trade flow determination in spatial equilibrium models. Rather than take imports from various sources, the model will project a trade flow from a single source even though trading arcs from several regions are specified. As a result, an importing region may act as an exporter, as was the case with softwood lumber in Korea, by acting as a through-put region, i.e. it exports what it imports from other regions. To limit the negative effects associated with this shortcoming we specify a large number of trading arcs so as not to impose unwanted constraints on regional trade activity in CGTM. We also make additional efforts to understand bilateral trade flows and their implications for total exports and imports for each region in the model.

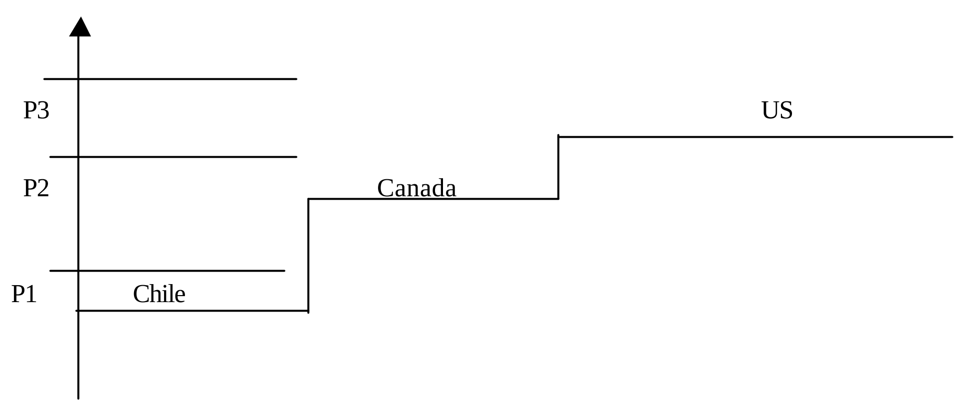

Figure 7.1. Cumulative Potential Export Quantity to Importing Country

7.2 NON-PRICE MARKET BEHAVIOR.

Alternative assumptions regarding the economic behavior for different regions are used to construct the global forest sector. In this section we report on the various assumptions used to characterize the timber, product and consumptive sectors.

7.2.1 Timber Supply Assumptions

Log supply behavior is described through timber supply equations that specify harvests in each region given log prices, forest inventory levels and other information. Depending on the particular region, the CGTM uses one of four log supply functions.

The most common supply specification estimates the quantity supplied as a positive function of both log prices and the level of growing stock inventory. Increases or decreases in timber inventory, determined by growth and yield models and removal information, shift the supply curve in or out, period by period.

The second specification has an upward sloping curve but also places an upper harvesting limit to log supply. If a region is operating below the limits on harvests, timber supply will respond positively to increases in log prices. When harvest levels hit the limit, further increases in timber prices have no effect on harvest levels. The upper limit on harvests can be thought of as the maximum allowable annual cut (AAC) on the mature or harvestable inventory. Timber supply in Chile and New Zealand, and Canada more recently, under alternative scenarios, is modeled in this fashion.

A third specification fixes log supply at a predetermined level for each period of the simulation. In any one period, log supply is wholly unresponsive to price changes. Examples of regions utilizing this strict AAC supply specification include China and the CGTM-defined Eastern European region where planning rather than prices determine harvest levels. Public timber supply regions in the U.S. are also specified using projected annual cut levels. The specified levels reflect a combination of constraints based on physical productivity of the forest, the infrastructure available to access the forest, and policies that restrict industrial access to timber.

A fourth alternative for log supply assumes that log supply is perfectly elastic, so log supply is determined by product supply. An example is Brazil's solidwood hardwood forest sector where log supply is not a constraint on the production of hardwood solidwood products. In the case of Brazil, log supply behavior is implicit in product supply behavior.

Table 7.1 reports timber supply parameters for important softwood producing regions around the globe using 1993 data. Each of the alternative supply representations identifies a special case of a generally rising cost curve in which harvesting limits are imposed to model the most appropriate supply behavior for each region and public ownerships.

Table 7.1. Parameters for Important Softwood Log-Supplying Regions in the CGTM: 1993

Region	Log Price $US1980/m^3	Price Elasticity	Log Production Million m^3	Previous Period Inventory Level Million m^3
U.S. PNW[a]	$79.55	0.79	32.458	811.5
Eastside U.S. West[a]	$58.74	1.22	5.581	230.1
Interior U.S. West[a]	$50.09	0.74	17.674	785.1
U.S. South[a]	$37.73	0.56	93.669	2529.0
U.S. North[a]	$36.95	2.16	8.374	1038.0
Coastal B.C.[b]	$67.52	4.04	18.184	25.1
Interior B.C.[b]	$39.54	7.35	56.355	67.1
Eastern Canada[b]	$38.92	3.12	30.535	65.0
Chile[b]	$55.74	2.84	7.923	9.4
Finland[a]	$19.04	2.88	16.232	1550.0
Sweden[a]	$41.63	0.41	25.400	2284.0
Western Europe[a]	$56.62	1.00	55.618	3995.0
Japan[a]	$162.37	0.95	16.099	1904.0
New Zealand[b]	$72.44	1.00	10.466	9.5

[a]--supply is a function of both prices and the level of growing stock.

[b]--upward sloping supply with AAC constraint.

7.2.2 Production Assumptions:

Supply of a product is considered a function of prices, wood costs, other manufacturing costs, other wood product revenues and milling capacity. Total processing capacity in a region acts as a constraint to total lumber and plywood manufacturing activity. Capacity is updated based on historical profitability. Table 6.2 reports the parameters for important processing regions for softwood lumber in the CGTM. Table 6.3 reports parameters for important processing regions for softwood plywood in the CGTM.

Table 7.2. Parameters for Important Softwood Lumber Processing Regions in the CGTM: 1993

Regions	Price Elasticity	Price $US/m^3 $1980	Product Quantity Mill m^3 1993	Installed Capacity Mill m^3 1992
U.S. PNW	0.32	$188.85	11.710	16.052
Eastside U.S. West	0.55	$290.50	3.759	6.536
Interior U.S. West	0.45	$176.13	10.626	14.172
U.S. South	0.19	$153.65	23.322	28.875
U.S. North	0.34	$136.78	2.749	3.675
Coastal B.C.	0.19	$197.85	6.432	8.100
Interior B.C.	0.24	$173.31	20.866	23.090
Eastern Canada	0.58	$201.50	12.287	16.461
Chile	1.06	$180.41	2.660	3.551
Finland	0.61	$145.73	8.300	9.762
Sweden	0.25	$146.04	12.544	13.494
Western Europe	0.10	$163.56	31.510	41.158
Japan	0.11	$275.95	23.301	23.999
Korea	0.37	$308.21	2.704	3.312
New Zealand	0.28	$214.10	2.684	2.860

Table 7.3. Parameters for Important Softwood Plywood Processing Regions in the CGTM: 1993

Regions	Price Elasticity	Price $US/m^3 $1980	Product Quantity Mill m^3 1993	Installed Capacity Mill m^3 1992
Westside US West	0.46	178.29	4.337	8.438
Eastside U.S. West	0.64	178.28	1.037	1.189
Interior U.S. West	0.53	178.29	1.403	1.722
U.S. South	0.37	170.54	12.920	18.530

The number of softwood plywood producing regions outside of the US is limited. As a result, the major effects from the ATL policy are observed within the US.

Tables 7.4 and 7.5 list the parameters for the hardwood sector.

Table 7.4. Parameters for Important Hardwood Lumber Processing Regions in the CGTM: 1993

Regions	Price Elasticity	Price $US/m^3 $1980	Product Quantity Mill m^3 1993	Installed Capacity Mill m^3 1992
U.S. South	0.24	185.87	12.731	19.701
U.S. North	0.18	185.87	12.388	16.528
Western Europe	0.08	361.06	7.346	13.736
Japan	0.31	474.41	2.962	4.996
Korea	0.52	313.97	0.503	1.637
Taiwan/Hong Kong	0.16	263.78	1.250	1.831
East Malaysia	0.31	257.49	3.122	3.876
West Malaysia	0.32	213.61	5.912	1.716
Indonesia	0.14	419.89	8.200	12.354
Philippines	0.16	307.19	0.440	1.290

Table 7.5. Parameters for Important Hardwood Plywood Processing Regions in the CGTM: 1993

Regions	Price Elasticity	Price $US/m^3 $1980	Product Quantity Mill m^3 1993	Installed Capacity Mill m^3 1992
Japan	0.17	371.20	5.263	7.884
Korea	0.26	359.21	0.898	1.594
Taiwan/Hong Kong	0.37	379.13	0.702	1.047
East Malaysia	0.21	325.56	1.705	2.850
West Malaysia	0.43	332.99	1.067	1.409
Indonesia	0.19	364.63	10.050	11.235
Philippines	0.73	346.94	0.331	0.459

7.3 CONSUMPTION ASSUMPTIONS:

The CGTM employs two demand specifications. One specifies consumption as a function of prices and is used to model softwood lumber demand in the U.S., Canada, Japan, Korea, Chile, New Zealand, the CGTM-defined European regions as well as major hardwood consuming regions of the world. The second approach utilizes projections of consumption that are unresponsive to price changes. China and the former Soviet Union are examples of this second application. Demand end-use factors and projections of economic and population growth are used to shift demand from period to period providing a dynamic linkage between yearly calculations of quantities consumed.

The following table provides projected shifts in the demand function due to economic activity in CGTM regions expressed in percentage growth from 1993 to 2010 (1993 = 1.000). For example 1.226 represents a 22.6 percent shift outward in demand from 1993. Adjustments are made year by year to the demand function intercept to implement the shift in demand. Annual demand shifts are assumed to follow a trend, without attempts to model business cycles.

Table 7.6. Demand Growth Data.

	Product			
Demand Region	**Softwood Lumber**	**Hardwood Lumber**	**Softwood Plywood**	**Hardwood Plywood**
U.S. West	1.892	1.117	1.168	1.168
U.S. South	1.892	1.117	1.168	1.168
U.S. North	1.892	1.117	1.168	1.168
Canada	1.457	1.122	0.847	0.847
Brazil	(1)	1.316	(1)	(1)
Chile	1.626	1.661	1.916	1.916
S. South America	1.186	1.325	(1)	1.088
Finland	1.080	1.000	1.314	1.314
Sweden	1.290	1.000	1.255	1.255
W. Europe	1.070	1.102	1.320	1.320
E. Europe	1.151	1.314	1.231	1.231
Japan	1.182	0.760	1.236	1.236
Korea	1.182	1.986	(1)	1.680
China	1.473	1.518	2.846	2.846
Taiwan/Hong Kong	1.182	1.575	(1)	2.227
East Malaysia	(1)	1.573	(1)	2.182
West Malaysia	(1)	1.573	(1)	2.182
Indonesia	(1)	2.039	(1)	2.613
Philippines	1.340	1.000	(1)	1.248
Papua New Guinea	(1)	1.102	(1)	1.576
Indochina	1.340	1.192	(1)	2.061
India	1.082	1.354	(1)	1.085
Middle East	1.585	1.841	(1)	2.119
East Africa	1.401	1.202	(1)	1.811
North Africa	1.716	1.716	1.972	1.972
South Africa	1.269	1.000	1.000	(1)
West Africa	(1)	1.171	(1)	1.751
Australia	1.338	1.000	1.216	1.216
New Zealand	1.629	1.000	1.236	(1)
Oceania	1.381	1.000	(1)	1.940

Notes: (1) implies no demand function or demand is exogenous.

7.4 PULP AND FIBERBOARD ASSUMPTIONS

Pulp and fiberboard production acts as a fiber accounting sector in the CGTM. Projections for each product are made using economic factors, population levels, capacity outlook and production shares. The production levels are then met individually using either residuals from solidwood product production or pulpwood harvests. The pulp and fiberboard production projections impose material balance between residual production and pulpwood harvests. If solidwood production is reduced, lowering output of wood residuals, then pulp and fiberboard production levels are met using more pulpwood roundwood.

7.5 MODEL DYNAMICS

The timber supply dynamics are captured in CGTM by changes in merchantable inventory caused by timber removals and growth in each region. Several inventory models have been linked with the CGTM to describe the development of the merchantable inventory in each region including ATLAS (Mills and Kincaid 1992) and SRTS (Pacheco *et al*., 1996). Both models provided detailed inventory descriptions and information on how the structure of the inventory in a region changes as each region meets its harvest requirements.

In CGTM prices are determined period by period with no anticipation of future price levels. For each region, 1) the supply of logs, 2) processing capacity, and 3) product demand are constructed from observations of the price and quantity produced and consumed of each product. The demand for logs is derived from the product demand assuming a fixed ratio of logs used to produce a given quantity of lumber. International price levels define excess supplies and excess demands. Excess supply exists when international prices are higher than domestic prices after deducting transfer costs. Excess demand exists when international prices are lower than domestic prices including transfer costs. At the international price where excess demand and supply intersect, equilibrium is reached. The interaction among regions is defined by trade activity: a trade flows of logs, lumber and plywood between two regions. Trade activity exists when the sum of the domestic price of a product and the transfer cost associated with shipping the product to the importing region is lower than the importer's price. Single-period solutions in the model are derived by maximizing the consumer and producers welfare (i.e. for all regions, the triangular area found under the demand curve and above the supply curve).

7.6 EFFECTS ON THE ENVIRONMENT: WHICH FORESTS AND WHERE

Only a cursor analysis is made to determine environmental effects in this study. The environmental effects are reported using changes in log production as an indicator of an environmental impact. We note where the change in production takes place and comment on forest types that exist in the region. Time constraints limit the ability to translate the change in production levels to area changes and a more direct measure of environmental impacts. Also no effort is made distinguish between different environmental amenities associated with forests such as carbon sinks and biodiversity.

According to model projections, the largest volume increases occur in Canada for softwood production, followed by the US. Europe is the third region where production increase occurs in softwood logs occurs. Much of Canada's forests are natural versus plantations. Much of the US and European harvests would occur in secondary forests.

Hardwood forests produce more timber mostly from the US. These results depend on consumption targets in China and other Asian consumers and how effective harvesting restraints in Malaysia and Indonesia are implemented. Should China increase its consumption and harvest levels allowed to increase, much of this increase in demand would occur using hardwoods from tropical forests in Malaysia, Indonesia and the Philippines.

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9 APPENDICES:

The following table can be found on the CINTRAFOR website (www.cintrafor.org) as MS-Excel spreadsheet files.

ATLC Summary Tables.xls	(Softwood sector output summary)
ATLN Summary Tables.xls	(Hardwood sector output summary)
TFQNT ATLC.xls	(softwood sector input worksheet), and
TFQNT ATLN.xls	(hardwood sector input worksheet).

If you are unable to download this files, a CD-ROM can be provided.