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The Canada-U.S. Softwood Lumber Dispute: Economic Welfare Under Alternative Trade Regimes

By

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The undersigned certify that they have read and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "The Canada-U.S. Softwood Lumber Dispute: Economic Welfare Under Alternative Trade Regimes" submitted by Liping Zhang in partial fulfillment of the requirement for the degree Master of Arts.

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ABSTRACT

The Canada-U.S. softwood lumber dispute has been a major trade irritant between the two countries for over 25 years. This thesis provides a systematic analysis of each phase of the dispute. Recent work by Zhang (2001) and Kinnucan and Zhang (2003) has suggested that Canadian producers gained under the Softwood Lumber Agreement (SLA). While Canadian producers are harmed by a lower Canadian price, they gain rents from quota system governing exports. In their calculations, however, Kinnucan and Zhang used elasticities of demand and supply that they admit may now be out of date. The analysis of this thesis suggests that is very unlikely that Canadian producers gained from the SLA relative to free trade. Nevertheless, the thesis provides strong support for the contention that a system of export quota and taxes such as the SLA is the least damaging type of restricted trade regime for Canadian producers.

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Finally, for those family members and friends behind me who support and encourage me a lot, I would like give you my special thanks and love.

DEDICATION

To my grandmother, Xiugai,

Mom, Yanmin, Dad, Hongzhong,

and younger brother, Zhe

I will never forget your love and support for me

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CHAPTER ONE

INTRODUCTION

1.1 Background

Recently, after the expiration of the U.S.-Canada Softwood Lumber Trade Agreement (SLA) on March 31, 2001, U.S. softwood lumber imports from Canada lumber increased. U.S. timber companies claimed that Canada was dumping softwood lumber into the U.S. market and that Canadian provincial governments were indirectly subsidizing their timber industries. U.S. softwood lumber producers mounted a successful case for protection, and a 27.22% combined Countervailing Duty and Anti-Dumping Duty was implemented. With this, the long-standing Canada-U.S. softwood lumber dispute entered a new phase. This thesis provides both a theoretical and empirical investigation of how the various policies pursued during the course the 25 years of this dispute have affected markets and welfare in both countries.

Canadian softwood lumber exports have been a serious source of contention between U.S. and Canadian lumber producers for a long time. For Canada, softwood lumber represents one of the largest exports to the United States. Canadian softwood lumber exports to the U.S. currently consist of over 60% of Canadian softwood lumber production (Department of Foreign Affairs and International Trade, 2002). Further, Canada has supplied over a third of the United States' consumption of softwood lumber since 1984. U.S. softwood lumber imports from Canada have risen from 3.4 bbf (billion board feet) in the early 1960s to more than 19.3 bbf in 2003 (U.S. Department of

Commerce). Canadian sawmills employed around 60,000 Canadians and roughly 300 communities were dependent upon the forestry sector in 1990s (Statistics Canada). In the U.S., house building and other lumber consuming industries, which employed over 7 million American workers in 1990s, rely on Canadian softwood lumber (Department of Foreign Affairs and International Trade, 2002).

The dispute over softwood lumber trade between Canada and the U.S. is the largest forest products trading dispute in the world (Cashore 1998) and the longest lasting trade dispute between the two countries. There exist different factions on each side of the border. In general, Canadian lumber producers and exporters promote "free trade" without any trade restrictions, while U.S. lumber producers take a "fair trade" position. U.S. lumber consumers such as house builders, house buyers and other lumber users, however, tend to be on the "free trade" side. Canada and the U.S. have had several rounds of accusation, threats, investigations, negotiations, and settlements over softwood lumber in the last twenty five years. This thesis will examine each of the phases of the dispute in depth.

1.2 Thesis Structure

The thesis consists of nine chapters. Chapter two provides an overview of the industries and markets in both countries, and the third chapter describes the history of the softwood lumber dispute between Canada and the U.S. The fourth chapter reviews the important economic literature on the issue. The fifth chapter provides a theoretical analysis of the various trade-restriction policies that had been using during the dispute. The sixth chapter contains empirical results pertaining to the estimation of the demand and supply for softwood lumber in Canada and the U.S. Chapter seven, discusses the procedures for the

calibration of the model and sets the stage for a quantitative assessment of each policy phase in chapter eight. Chapter nine concludes the thesis and discusses policy implications and further research.

CHAPTER TWO

INDUSTRY TRENDS AND ADJUSTMENTS

Chart 1-a and 1-b show Canadian and U.S. softwood lumber production, consumption and trade. Between 1970 and 1996, there appear to be some rather regular cycles occurring approximately every seven years. Both countries appear to have similar trends in consumption and production. A crucial feature of data is that Canadian exports to the U.S., and thus U.S. imports from Canada, have almost quadrupled since 1970. The increase in lumber trade has a reason due to more rapid growth in consumption than production in U.S. and more rapid growth in production than consumption in Canada. After 1996, however, the trade volume between Canada and the U.S. became more stable.

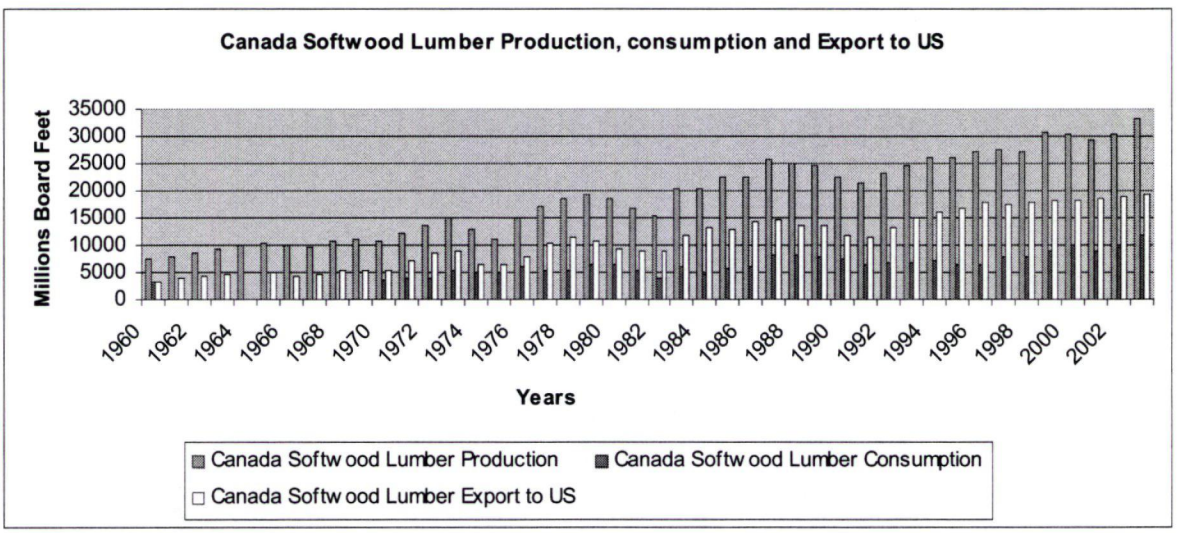
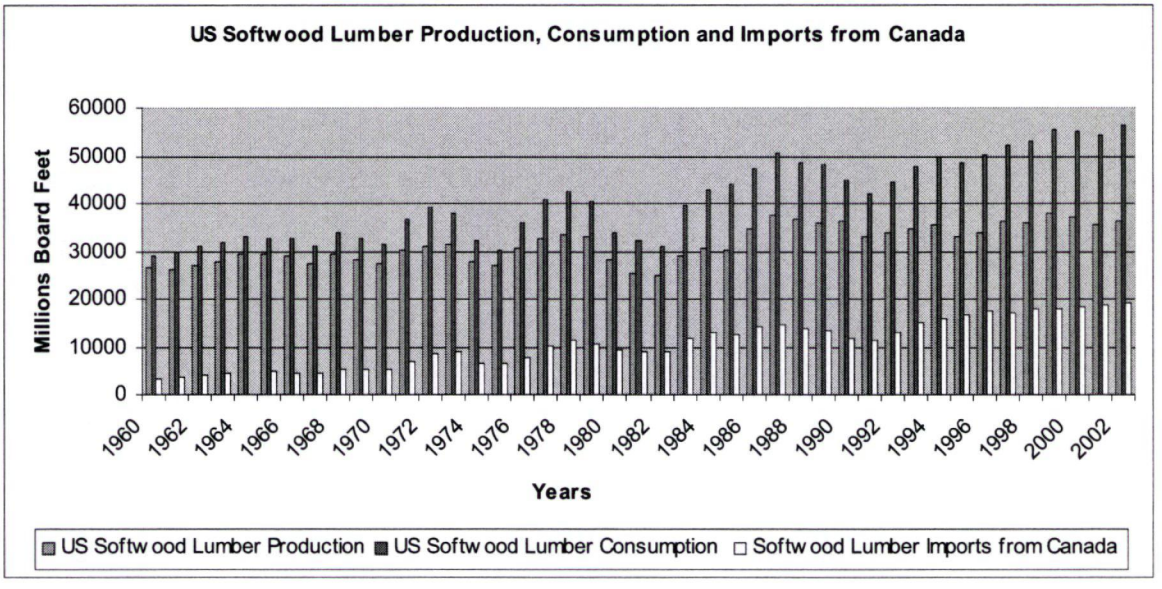


Chart 1-a: Canada Softwood Lumber Production and Trade with U.S.

Source: Department of Foreign Affairs and International Trade Export Import Controls Bureau (for Canadian softwood lumber export to U.S.)
The Canada Softwood Lumber Consumption data from 1961 to 1969 is not available.

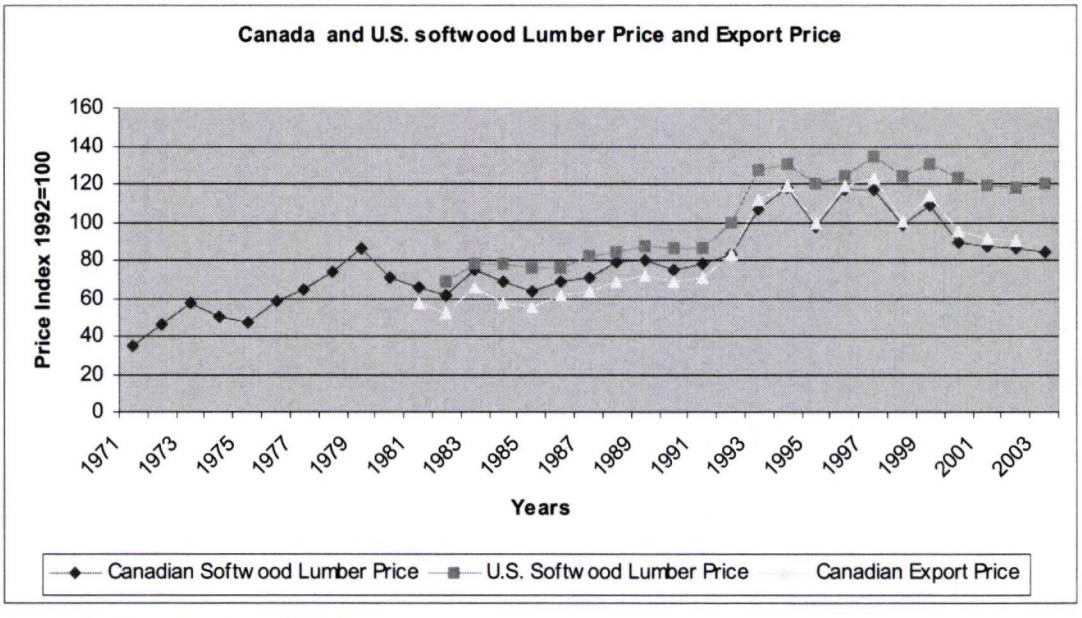
Chart 1-b: U.S. Softwood Lumber Production, Consumption and Imports from Canada.



Source: U.S. Department of Commerce, Economics and Statistics Administration and U.S. Census Bureau (for U.S. softwood lumber consumption and production)
Department of Foreign Affairs and International Trade Export Import Controls Bureau (for Canadian softwood lumber export to U.S.)

Chart 2 shows the domestic lumber price indexes for both Canada and the U.S. and Canada's export price index. Between 1981 and 1995, all three price indexes appear to have similar trends. The Canadian domestic lumber price tended to lie between the U.S. domestic price and the export price prior to 1993. Since 1993, the Canadian domestic lumber price and the export price appear to have been tied more tightly, although in some years the Canadian export price was a little higher. Both of the Canadian prices remained lower than the U.S. price. Since 1995, the spread between the U.S. domestic price and the Canadian domestic price has tended to expand.

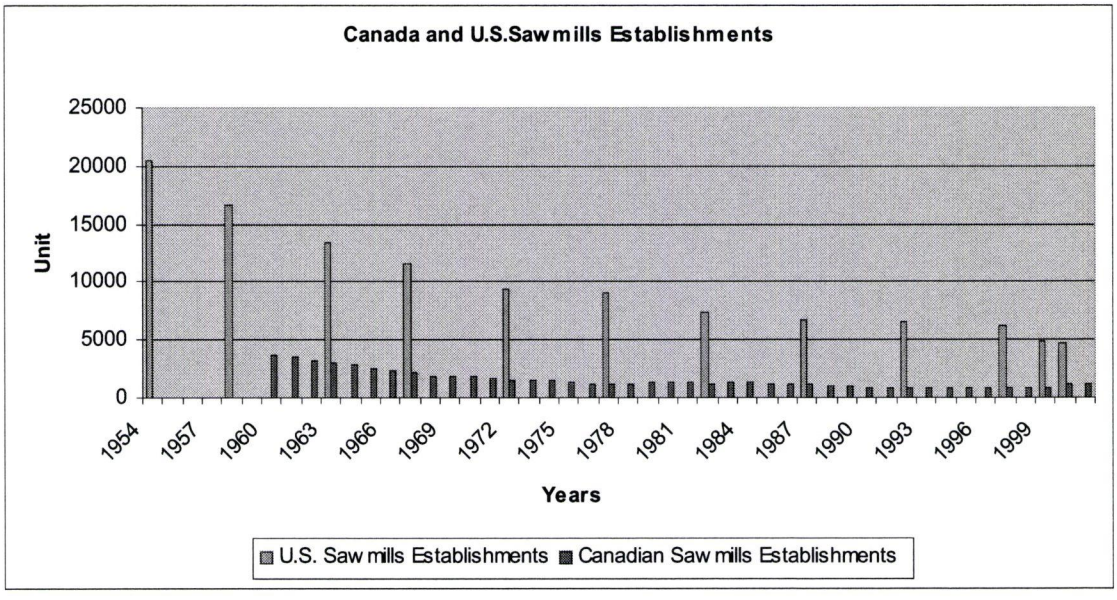
Chart 2: The Softwood Lumber Price in Canada and U.S. market, and Canadian Softwood Lumber Export price:



Source: Statistics Canada and U.S. Department of Commerce

Chart 3-a shows marked declines in the number of sawmills in both Canada and the U.S. since 1960s. An important difference in the trends is that the number of Canadian sawmills seems to have been somewhat more stable since 1990s, and indeed, the number of sawmill increased slightly from 1999 to 2003. Especially in the period since 1997 when lumber prices have been weak (see chart 2), lumber manufactures in both Canada and the U.S. have responded by closing down older sawmills. Nearly three-dozen other sawmills increased capacity under the pressure. In Canada, however, new sawmills have been built at a faster rate than the U.S. (Wright 2002).

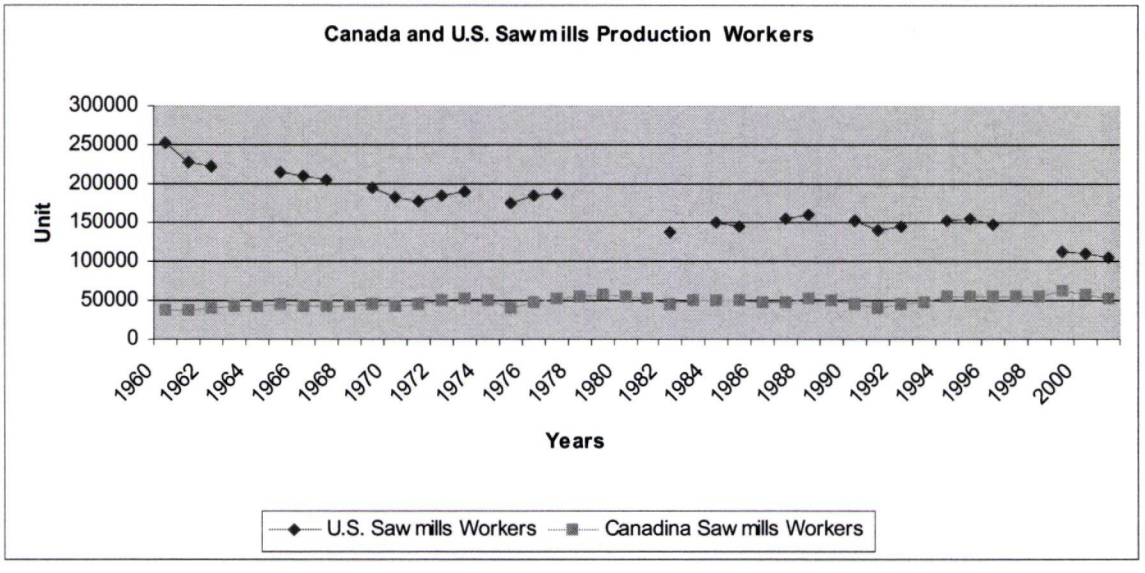
Chart 3-a: Canada and U.S. Sawmills Establishments



Source: Statistics Canada and U.S. Census Bureau
Note: The number of the Canadian Sawmills Establishments was not available before 1960

Chart 3-b shows sawmill employment in Canada and the U.S. Here, there are dramatic differences between the two countries. In Canada, the number of sawmill workers has been relatively stable since 1960, but U.S. employment has fallen to about 40% of its level in 1960. Because the increase in Canada-U.S. lumber trade visible in Charts 1-a and 1-b, has been contemporaneous with the decline in employment shown in Chart 3-b, it is hardly surprising that softwood lumber trade has been highly politically charged in the U.S.

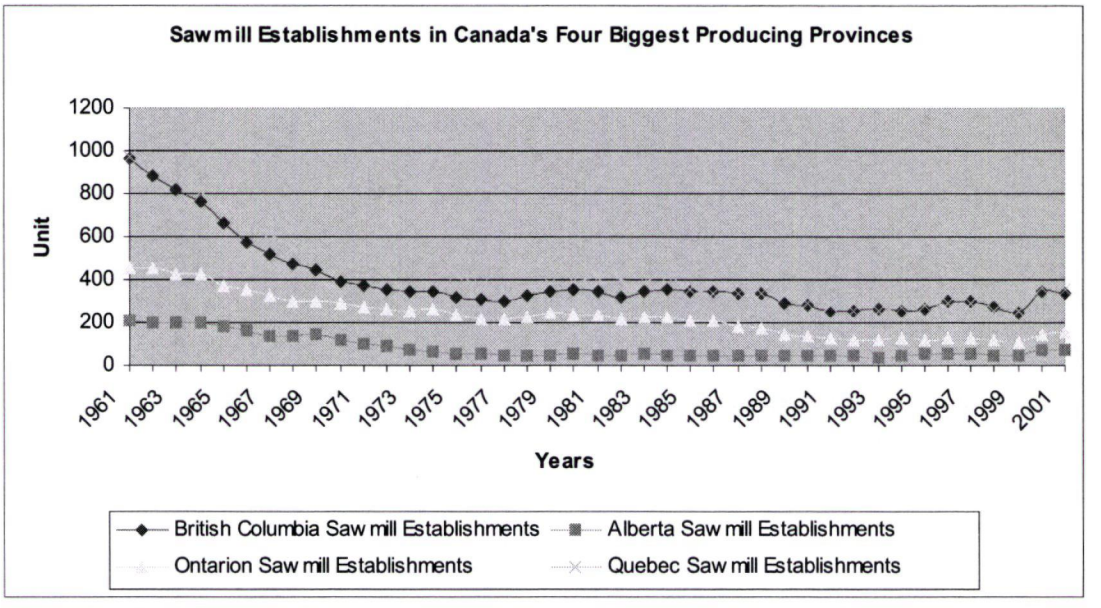
Chart 3-b: Canadian and U.S. Sawmill Production Workers



Source: Statistics Canada and U.S. Department of Labor

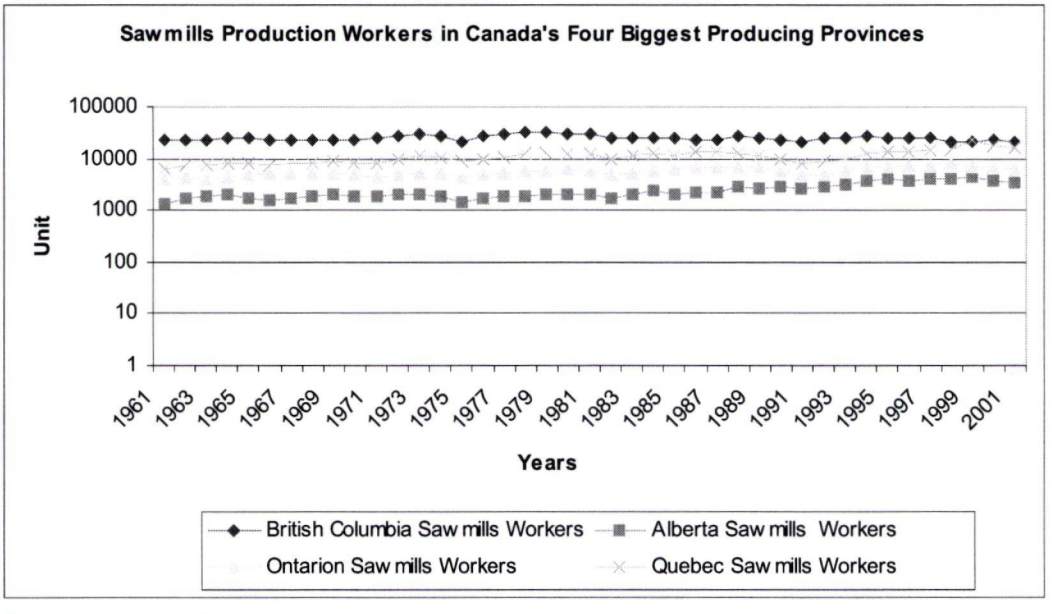
Chart 3-c and 3-d show the number of sawmills and sawmill employment on logarithmic scales for the largest lumber producing provinces in Canada, British Columbia, Quebec, Ontario and Alberta. These are also the provinces that have been at the center of the softwood lumber dispute. The number of sawmills has declined significantly in all four provinces over the past forty years, albeit from different initial levels. Since 1999, however, there have been notable increases in the number of sawmills in each of these provinces. Alberta's sawmill establishments fell more sharply in the 1970s, but recovered more sharply after 1999. Over the forty-year period there have been increases in sawmill employment in Quebec and Alberta and roughly stable numbers in Ontario and British Columbia.

Chart 3-c: Sawmill Establishments in Canada's Four Biggest Producing Provinces



Source: Statistics Canada

Chart 3-d: Sawmills Production Workers in Canada's Four Biggest Producing Provinces



Source: Statistics Canada

The raw data does suggest two very different possible explanations. On the one hand, the increase in Canada-U.S. softwood exports and the increase in the size of Canada's industry relative to that of the U.S. could simply be the result of Canada exploiting its comparative advantage in an era of generally liberalizing trade. The Canadian industry has vigorously maintained this claim. On the other hand, the increase in exports and the change in the ratio of outputs could be the result of unfair Canadian trading practices as the U.S. industry has frequently alleged. While this thesis will not attempt to draw conclusions on the validity of Canadian versus U.S. claims, it will systematically examine the economic impact of the policies imposed in each phase of the dispute.

Substantive differences in forest ownership and regulation between Canada and U.S. appear to have added an important dimension to the dispute. In Canada, 94% of forests belong to provincial governments and lumber industries have to pay a stumpage or cutting fee to provincial governments. According to the U.S. lumber industries, there are two kinds of subsidies in Canada. The first type of alleged subsidy arises through the administration of stumpage fees. Rather than selling timber through competitive bidding at market prices, the provincial governments set stumpage rates administratively. Cutting rights for timber on public and private lands in the United States appear to sell for many times the stumpage fees on similar trees in close proximity in Canada, even after appropriate consideration is given to road building and other expenses. These indirect subsidies are alleged to occur in the four largest producing provinces: British Columbia, Ontario, Quebec and Alberta. U.S. petitioners do not allege subsidies against lumber production in the Atlantic Provinces because nearly 75% of the Atlantic timber harvested is derived from private land. (The Atlantic Provinces consist of New Brunswick, Nova

Scotia, Prince Edward Island and Newfoundland.) A related controversial feature of the Canadian system is that Canadian provinces provide large lumber companies with timber harvesting licenses that essentially run into perpetuity. The second type of alleged indirect subsidy arises through export restrictions on logs. Canadian federal and provincial prohibitions on log exports depress provincial log prices and, thus, encourage greater Canadian lumber production and exports to the United States. Meanwhile, the restrictions on the export of unprocessed logs prevent the U.S. producers from receiving this low-priced timber.

CHAPTER THREE

THE HISTORY OF THE SOFTWOOD LUMBER DISPUTE

The dispute over softwood lumber trade between Canada and the U.S. has a long history. The first recorded dispute date was the disagreement between New Brunswick and Maine in the 1820s (Department of Foreign Affairs and International Trade, 2003), but the recent sequence of disputes began in the 1980s. In general, there are five main stages in this sequence. (Department of Foreign Affairs and International Trade, 2003)

Lumber I (Oct. 07, 1982---May 31, 1983)

In 1981, the U.S. softwood lumber producers faced low demand. The U.S. Department of Commerce (DOC) was asked to investigate whether the Canadian timber licensing system constituted a subsidy by lobbyists in the U.S. Congress. In October 1982, the DOC started to investigate the stumpage programs or tree cutting fees of British Columbia, Alberta, Ontario and Quebec. In May 1983, it ended its investigation, finding that the stumpage programs did not warrant countervailing duties because they were generally available and not limited to a specific industry.

Lumber II: Memorandum of Understanding-MOU (May 19, 1986---Sept. 1991)

Under the pressure of the U.S. Softwood Lumber Coalition, the DOC started another investigation in May 1986. In a preliminary finding announced in October 1986, the

DOC determined that there was an approximately 15% subsidy to lumber producers from the Canadian provincial governments. This finding was based on the premise that stumpage revenues received by Canadian provincial governments should exceed the full costs of harvesting including reforestation. However a final decision by the DOC on this problem was never reached. Negotiations between the Canadian and U.S. governments, in December 1986, led to a Memorandum of Understanding (MOU). Following the MOU, the Canadian government collected a 15% export tax on the lumber exports to the U.S. The MOU stated that the Canadian provincial governments could reduce or eliminate the 15% export charge by implementing so-called "replacement measures", that meant increasing the stumpage or other provincial charges on softwood lumber production. British Columbia and Quebec provincial governments made forest management policy changes that were accepted by the U.S. as "replacement measures" for the softwood lumber export charge. Thus the 15% export charge was eliminated for British Columbia and reduced to 3.1% for Quebec. The MOU had the advantages of keeping the export tax revenue in Canada; the export taxes were collected by the Canadian government and redistributed to the provinces. Since provincial governments had to keep "replacement measures" in place to get a lower the export tax, industry pressure mounted in Canada. Eventually, in October 1991, Canada unilaterally terminated the MOU. It is interesting that chart 2 shows that, since 1993, the Canadian softwood lumber export price has tracked the Canadian domestic lumber price much more closely than in the earlier period.

Lumber III (Oct.31, 1991---1996)

In response to the termination of MOU by Canada, the U.S. DOC unilaterally set up a new countervailing duty investigation. The U.S. DOC found that the forest management programs in the four largest Canadian provinces (British Columbia, Ontario, Quebec and Alberta) and the log export controls imposed by British Columbia conferred unfair subsidies that warranted countervailing duties (CVDs). A 6.5% CVD was immediately imposed in the form of a temporary bonding requirement on imports of softwood lumber from Canada. After an extremely contentious process under the U.S.-Canada Free Trade Agreement Binational Dispute Settlement Procedure (Chapter 19 of FTA), this CVD was overruled. Thus, all duties tentatively paid by Canadian exporters (around US $800 million) were refunded (Lindsey 2000). Nevertheless, this process cost the Canadian industry dearly in legal fees. When further threats of duties arose in 1995 and 1996, the Canadian and the U.S. governments concluded the Canada-U.S. Softwood Lumber Agreement, which employed a combination of export quotas taxes.

Lumber IV: The 1996-2001 Softwood Lumber Agreement (SLA)

The SLA ran from April 1, 1996 to March 31, 2001. This agreement was intended to ensure that there was no material injury or threat thereof to the industry in the United States from imports of softwood lumber from Canada. It permitted annual lumber exports from British Columbia, Alberta, Ontario and Quebec (the provinces covered) to the U.S. up to 14.7 billion board feet (bbf) without taxes or fees. This range of exports was known as the "fee-free base." Trade volumes greater than 14.7 bbf but less than 15.35 bbf (the "lower fee base") were subject to a $50 per thousand board feet export tax collected by the Canadian government. Any exports by British Columbia, Ontario, Quebec and Alberta in excess of 15.53 billion board feet (the "upper fee base") were subject to an

export fee of $100 per thousand board feet paid to the Canadian government (Softwood Lumber Agreement between the Government of Canada and the Government of the United States of America, Treaty series 1996/16 Article II). The SLA also allowed for additional fee-free shipments if the U.S. lumber prices exceeded a trigger price, $405, in any calendar quarter during the period April 1, 1996 through March 31, 1998 and another trigger price, $410, in any subsequent calendar quarter (Softwood Lumber Agreement between the Government of Canada the government of the United States of America, Treaty series 1996/16 Article III). Under the SLA, the primary producers could transfer lumber and/or quota rights to re-manufacturers, and both were allowed to transfer quota rights and/or lumber to wholesalers.

Under the SLA, therefore, Canada established a hybrid of voluntary export restraints (VERs) and export taxes much like a tariff rate quota on imports. This was done so as to avoid a potentially worse outcome, such as an import tariff charged by the U.S. government. Under an import tariff as discussed extensively below, the U.S. government obtains the rents associated with restricting trade in the form of tariff revenue, while the Canadian government and Canadian lumber producers get nothing. By contrast, under the SLA the VER-style export quotas were allocated to individual Canadian lumber producers, who directly or indirectly gained the some of the rents. Any trade restriction leads to a lower price in the exporting country, Canada, than the importing country, the U.S. Under the SLA, therefore, Canadian quota holders received a higher price in the U.S. market than in the Canadian market. These rents at least partially compensated for the lost producer surplus from the reduced Canadian price. For its part, the Canadian

government administered the program and collected any exports fees that were assessed on large export volumes.

It appears that the SLA may have imposed significant constraints on the Canadian industry, since the number of sawmills in Canada reached at its lowest point in 1999, which is the second last year of the SLA (see charts 3-a and 3-c). Nevertheless, the number of sawmills in the U.S. also fell rapidly during the SLA years, and U.S. sawmill employment fell even more dramatically. Consequently, the U.S. lumber industry continued to face difficulties, which appeared to have been compounded by pressure from the lumber imports from Canada.

Lumber V (May 22, 2002-current)

After the expiration of the SLA on March 31, 2001, Canadian softwood lumber exports to the U.S. increased so as to comprise 34.5% of the softwood lumber sold in the U.S. market (Department of Foreign Affairs and International Trade, See chart 1-a and b). In 2001 U.S. prices moved downward slightly and Canadian domestic and export prices moved downward more sharply (see chart 2). The DOC found that Canadian softwood lumber was being sold in the United States at less than its fair market value. Their main rationale was that stumpage fees in Canada were lower than in the U.S. constituting an indirect form of subsidization. The U.S. International Trade Commission (ITC) voted 4 to 0 that the United States softwood lumber industry was "threatened" with material injury by the imports of softwood lumber from Canada. The "threat of injury" meant that the U.S. industry had not been injured to date by imports of Canadian lumber, but that future

injury was likely. The U.S. DOC published the CVD and ADD in the U.S. Federal Register Notice on May 22, 2002. The final subsidy rate was determined to be 18.79% and the final dumping rate was to be at 8.43%. As of that date, importers were required to post cash deposits with the U.S. Customs Service in the amount of 18.79% as a CVD. Exporters were also required to make cash deposits at the rate of 8.43% as an ADD (Department of Foreign Affairs and International Trade, 2002). The total duty levied on Canadian softwood lumber exports was 27.22%.

After the heavy duties were levied, softwood lumber shipments to the U.S. from Canada required border payments in cash. The Canadian industry maintains that many Canadian lumber companies will not be able to survive the heavy duties that have been imposed. Especially in British Columbia, the forest industry expects a large negative impact. Since 2001, sawmills in British Columbia have been forced to shut down and more will likely close. Job losses were initially estimated at 20,000, but are expected to grow to 50,000 (Wright 2001, see also Chart 3-b and 3-d). After a rise in 2000, the number of sawmills in Canada has fallen again (see Charts 3-a and 3-c). It is interesting that U.S. sawmill employment continued to decline after 2001.

Canada has engaged in several legal challenges through the North American Free Trade Agreement (NAFTA)[1] and the World Trade Organization (WTO)[2] to defend the interests of Canadian softwood lumber exporters. There are three NAFTA challenges and three

[1] NAFTA panels can only determine whether U.S. countervailing and antidumping duties have been applied in a manner consistent with US trade law.
[2] WTO panels can determine whether the U.S. law is consistent with the WTO agreement. While the WTO has no legal authority to require the U.S. to change its decision, the WTO can give authority for countries

WTO challenges under way. These challenges question the U.S. Department of Commerce's final countervailing duty and dumping determinations and the U.S. International Trade Commission's final determination of threat of injury. There were three remand determinations issued in recent years by NAFTA and a final report issued by WTO. Both NAFTA and WTO agreed that the U.S. DOC erred in its methods of calculating duties. They also both agree that the U.S. ITC did not sufficiently prove that the U.S. lumber industry has been harmed by imports of Canadian lumber, which essentially makes all prior rulings on countervailing and anti-dumping duties open to question. For the first two remand determinations, U.S. DOC refused to accept the instruction of NAFTA. The third one is still ongoing. According to WTO's finding, Canadian stumpage programs are a financial contribution under prevailing market conditions, but that the U.S. incorrectly assessed the effective subsidy rates. Consequently, there was no basis for the U.S. to conclude that stumpage is a countervailable subsidy (Department of Foreign Affairs and International Trade, 2005).

In Canada, under a long-term, policy-based solution, BC and other provinces are making forest policy changes. In March 2003, BC announced major changes to encourage a more competitive industry, including the implementation of an auction-based system for selling Crown timber. When fully implemented, the new pricing system, a portion of crown forests will be reallocated from large long-term tenure holders to BC Timber Sales, First Nations, woodlots and community forests (BCStats, 2004).

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to employ retaliatory trade measures on imports of products from the U.S. if the U.S. does not comply with the WTO panel decision.

CHAPTER FOUR

LITERATURE REVIEW

There are many papers that address the softwood lumber dispute between Canada and U.S. Among the most interesting papers are Adams and Haynes (1980), Boyd and Krutilla (1987), Kalt (1988), Wear and Lee (1993), Zhang (2001), and Kinnucan and Zhang (2003).

Adams and Haynes (1980) used a spatial model of North American softwood lumber, plywood and stumpage markets to design a long-range projection system of price, consumption and production trends. The model includes six demand regions and nine supply regions in Canada and U.S. The full model was evaluated in a historical simulation with data from 1966 to 1976. The analysis replicates trends as well as major cyclical movements in both prices and quantities at the national and regional levels. They forecasted forest product prices and quantities and stumpage prices from 1980 to 2030. Between 1980 and 1990, the rates of increases in prices were predicted to be higher than the long-term historical rates and after 1990 the rates of increase were predicted to be lower than the long-term historical rates. The domestic production capacity in lumber and plywood was forecast to continue to decline in the Western region of the U.S. and increase in the Southern region between 1980 and 2000 and then begin a gradual reversal after 2000. They also indicated that increasing management intensity on private forests lands would lead to a significant reduction in prices and increase in production in the U.S.

Boyd and Krutilla (1987) use a spatial equilibrium analysis similar to Adams and Haynes (1980). They, however, use 39 demand regions and 34 supply regions. Boyd and Krutilla focused on the impact on welfare of trade restrictions, but not price and output growth rates. Annual data for 1981 are employed to specify the model. This data was derived from a variety of sources such as housing starts, market price and supply price, Canada and U.S. softwood lumber production and transportation costs. Boyd and Krutilla found that the tariff losses incurred by Canadian producers could be substantial, depending on the elasticity of their export supply. That means that the U.S. benefits from protection would be reduced when Canadian export supply was more elastic, even though the U.S. producers gain more in this situation. Canadian exporters would clearly gain under a voluntary restraint agreement and lose under an import or export tariff. The net impact on U.S. welfare would follow precisely the opposite pattern. Actually, voluntary export restraint agreements might lead to Canadian gains as high as 40 percent of their previous profits. Since the quota limitation becomes the effective export supply schedule, the incidence of this quota on the U.S. lumber producer and consumer is invariant to the elasticity of the non-distorted Canadian export supply schedule.

Kalt (1988) tried to explain the determinants of lumber trade policy between Canada and the U.S. in the political field. Kalt tested whether the Canadian supply of timber was responsive to the stumpage subsidy and estimated the welfare consequences of U.S. protection on lumber imports from Canada. In the paper, Kalt estimated the supply of Canadian logs over 1977 to 1984 and found that the effect of the implicit subsidy on Canadian lumber production was equal to zero. This result suggested that the U.S. incorrectly imposed countervailing duties on Canadian lumber exports. In his paper, he

estimated lumber supply and demand equations for Canada and an import demand equation for the U.S. The independent variables in Canada's supply equation consisted of the lumber price, a stumpage subsidy, input costs and productivity. Canada's demand equation included housing starts and aggregate income. The demand and supply schedules were estimated with pooled data utilizing a two-stage least squares, instrumental-variable technique that allows for the separation of supply factors from demand influences on Canadian timber prices and quantities. Kalt also checked his simple three-sector model of North American lumber trade by employing the supply and demand elasticities estimated by other researchers. Kalt concluded that U.S. lumber producers and the U.S. government gained enough from a 15% tariff to offset the losses of U.S. consumers. Since the 15% import tax transferred rents from Canadian producers to U.S. producers and the U.S. government, there would be a net negative effect on Canada. Due to the decrease in efficiency, there would also be a joint loss for both countries.

Wear and Lee (1993) analyzed the effects of the MOU from 1987 to 1991 using a market share model. This paper began with an investigation of the market impact of the MOU by estimating an aggregate model of the Canadian share of the U.S. softwood lumber market and then considered resulting effects on price, quantity, and welfare. The study showed the anticipated gains to U.S. producers of softwood lumber and losses to Canadian producers and U.S. consumers. While efficiency costs were high, Canada's export tax revenue was strongly positive and exceeded the lost profits of Canadian producers. In addition, the impact on the market share appears to have persisted through 1990, in spite of the considerable change in the policy's structure. The model included U.S. housing

starts, U.S. GNP, U.S. imports of lumber and logs, the exchange rate between the U.S. and Canada, Canadian lumber consumption, a vector of dummy variables for different time periods during MOU and a time index. The estimated model provided a reasonable explanation of variations in the Canadian share of the U.S. market share from 1960 to 1990, and it indicated the significant shift, which is roughly coincident with the introduction of the MOU policy. While the model did not provide a mechanism for testing for the presence of Canadian subsidies, it did suggest that the increase in the Canadian share after 1975 might be largely explained by changes within the U.S. This result was consistent with the Kalt (1988). Sensitivity tests showed that shifts in the Canadian share are relatively insensitive to changes in elasticities over the range tested.

Zhang (2001) focused on how the SLA affects the U.S. market and welfare over the first four years. In his research work, he used the quarterly data from 1976 to 2000 in an OLS regression model estimating the U.S. price (measured as a real price in 1997 dollars and deflating with the consumer price index):

$$P = f(P_{(-1),}\ HS, CAPA, WAGE, TECH, EXCH, D_{MOU,} D_1, D_{2,} D_{3,} D_{97,} D_{98,} D_{99,} D_{00})$$

The independent variables included the lagged U.S. lumber price, real housing starts in the U.S., softwood lumber production capacity in the U.S., wage rates (cost of labour), softwood lumber productivity (technological change), the exchange rate between U.S. and Canada, a dummy variable for the MOU period, quarterly dummies, and dummies representing each year of the first four years of the SLA. The results in Zhang (2001) showed that the largest reduction in U.S. lumber consumption and the largest consumer

losses took place in the first year and fourth year. My estimated results are consistent with this. Zhang (2001) also found that the market impacts are sensitive to the elasticities used in his paper, but the welfare effects are not sensitive. In comparison with the 1986 MOU as examined by Wear and Lee (1993), Zhang found that the SLA has a larger positive impact on the U.S. price and U.S. producer surplus, while the SLA has a larger negative impact on U.S. consumer surplus. Zhang found that there was an increase in the profits of Canadian producers on their sales in the U.S. market under the SLA, but a slight decrease under the MOU. The empirical results of this thesis however, show producer losses rather than gains under the SLA. The Zhang (2001) paper, however, only covered the U.S. market and Canadian producer profits on their U.S. lumber sales. In Kinnucan and Zhang (2003), an analysis of the Canadian domestic market was added.

Kinnucan and Zhang (2003) examined the incidence of the SLA and determine the optimal export tax. They used partial-equilibrium to analysis to assess the welfare effects in both Canada and the U.S. Their theoretical model consisted of a system of supply, demand and market clearing equations for softwood lumber. The model was calibrated using pre-existing estimates of the elasticity of U.S. demand and supply and the Canadian export supply elasticity. The results showed that the losses of U.S. consumers exceed the gains of U.S. producers. Canadian consumers and the Canadian government gained through standard channels and Canadian producers also gain because the VER rents outweigh the loss of producer surplus. On an overall basis, Canada's economy benefits at the expense of the U.S., but there was an efficiency loss of 1.48 billion U.S. dollars. Kinnucan and Zhang also found that Canada's optimal export tax rate is 5%. Under this export tax level, the net loss for the combined U.S. and Canadian economics is modest

although the U.S. welfare is diminished. Canadian welfare would increase at least in a short term. Nevertheless, they still think that SLA is an efficient mechanism for redistributing economic surplus from consumers to producers. As Kinnucan and Zhang acknowledge, their analysis is dependent on dated elasticity estimates and that re-estimating these elasticities should be a priority. A central contribution of this thesis is to provide updated estimates of the elasticities of demand and supply in Canada and the U.S. With these new estimates, it turns out that Canadian producers lose rather than gain.

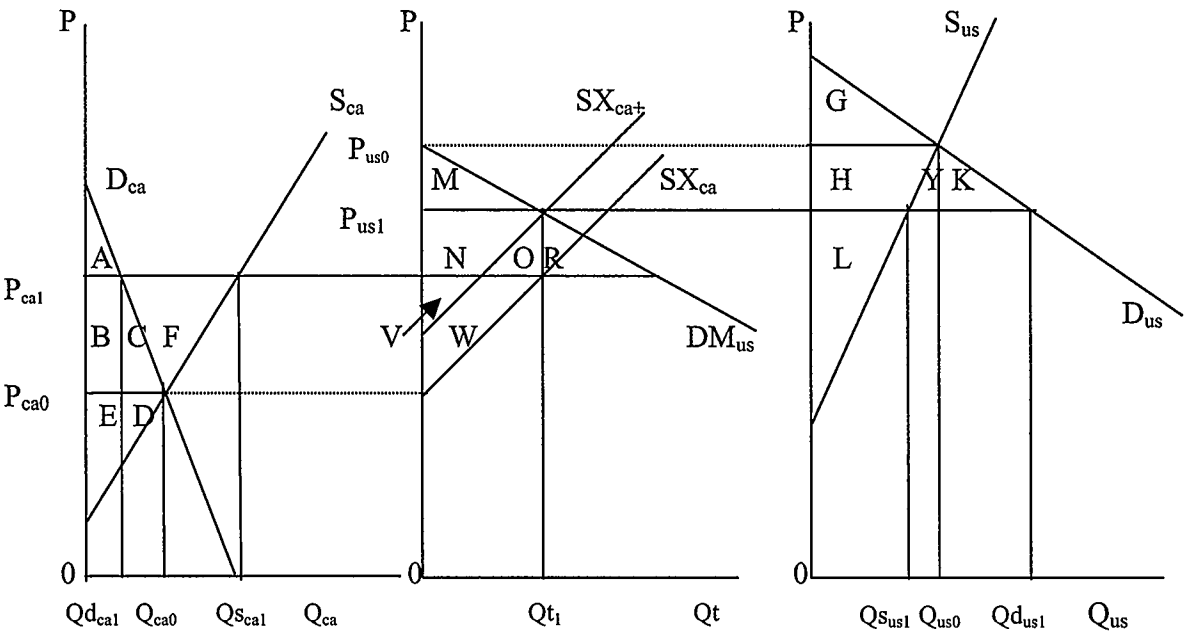
CHAPTER FIVE

THEORETICAL ANALYSIS: A PARTIAL EQUILIBRIUM MODEL OF CANADA-U.S. SOFTWOOD LUMBER TRADE

There are several kinds of trade restrictions that have been used in the course of the Canada-U.S. softwood lumber dispute. The CVDs that were used in Lumber III and the CVDs and ADDs that were used in Lumber V are examples of *ad valorem* import tariffs. Export taxes were used in the MOU (Lumber II) and a combination of VERs (export quotas) and export taxes were used under the SLA (Lumber IV). Consequently it is important to assess the impact of import tariffs, export taxes and export quotas in a model of Canada-U.S. softwood lumber trade.

A partial-equilibrium model of Canada-U.S. trade in softwood lumber is illustrated in Figure 3. The assumption that Canada and the United States are the only relevant regions serves as a good first approximation since U.S. imports of lumber from other countries are less than 1 bbf per year compared to annual imports from Canada exceeding 18 bbf. Canadian exports to other countries (mainly Japan) are also relatively small (less than 4 bbf annually). While it would be interesting to consider separate exporting and/or importing regions in each (see Adams and Haynes 1980, 1986; Boyd et al. 1993), this is not practical due to data limitations. In the literature, it has been conventional to simplify by assuming that the softwood industries in Canada and the U.S. are competitive. While this thesis also adopts the competitive assumption, further research allowing imperfect competition in the softwood industry would be worthwhile.

Figure 3: Model of International Trade in Softwood Lumber



(a) Canadian Market (b) International Market (c) U.S. Market

In Figure 3, Canadian and U.S. domestic demand and supply functions are labelled $\mathbf{D_{ca}}$ and $\mathbf{S_{ca}}$, and $\mathbf{D_{us}}$ and $\mathbf{S_{us}}$, respectively. Without trading, $\mathbf{Q_{ca0}}$ units of lumber will be consumed in Canada at a domestic price of $\mathbf{P_{ca0}}$ (as shown in panel a). In the U.S. lumber market, consumption will be $\mathbf{Q_{us0}}$ at price $\mathbf{P_{us0}}$ (as shown in panel c). The well being of citizens in each country (ignoring foreign ownership) is determined by the sum of the consumer and producer surpluses. In the absence of trade, the consumer surplus is given by area (**A+B+C**) in Figure 3(*a*) for Canada and by area **G** in Figure 3(c) for the U.S. In the absence of trade, the producer surplus (or quasi rent) is measured by area (**E+D**) for Canada, and by area (**H+L**) for the U.S. For Canada, total surplus in the absence of trade is given by area (**A+B+C+D+E**), while it is area (**G+H+L**) for the United States.

5.1 Unrestricted Free Trade

In panel (b) of Figure 3, $\mathbf{DM_{us}}$ is the U.S. excess demand or import demand curve in the international lumber market. $\mathbf{SX_{ca}}$ is the Canadian excess supply or export supply curve, and $\mathbf{SX_{ca+}}$ is the Canadian export supply curve adjusted for the transportation cost associated with moving lumber from Canada to the U.S. Since $\mathbf{P_{us0}}$ is greater than $\mathbf{P_{ca0}}$ prior to trade, lumber will flow from Canada to the U.S. as long as the difference in price between the two regions exceeds the transportation cost. In Figure 3, unrestricted trade will cause the Canadian price to increase from $\mathbf{P_{ca0}}$ to $\mathbf{P_{ca1}}$ and the U.S. price to decrease from $\mathbf{P_{us0}}$ to $\mathbf{P_{us1}}$.

As a result of the price increase, consumption in Canada falls from $\mathbf{Q_{ca0}}$ to $\mathbf{Qd_{ca1}}$. The remaining consumer surplus is only area **A** implying that area **B+C** is lost. The increase in the Canadian price leads to an increase production from $\mathbf{Q_{ca0}}$ to $\mathbf{Qs_{ca1}}$. The amount $\mathbf{Qs_{ca1} - Qd_{ca1}}$ (which is equal to $\mathbf{Qt_1}$) is the quantity exported to the U.S. Producer surplus increases by area **B+C+F**. Since the change in Canada's total surplus consists of the sum of the changes in producer and consumer surplus, Canada experiences an overall gain of area **F**. The situation in the U.S. is a mirror image of that in Canada. The fall in U.S. prices causes an increase in consumption from $\mathbf{Q_{us0}}$ to $\mathbf{Qd_{us1}}$ and an increase in consumer surplus given by area **K+H+Y** in U.S. By contrast, the lower price causes producers to curtail output to $\mathbf{Qs_{us1}}$ from $\mathbf{Q_{us0}}$, and leads to a loss of producer surplus of area **H** in U.S. However, the consumer gain is greater than the producer loss and results in a gain in U.S. total surplus of area **Y+K**. Consequently, trade between Canada and U.S. improves overall welfare in both countries.

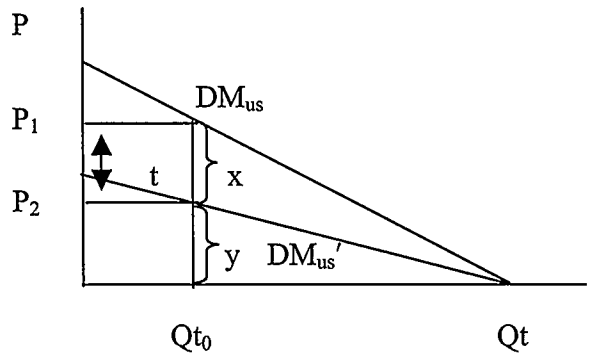
The main results can be summarized in the international market, panel (b) of Figure 3. The amount traded is $\mathbf{Qt_1 = Qs_{ca1} - Qd_{ca1} = Qd_{us1} - Qs_{us1}}$. The net gain to the U.S. is area **M**, which is equal to area **Y+K** in panel (c). This net gain accrues to U.S. importers and therefore is measured under the import demand curve $\mathbf{DM_{us}}$. The gain to Canada's exporters equals the area inside the excess supply curve $\mathbf{SX_{ca}}$ below the new U.S. price, or area **(N+O+R+V+W)**, but transportation costs of **(N+O+R)** are incurred. Hence, the net gain from trade is **(V+W)**, which is equal to area **F** in panel (a). Once again, both countries are shown to be better off with trade.

5.2 *Import Tariffs*

In addition to unrestricted free trade, it is necessary to consider three other scenarios: (1) an import duty or tariff, (2) an export tax, and (3) an export quota or VER. Under perfect competition, a tariff levied by the U.S. or an export tax levied by Canada have the same effect on prices and quantities produced and consumed as an export quota if the duty or tax is set to achieve the same reduction in the quantity traded. On the one hand, Canadian producers and U.S. consumers will lose, and on the other hand, Canadian consumers and the U.S. producers gain. Because tariffs are levied by the U.S., but export taxes and quotas are imposed by Canada, the distribution of the rents associated with trade restriction between the two countries will be different. An import tariff generates revenue for the U.S. treasury and an export tax creates revenue for the Canadian government. An export quota leads to rents that accrue to Canadian producers. These rents may partially or fully mitigate the losses in producer surplus.

An import tariff is a tax on a foreign imported item paid at the time it passes into the domestic market. This is equally truly for a countervailing duty or anti-dumping duty. The only difference between a simple tariff and a CVD or ADD is that the latter are responses to alleged unfair trading practice or foreign firms or countries. The theoretical framework of an *ad valorem* tariff is shown in Figure 4. Tariffs are a traditional form of protective trade policy used by governments of importing countries to shield domestic producers from foreign competition. A tariff does typically raise the domestic price for an import-competing good and it also creates revenue for the government.

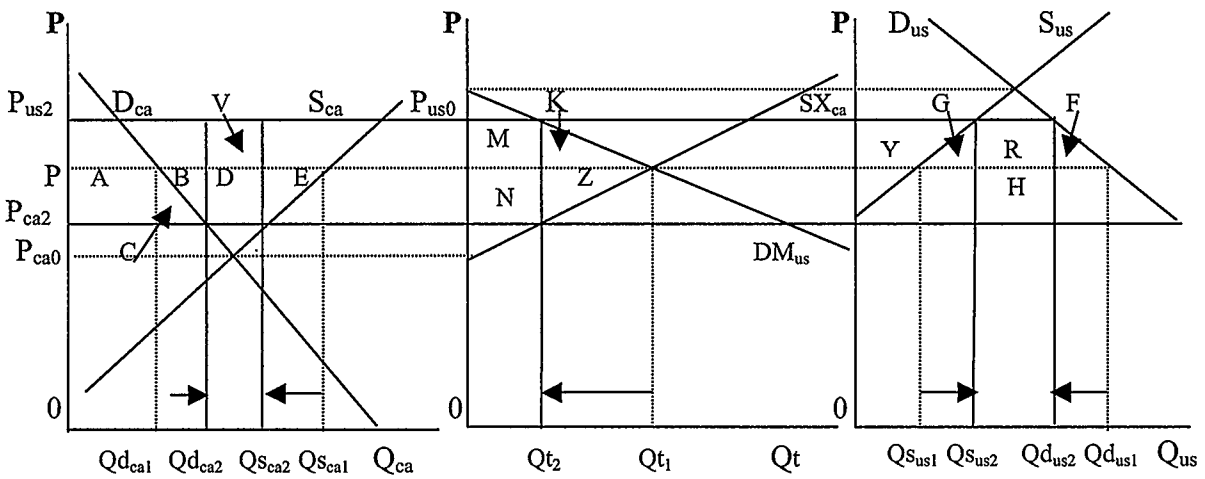
Figure 4: The Theory of Tariff



In Figure 4, $\mathbf{DM_{us}}$ refers to the U.S. import demand for softwood lumber from Canada. This curve can also show the price that the U.S. importers are willing to pay for any given level of imports such as $\mathbf{Qt_0}$. The tariff-adjusted import demand curve, $\mathbf{DM_{us}'}$, shows how much that U.S. importers are willing to pay Canadians when an *ad valorem* tariff of $\mathbf{t = x/y}$ is in place. While the $\mathbf{DM_{us}}$ continues to show the U.S. price under the tariff regime, the $\mathbf{DM_{us}'}$ curve shows the world, or in this case, Canadian price. As the tax rate, **t**, increases, the $\mathbf{DM_{us}'}$ curve will shift down.

Since the U.S. is a large country, it has ability to affect the world price, in this case the Canadian price, when the U.S. market changes. The analysis is shown in the below Figure 5. We assume that the transport costs are equal to zero to simply the diagram. After the tariff, the Canadian lumber price falls from $\mathbf{P_{ca1}}$ **(=P)** to $\mathbf{P_{ca2}}$ since the U.S. demand in the international market is reduced. This results in a reduction of quantity trade in the international market from $\mathbf{Qt_1}$ to $\mathbf{Qt_2}$. On the other hand, the domestic lumber price in the U.S. goes up because of the tariff to $\mathbf{P_{us2}}$, from $\mathbf{P_{us1}}$ **(=P)** where $\mathbf{P_{us2} = (1+ t)}$ $\mathbf{P_{ca1}}$. In the U.S. domestic market, the total quantity consumed is reduced from $\mathbf{Qd_{us1}}$ to $\mathbf{Qd_{us2}}$ while the amount produced increases from $\mathbf{Qs_{us1}}$ to $\mathbf{Qs_{us2}}$. Imports decrease from $\mathbf{Qd_{us1} - Qs_{us1} = Qt_1}$ to $\mathbf{Qd_{us2} - Qs_{us2} = Qt_2}$.

Figure 5: The International Effect of the Tariff and Quota



(a)Canadian Market (b) International Market (c) U.S. Market

Note: Area N=D=H, M=V=R, K=G+F, and Z=B+E

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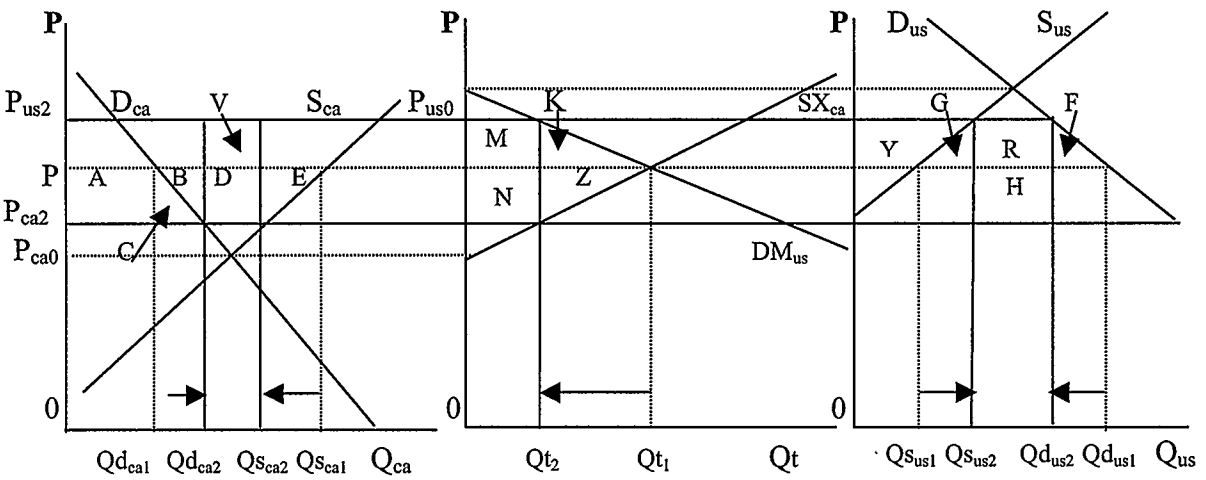


(a)Canadian Market (b) International Market (c) U.S. Market

Note: Area N=D=H, M=V=R, K=G+F, and Z=B+E

The U.S. treasury gains tariff revenue given by area **R+H** in panel (c), or area **M+N** in panel (b), or **V+D** in panel (a). U.S. producer surplus rises by area **Y**, and consumer surplus falls by area **Y+G+R+F**. Area **G** is considered a welfare loss dues to producer inefficiency because the new higher price results in resources being diverted to the production of lumber products that could have been utilized more efficiently elsewhere in the economy. Area **F** is a welfare loss due to consumer inefficiency because consumers are now paying more and receiving fewer goods than they were before the implementation of the tariff. The change in U.S. welfare due to the tariff is summarized as follows:

Δ U.S. Producer Surplus: +Y

Δ U. S. Consumer Surplus: -Y - G - R - F

Δ Import Surplus: - G - R - F = - M - K

Δ U.S. Terasury gain: +R + H = M + N

Δ Total Surplus: - G - F + H = N–K = [N+Z] - [K+Z]

The change in U.S. total surplus is comprised of a term of trade gain given by area **N+Z** and a distortionary loss given by **K+Z**. If area **K** is larger than area **N**, then there is a net loss. If area **K** is smaller than area **N**, then there is a gain. Because the U.S. is a large country that can affect the world price, the incidence of the tariff falls partially on Canadian exporters, who make payments equal to area **N**, leading the possibility of the U.S. welfare gain. This means that, if the tariff is not excessively large, the U.S.

government could compensate for the net private sector losses by redistributing the tariff revenue to those who have been affected.

In Canadian domestic market, when the price falls to $\mathbf{P_{ca2}}$ from **P**, consumption of lumber will increase from $\mathbf{Qd_{ca1}}$ to $\mathbf{Qd_{ca2}}$ and the production of lumber will decrease from $\mathbf{Qs_{ca1}}$ to $\mathbf{Qs_{ca2}}$. The resulting quantity of exports falls from $\mathbf{Qs_{ca1} - Qd_{ca1} = Qt_1}$ to $\mathbf{Qs_{ca2} - Qd_{ca2} = Qt_2}$. The Canadian treasury will get nothing. Canadian consumers gain area **A+C** and Canadian producers lose area **A+B+C+D+E**. The change in Canadian welfare in responses to the tariff is summarized as follows:

Δ Canadian Producer Surplus: -A - B - C - D - E

Δ Canadian Consumer Surplus: +A + C

Δ Export Surplus: -B - D -E = - N - Z

Δ Canadian Terasury gain/loss: 0

Δ Total Surplus: -B - D - E = - N - Z

The loss in producer surplus cannot be fully offset by gain in consumer surplus. Consequently, Canadian welfare declines because of the terms of trade loss given by the area **N+Z.** Notice that magnitude of the U.S. terms of trade gain is exactly equal to that of the Canadian terms of trade loss.

5.3 Export Taxes

Whereas import taxes in the form of CVDs and/or ADDs were used in Lumber III and V, export taxes were used under the MOU (Lumber II). The case of an export tax has many

similarities with an import tariff, but when an export tax is levied, the Canadian government will collect the tax revenue. Of course, this means that the U.S. treasury no longer collects tax revenue. In the U.S. market, lumber price again goes up to $\mathbf{P_{us2}}$ after tax, lumber consumption decreases to $\mathbf{Qd_{us2}}$ and consumers lose area **Y+G+R+F**. At the same time, U.S. lumber output again increases to $\mathbf{Qs_{us2}}$, and producers gain area **Y**. The change in U.S. welfare under the export tax is summarized as follows:

Δ U.S. Producer Surplus: +Y

Δ U. S. Consumer Surplus: -Y - G - R - F

Δ Import Surplus: - G - R - F = - M - K

Δ U.S. Terasury gain: = 0

Δ Total Surplus: -G - R - F = - M - K

Since the U.S. does not collect the tax revenue, in this case U.S. is a net loser. The loss in total surplus given by area **M+K** is attributable to the deterioration in the U.S. terms of trade. American importers now pay Canadians more.

The export tax is similar to the tariff in that the Canadian domestic lumber price falls to $\mathbf{P_{ca2}}$, consumption rises to $\mathbf{Qd_{ca2}}$, production falls to $\mathbf{Qs_{ca2}}$, and export falls to $\mathbf{Qt_2 = Qs_{ca2} - Qd_{ca2}}$. Canadian consumers still gain area **A+C**, and producers still lose area **A+B+C+D+E**. Now, however, the Canadian treasury will get area **D+V**. Changes in Canadian welfare brought about by the export tax are summarized as follows:

Δ Canadian Producer Surplus: -A - B - C - D - E

Δ Canadian Consumer Surplus: +A + C

Δ Canadian Export Surplus: -B - D - E = - N - Z

Δ Canadian Treasury gain/loss: + D + V = N + M

Δ Total Surplus: -B - E + V = M - Z = [M+K] –[Z+K]

In the international market, area **M+K** represents a terms of trade gain for Canada while area **K+Z** represents a distortionary loss. If the area **M**, which is the share of the tax paid by U.S. residents, is greater than area **Z**, which is the inefficiency cost falling on Canadian consumers and producers, Canada is a net gainer. Provided that the export tax is not excessively large, the Canadian government can use its revenue to compensate for the net private sector loss falling on exporters. Since the tax revenue has switched from the U.S. government to the Canadian government, it is now possible for Canada rather than U.S. to experience an overall welfare gain. If the export tax is excessively large, however, such that area **Z** is larger than area **M**, Canada will be a loser.

5.4 A Voluntary Export Restraint (VER) or Export Quota

A VER or export quota was an important component of the SLA (Lumber IV). The incidence of an export quota depends significantly on the way in which quota licences are administered. For example, if the quota licenses were auctioned, the Canadian government would get rents associated with trade restriction, and the analysis would proceed in the same manner as an export tax. As it happens, however, export licences were assigned to Canadian producers on the basis of historic exports. This implies that the quota rents will go to Canadian producers rather than the government. Assuming that

the export quota is set equal to $\mathbf{Qt_2 = Qs_{ca2} - Qd_{ca2}}$, the impact on all prices and quantities remains unchanged from the previous analysis of export taxes and tariff. Further, the welfare effects on the U.S. are the same as in the case of the export tax. Canadian consumers continued to gain area **A+C**, but the overall impact on Canadian producers is now ambiguous. The lower Canadian price, $\mathbf{P_{ca2}}$, continues to reduce producer surplus by area **A+B+C+D+E**, but now producers get quota rents equal to area **V+D** or **M+N**. Therefore, the net gain to producers is equal to area **V–(A+B+C+E)**, which could be positive or negative. Canadian welfare is now summarized as follows:

Δ Canadian Producer Surplus: -A - B - C - E + V

Δ Canadian Consumer Surplus: +A + C

Δ Canadian Export Surplus: -B - E + V = M - Z

Δ Canadian Treasury gain/loss: = 0

Δ Total Surplus: -B -E + V = M - Z = [M+K] -[Z+K]

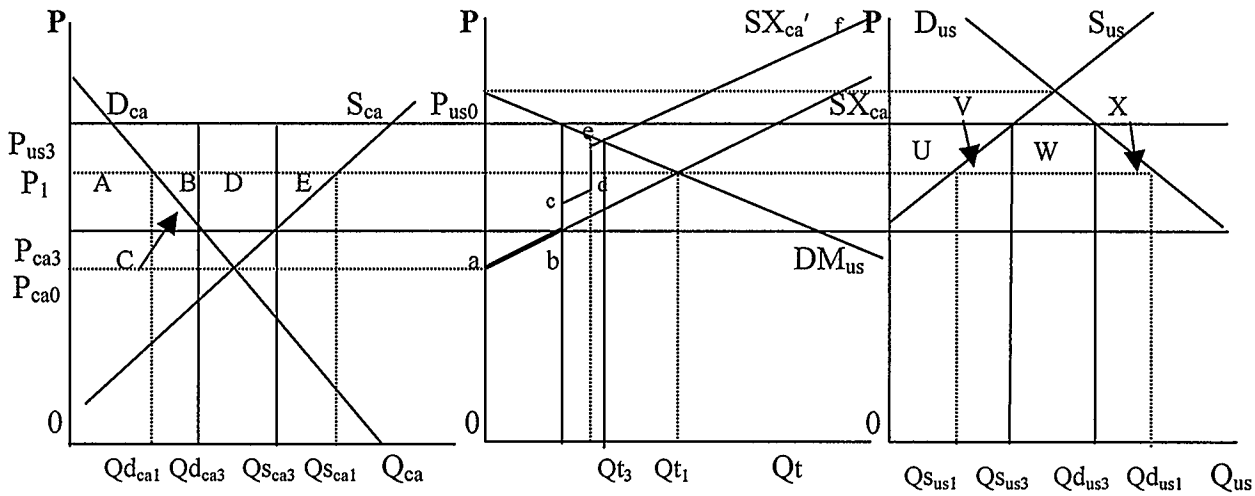
Given that markets are competitive, the export quota and the export tax have equivalent effects on overall Canadian welfare.

5.5 Export Tax Quota Policy

The SLA has export tax components in addition to export quota components much like so called tariff rate quotas have a blend of import tariff and import quota components (Gaisford and Kerr, 2001 and Kinnucan and Zhang, 2003). The blend of export taxes and export quotas under the SLA can be called an export tax quota policy. Following Kinnucan and Zhang, such a policy can be analysed using Figure 5′. The export tax quota

policy leads to two kinks in Canada's SLA export supply curve, $\mathbf{SX_{ca}}'$. The $\mathbf{SX_{ca}}'$ curve coincides with the $\mathbf{SX_{ca}}$ curve over the fee-free base up to 14.7 bbf annually. This is shown as the segment ab in Figure 5'. The vertical segment bc occurs at the export volume of 14.7 bbf, and represents an export tax of $50 per thousand board feet. This tax applies over the low fee base which shown as segment cd where export volumes lie between 14.7 bbf and 15.35 bbf. The vertical segment of the $\mathbf{SX_{ca}}'$ curve, de, occurring at 15.35 bbf corresponds to an increase in the export tax to $100 per thousand board feet. The final segment of $\mathbf{SX_{ca}}'$ curve, ef, represents the upper fee base where the higher tax applies.

Figure 5': The International Effect of the SLA



(a) Canadian Market (b) International Market (c) U.S. Market

In Figure 5′ and Figure 5″, the equilibrium for the SLA is determined by the U.S. import demand curve, $\mathbf{DM_{us}}$ and Canada's SLA export supply curve, $\mathbf{SX_{ca}'}$. Consequently, the U.S. price under the SLA is $\mathbf{P_{us3}}$, the Canadian price is $\mathbf{P_{ca3}}$ and the quantity of lumber trade is $\mathbf{Qt_3}$, which happens to exceed 15.35 bbf. Since the equilibrium falls on segment ef of Canada's SLA export supply curve, Canadian exports above 15.35 bbf are subject to the high tax rate of $100 per thousand board feet. If we continue to abstract from transportation costs, this implies that $\mathbf{P_{us3} = P_{ca3} + 100}$. Notice that we would have $\mathbf{P_{us3} = P_{ca3} + 50}$ if the equilibrium fell on the segment cd, and $\mathbf{P_{us3} = P_{ca3}}$ if the equilibrium fell on the segment ab. Similarly, if the equilibrium fell on the vertical segment bc then the difference between the Canadian and U.S. prices would be between zero and $50, and if the equilibrium fell on the segment de, the price difference would be between $50 and $100.

In the U.S. market, where the lumber price has gone up from $\mathbf{P_1}$ to $\mathbf{P_{us3}}$ because of the export tax quota policy, consumption decreases from $\mathbf{Qd_{us1}}$ to $\mathbf{Qd_{us3}}$ and consumers lose area **U+V+W+X**. U.S. output rises from $\mathbf{Qs_{us1}}$ to $\mathbf{Qs_{us3}}$, and producers gain area **U**. The change in U.S. welfare under the export tax quota policy is summarized as follows:

Δ U.S. Producer Surplus: +U

Δ U. S. Consumer Surplus: -U - V - W - X

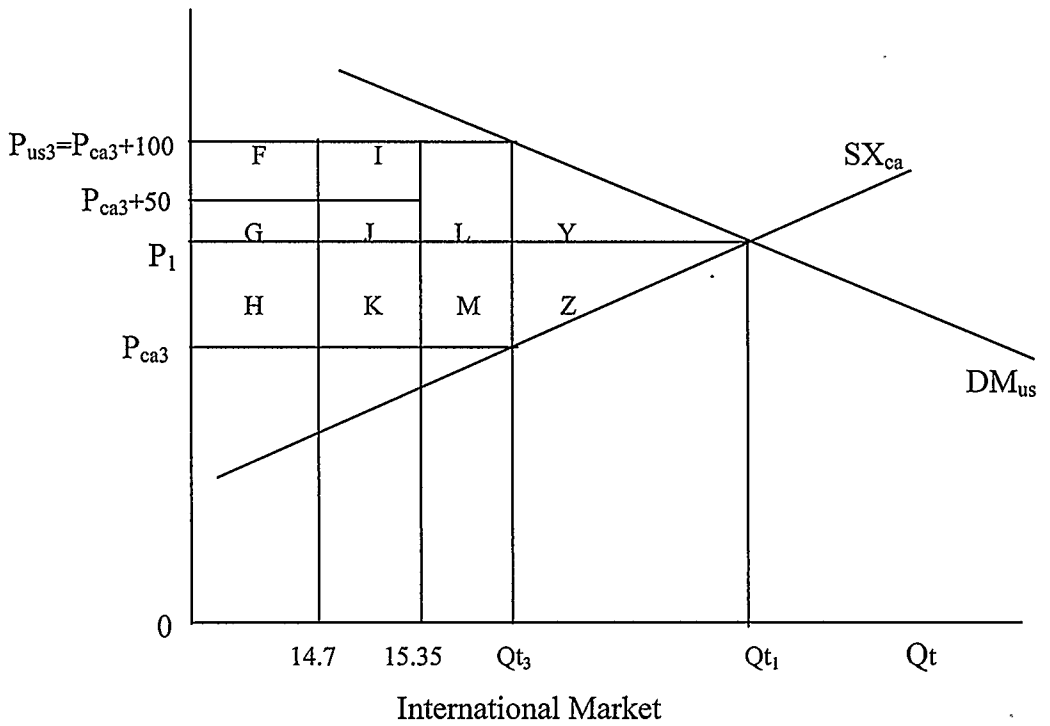
Δ Import Surplus: -V - W - X = - H - K - M - Z

Δ U.S. Terasury gain: 0

Δ Total Surplus: -V - W - X = - H - K - M - Z

The U.S. experiences an unambiguous welfare loss because the terms of trade change; it pays more for Canadian softwood lumber.

Figure 5'': Details of the International Market under the SLA from Figure 5'



In Canada, the price decreases from $\mathbf{P_1}$ to $\mathbf{P_{ca3}}$ in Figure 5' causing an increase in Canadian consumption from $\mathbf{Qd_{ca1}}$ to $\mathbf{Qd_{ca3}}$ and an increase in consumer surplus equal to area **A+C**. Production decreases from $\mathbf{Qs_{ca1}}$ to $\mathbf{Qs_{ca3}}$. If the Canadian government auctioned the quota licences, then the impact of the SLA on producers and treasury would have been same as the export tax. As discussed above, however, the quota licences were assigned directly to producers on the basis of previous (historic) exports. As result, some quota rents accrued to Canadian producers in a manner similar to the VER analysis. Producers lose area **A+B+C+D+E** in Figure 5', due to the price increases, but they gain

area **F+G+H+I** in Figure 5″ due to the creation of quota rents. The net gain to producers is **(F+G+I+H)-(A+B+C+D+E)**, which could be positive or negative. While Kinnucan and Zhang (2003) argue that Canadian producers gained from the SLA, their results made use of out of date estimates of demand and supply elasticities. Consequently, the empirical analysis conducted below will check the Kinnucan and Zhang finding. It should be observed that area **H+K+M** in Figure 5″ is equal to area **D** in Figure 5′. The Canadian government gains area **K+J+L+M** in export tax revenue. Consequently, the change in Canadian welfare due to the SLA can be summarized as follows:

Δ Canadian Producer Surplus: -A - B - C -D - E

Δ Canadian Producer Rents: +F + G + H + I

Canadian Producer Gains: - A - B - C - E - K - M + F + G + I

Δ Canadian Consumer Surplus: +A + C

Δ Canadian Export Surplus: -B - E - K - M + F + G + I

Δ Canadian Treasury gain: +J + K + L + M

Δ Canadian Total Surplus: -B - E + L + F + G + I + J = [F + G + I + J + L] -Z

$$= [F + G + I + J + L + Y] - [Z + Y]$$

Although the export tax quota policy is more complicated than either the export tax or the VER, the implication for overall Canadian welfare remains unchanged. Canadian welfare rises provided that the export tax quota policy is not excessively restrictive and the terms

of trade gain, which is equal to area **F+G+I+J+L+Y**, exceeds its distortionary loss, which is equal to **Z+Y**.

The Softwood Lumber Agreement (SLA) included some further notable details. Since U.S. producers only complained about exporters based in British Columbia, Alberta, Ontario and Quebec, only these four provinces were covered under the SLA. Further, Canada was not required to collect fees from any exporter whose production of softwood lumber was less than 10 million board feet in the previous year, or whose production of softwood lumber during the preceding calendar quarter was substantially disrupted by some reasons beyond human control.

CHAPTER SIX

EMPIRICIAL ANALYSIS OF DEMAND AND SUPPLY

6.1 Regression Model and Variables

It is necessary to make some assumptions to estimate the demand and supply elasticities for softwood lumber in Canada and the U.S. We continue to assume that softwood lumber prices are determined under competitive conditions. In addition, we adopt a log-linear specification of demand and supply. This specification generally performed better than linear or log-log specifications (see Appendix G). The log-linear specification makes it easy to determine import demand and export supply functions, but it has the disadvantage that the elasticities are not constant.

The first step in the empirical analysis is to estimate the elasticity of demand and supply and then calculate the corresponding exports supply and imports demand elasticities (price-cross). The model of demand and supply is similar to Kalt (1988). Table 1 lists the variables used in the model.

Table 1. Regression Model Variables in the Model

Symbol	Variable
Dependent Variables:	
Canada	
Q_x	Canadian softwood lumber exports to U.S. (mbf)
Qd_{ca}	Canadian domestic softwood lumber consumption (mbf)
Qs_{ca}	Canadian softwood lumber production (mbf)
U.S.	
Q_m	U.S. softwood lumber imports from Canada (mbf)
Qd_{us}	U.S. domestic softwood lumber consumption (mbf)
Qs_{us}	U.S. softwood lumber production (mbf)
Independent Variables:	
Canada:	
Demand Variables	
P_{ca}	Canadian domestic price of softwood lumber (1997 U.S. dollars)
i_{ca}	Canadian 5-year mortgage rate
H_{ca}	Canadian housing starts (in 1000 units)
Y_{ca}	Canadian disposable income (1997 U.S. dollars)
Ps_{ca}	Canadian steel price (1997 U.S. dollars)
Supply Variables	
P_{ca}	Canadian domestic price for softwood lumber (1997 U.S. dollars)
W_{ca}	Canadian hourly earning for sawmill plant workers (1997 U.S. dollars)
U.S.	
Supply Variables	
P_{ca}	Canadian domestic price for softwood lumber (1997 U.S. dollars)
Y_{ca}	Canadian disposable income (1997 U.S. dollars)
Ps_{ca}	Canadian steel price (1997 U.S. dollars)
Demand Variables	
P_{us}	U.S. domestic price of softwood lumber (1997 U.S. dollars)
i_{us}	U.S. 30-year mortgage rate
H_{us}	U.S. housing starts (in 1000 units)
Y_{us}	U.S. disposable income (1997 U.S. dollars)
Ps_{us}	U.S. steel price index (1982=100)
Supply Variables	
P_{us}	U.S. domestic price of softwood lumber (1997 U.S. dollars)
W_{us}	U.S. hourly earning for sawmill plant workers

Note: Canadian and the U.S. lumber production, consumption and trade volumes are in levels and all other variables are in natural log form.

The data on Canadian domestic lumber price, production, consumption, housing starts, exports and export price are obtained from the "Selected Forestry Statistics Canada" database which was published by Natural Resources Canada, and originally from Statistics Canada. The data on Canadian disposable income, Canadian steel price and Canadian 5-year mortgage rate are directly obtained from Statistics Canada's CANSIM database. Most of the U.S. data, such as U.S. domestic lumber production, consumption, housing starts, consumer disposable income and steel price, come from "Statistical Abstract of the United States" which is published by U.S. Department of Commerce, Economics and Statistics Administration and U.S. Census Bureau. The U.S. domestic lumber price and 30-year mortgage rate come from the CANSIM database. Sawmill workers' hourly earnings come from the U.S. Department of Labour. The data on U.S. lumber imports comes from Department of Foreign Affairs and International Trade Export Controls Bureau, Canada. The data used in the regression model comprise a 31-year time series from 1971 to 2001.

Unit root tests show that most of the variables in the time series are non-stationary in levels. And all of the variables are stationary in first differences. It is not easy to show the relationship between the dependent variables and independent variables in first differences. Among the explanatory variables, however, there exist co-integrating relationships (See Appendix B). Consequently, the data in levels can be used to estimate the demand and supply regressions in our model.

The variables in both the demand and supply functions are similar to Kalt (1988) and Zhang (2001). While these variables would arise out of an optimizing framework, the

estimated log-linear functional forms for demand and supply in this thesis functions are somewhat *ad hoc*. The coefficients on prices in log-linear specification are significant and the implied elasticities are similar in magnitude to a log-log specification. The log-linear and log-log specifications generally perform better than a linear-linear specification. (See Appendix G, Table G2 and G3.) There are some omitted variables in the demand and supply functions for both countries, especially on supply side. For example, data limitations prevented the inclusion of input costs such as the costs of capital and energy. When the prime interest rate was tried as a proxy for capital costs, it was not statistically significant. Further, sign problems arose for the Canadian supply price.

Canadian Supply and Demand:

(6.1) $$Qs_{ca} = \beta_{0-sca} + \beta_{1-dca} \ln P_{ca} + \beta_{2-sca} \ln W_{ca} + \mu_{sca}$$

The Canadian supply equation shows that Canadian output is a function of the Canadian domestic lumber price and the hourly earnings of Canadian sawmill plant workers.

(6.2) $$Qd_{ca}=\beta_{0-dca}+\beta_{1-dca}\ln P_{ca}+\beta_{2-dca}\ln i_{ca}+\beta_{3-dca}\ln H_{ca}+\beta_{4-dca}\ln Y_{ca}+\beta_{5-dca}\ln P_{sca}+\mu_{dca}$$

The Canadian demand equation indicates that Canadian consumption is a function of Canadian domestic lumber price, the 5-year mortgage rate, housing starts, disposable income, and Canadian steel price.

(6.3) $$Qs_{ca} \equiv Qd_{ca} + Q_x + Q_{xrw}$$

The above equation is a market clearing condition where Canadian net exports to the rest of the world (Q_{xrw}) are assumed to be constant. While this is clearly a simplification,

Canada's exports to third countries will not be affected much by trade restrictions between Canada and the U.S. Note that Q_x denotes only lumber exports to the U.S. from Canada.

United States Supply and Demand:

(6.4) $$Qs_{us} = \beta_{0-dus} + \beta_{1-dus} \ln P_{us} + \beta_{2-sus} \ln W_{us} + \mu_{sus}$$

The United States supply equation specifies that U.S. output is a function of U.S. domestic softwood lumber price and the hourly earning of sawmill plant workers.

(6.5) $$Qd_{us} = \beta_{0-dus} + \beta_{1-dus} \ln P_{us} + \beta_{2-dus} \ln i_{us} + \beta_{3-dus} \ln H_{us} + \beta_{4-dus} \ln Y_{us} + \beta_{5-dus} \ln P_{us} + \mu_{dus}$$

The U.S. demand equation indicates the U.S. consumption depends on its domestic softwood lumber price, U.S. 30-year mortgage rate, housing starts, disposable income and U.S. steel price index.

(6.6) $$Qd_{us} \equiv Qs_{us} + Q_m + Q_{mrw}$$

The United States also has a market clearing equation. U.S. softwood lumber consumption equals to U.S. production plus imports from Canada. Imports from other countries are negligible. We assume U.S. imports from the rest of the world, Q_{mrw}, are exogenous but the U.S. imports from Canada, Q_m, are endogenous.

6.2 Regression Results

The above demand and supply system for Canada and U.S. are fully identified. By the order condition[3] for identification, the number of predetermined variables excluded from the equation must be greater than or equal to the number of included endogenous variables minus one. There also exists a simultaneity problem in the above demand-supply model since the price in each country depends on the softwood lumber production and consumption in both countries. Consequently, the Canadian and U.S. prices are endogenous variables in the supply and demand equations. Further, the market clearing condition requires balance between Canadian exports (including the exports to the U.S. and the rest of the world, ROW hereafter) and U.S. imports. The difference of between Canadian lumber supply and demand should be equal to the difference between U.S. lumber demand and supply plus the ROW. To address the simultaneity issue, we use three-stage least squares (3SLS) to estimate the equations. Appendix C compares three-stage least squares and two-stage least squares (2SLS) approaches. The two approaches give broadly similar results, but the Appendix C indicates the parameter estimates are more efficient in the 3SLS case. Table 2 reports the results for the 3SLS estimation of the model.

[3] In an econometric system of simultaneous equations, each equation may satisfy the order condition, or not do so. If it does not, its parameters are not all identified. Often the econometrician verifies that the order condition is satisfied and assumes with this justification that the equation is identified, although formally a stronger requirement, the rank condition, must be satisfied.

Table 2: The Results of the Three-Stage-Least-Squares regression of price as a function of Canadian and U.S. supply and demand

Variables	Corfficient		|p| > z
Canada:			
Supply			
Canadian Softwood Lumber Price:	6082.243*		0.060
Canadian Sawmill Plant Workers' hourly earning:	8163.591***		0.000
Constant:	-34769.7***		-0.009
R-squared:		0.7781	
Demand			
Canadian Softwood Lumber Price:	-6562.792**		-0.025
Canadian Housing Starts:	443.4063		0.725
Canadian Personal Disposable Income:	-9277.204 **		-0.014
Canadian 5-year Mortgage Rate:	-75801.15***		-0.001
Canadian Steel Price:	16818.78***		0.001
Constants:	34701.12*		0.167
R-squared:		0.3805	
United States:			
Supply			
U.S. Softwood Lumber Price:	10358.52*		0.039
U.S. Sawmill Plant Worker's hourly earning :	-5711.78		-0.243
Constant:	-12391.86		-0.494
R-squared:		0.3505	
Demand			
U.S. Softwood Lumber Price:	-13560.96**		-0.019
U.S. Housing Starts:	13708.85***		0.000
U.S. Personal Disposable Income:	10931.06***		0.000
U.S. 30-year Mortgage Rate:	-142846.3***		-0.000
U.S. Steel Price:	11268.96**		0.044
Constant:	-122274.4***		-0.000
R-squared:	0.9070		

Note: All variables are in natural log form except the Canadian and the U.S. lumber production and consumption;
*** indicates the explanatory variables are significant at the 1% level;
** means the explanatory variables are at the 5% level, and
* refers to the explanatory variables are significant at the 10% level.

6.3 Estimated Elasticities

In the above regression, most explanatory variables have the expected signs. And they are statistically significant at least at the 10% level. Demand in each country depends negatively on its own price. An increase in a country's mortgage rate reduces its lumber consumption. By contrast, an increase in either housing starts or the steel price leads to greater lumber consumption. An increase in disposable income should increase consumption given the lumber is normal good[4]. The regression results are consistent with this expectation for the U.S., but not for Canada. For Canada a statistically significant negative coefficient is obtained. Supply in each country depends positively on its price as expected. It is anticipated that higher wages for sawmill workers would lead to lower output. This result is confirmed for the U.S., but not for Canada where a strongly significant positive coefficient is obtained.[5] The adjusted R-squares are high for the U.S. demand equation and Canadian supply equation, but they are little disappointing for the U.S. supply equation and Canadian demand equation. Own-price elasticities of demand and supply can be calculated from the price coefficients in the appropriate equations.

$$\textbf{(6.7)} \qquad \varepsilon = \frac{P * dQ}{Q * dP} = \frac{\alpha}{Q}$$

In this formula, α is the estimated price coefficient from either a demand or a supply equation. The Canadian export supply elasticity and the U.S. import demand elasticity

[4] The sign on Canadian Personal Disposable Income is negative, which is unexpected and difficult to explain. Other policy changes correlated with income may have affected softwood lumber consumption in Canada.

[5] The sign on the hourly earnings Canadian sawmill worker is positive which is unexpected. This may be the result of increasing lumber production with a stable number of workers in Canadian sawmills.

can be calculated from underlying demand and supply elasticities of the respective countries.

$$\textbf{(6.8)} \quad \varepsilon_{ex} = \varepsilon_s * \frac{Qs_{ca}}{Qs_{ca} - Qd_{ca}} - \varepsilon_d * \frac{Qd_{ca}}{Qs_{ca} - Qd_{ca}}$$

$$\textbf{(6.9)} \quad \varepsilon_{im} = \varepsilon_d * \frac{Qd_{us}}{Qd_{us} - Qs_{us}} - \varepsilon_s * \frac{Qs_{us}}{Qd_{us} - Qs_{us}}$$

As noted above, the elasticites vary along each curve. This means different elasticity values will be calculated for each year. For the moment, we report average elasticities over the entire period to facilitate comparison with earlier authors. Table 3 shows that the current estimated U.S. demand elasticity, -0.32, is somewhat larger in magnitude than the earlier estimates, the current U.S. supply elasticity, 0.32, is somewhat smaller, and the resulting U.S. import demand elasticity is considerably larger in magnitude. The current estimates of the Canadian demand and supply give rise to an elasticity of export supply equal to 1.11, which is somewhat larger than earlier estimates. These differences with earlier studies, however, are not statistically significant.[6]

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[6] A price coefficient of -9050 in the U.S. demand function would have led to an elasticity of -0.17, which is used by Kinnucan and Zhang (2003). This 'anticipated' price coefficient falls within the 95% confidence interval, [-24,935; -2,186], for the current analysis. Similarly, for the US supply equation the 'anticipated' price coefficient needed to generate Kinnuncan and Zhang's elasticity of 0.4 is 14,500, which lies within the within the 95% confidence interval, [510; 20,206]. The 0.9 elasticity of export supply for Canada employed by Kinnucan and Zhang could have been obtained with various combinations of price coefficients in the demand and supply equations. For example, holding the price coefficient in the Canadian supply equation constant, the anticipated price coefficient in the demand equation would have been -1,345, which lies within the 95% confidence interval [-12,282; -843]. Alternatively, holding the price coefficient in the Canadian demand equation constant, the anticipated price coefficient in the supply equation would have been 11,400, which lies within the 95% confidence interval [-246; 12,411] respectively.

It should be observed that the average Canadian elasticity of demand, 1.07, is surprisingly high in comparison with either the current or past estimates of the U.S. elasticity of demand.[7] Of course, the log-linear formulation of the model does allow the elasticity of demand to vary along the demand curve. Since the policy regimes drive the U.S. price above the Canadian price, Canada tends to operate in a somewhat more elastic region of demand. Nevertheless, the extent to which the Canadian elasticity of demand exceeds that of the U.S. remains suspicious, and it is important to conduct sensitivity analysis on our model to explore the impact of less elastic of Canadian demand.

[7] The Canadian elasticity of demand does not appear to have been estimated directly in the past (Zhang, 2001).

Table 3: Reported Softwood Lumber Elasticities:

Elasticities:	Value:	Sources:
Canadian Demand Elasticity (εd_{ca})	**-1.07**	Current Result
Canadian Supply Elasticity (εs_{ca})	**0.31**	Current Result
Canadian Export Supply to U.S.(ε_e):	**1.11**	Current Result
	0.90	Zhang (2001); Kinnucan & Zhang (2003)
	0.625	Adams and Haynes (1996)
	0.917	Adams et al. (1986) and Krutilla (1987)
U.S. Demand Elasticity (εd_{us}):	**-0.32**	Current Result
	-0.17	Zhang (2001); Kinnucan & Zhamg (2003)
	-0.174	Adams and Haynes (1996)
	-0.173, -0.174	Spelter (1985, 1992)
U.S. Supply Elasticity (εs_{us}):	**0.32**	Current Result
	0.40	Zhang (2001); Kinnucan & Zhang (2003)
	0.572 for Pacific	Adams and Haynes (1996)
	0.574 for Interior	
	0.950 for South	
	0.239 for Pacific	Adams et al. (1986)
	0.460 for Interior	
	0.510 for South	
U.S. Import Demand Elasticity (ε_{im}):	**-2.09**	Current Result
	-1.28	Kinnucan and Zhang (2003)

Source: "Welfare Impacts of the 1996 United States-Canada Softwood Lumber (trade) Agreement" Daowei Zhang (2001)

CAPTER SEVEN

CALIBRATING THE MODEL

The subsequent policy analysis will compare the actual outcomes, which occurred under the various policy regimes, with what would have occurred if there was unrestricted trade. It is necessary, therefore, to construct the unrestricted trade scenario as a counterfactual. Allowing for *ad valorem* transport and transaction costs (τ) and an *ad valorem* trade tax (**t**), we obtain the following equilibrium linkage for prices:

(7.1) $P_{us} = P_{ca} * (1+\tau) * (1+t)$

Equation **(7.1)** can be used to calculate the transport and transaction cost. For the free trade counterfactual, the export tax rate equal to zero (i.e., $t = 0$)

(7.2) $P_{us1} = P_{ca1} * (1+\tau)$

Where P_{us1} and P_{ca1} refer to U.S. and Canadian lumber prices under free trade.

The Canadian and U.S. demand and supply equations, given by **(6.1), (6.2), (6.4)** and **(6.5)**, can be re-written as follows:

(7.3) $Qd_{ca} = \beta_{1-dca} \ln P_{ca1} + Ad_{ca}$

(7.4) $Qs_{ca} = \beta_{1-sca} \ln P_{ca1} + As_{ca}$

(7.5) $Qd_{us} = \beta_{1-dus} \ln P_{us1} + Ad_{us}$

(7.6) $Qs_{us} = \beta_{1-sus} \ln P_{us1} + As_{us}$

Where Ad_{ca}, As_{ca}, Ad_{us}, and As_{us} are intercepts that aggregate all of the exogenous variables and residuals in their respective equations. The intercepts were calculated by multiplying the estimated prices coefficients by the log of the price and deducting the result from the lumber quantity.

The international equilibrium condition requires that the net import demands of the rest of the world, Q_{rw}, are equal to the Canadian export supply minus the U.S. import demand:

(7.7) $Q_{rw} = (Qs_{ca} - Qd_{ca}) - (Qd_{us} - Qs_{us})$

We use equation **(7.7)** to infer the net imports of the rest of the world and we will assume that those imports are exogenous. Consequently, the same level of the net imports would have prevailed under free trade such that $Q_{rw1} = Q_{rw}$.

(7.8)

$$Q_{rw1} = \beta_{1-sca} \ln P_{ca1} + As_{ca} - \beta_{1-dca} \ln P_{ca1} - Ad_{ca} + \beta_{1-sus} \ln P_{us1} + As_{us} - \beta_{1-dus} \ln P_{us1} - Ad_{us}$$

(7.9)

$$\ln P_{ca1} = \frac{\left[-(\beta_{1-sus} - \beta_{1-dus}) * \ln(1+\tau) - (\beta_{1-sus} - \beta_{1-dus}) * \ln(1+t) + Q_{rw} - As_{ca} - As_{us} + Ad_{ca} + Ad_{us}\right]}{\beta_{1-sca} + \beta_{1-sus} - \beta_{1-dca} - \beta_{1-dus}}$$

Equation **(7.9)** is obtained using equation **(7.2)** and **(7.8)**. Canada's free trade price is obtained directly from equation **(7.9)** and the U.S. free trade is recovered using equation **(7.2)**.

The change in a country's consumer surplus caused by policy deviations from free trade is equal to (the negative of) the area inside its demand curve lying between the inferred free trade price (either P_{ca1} or P_{us1}) and the observed policy-induced price (either P_{ca2} or P_{us2}). Similarly, the policy-induced change in a country's producer surplus is equal to the area inside its supply curve. Taking the appropriate integrals with respect the log-linear functions, we obtain the following expressions[8]:

Canadian Consumer Surplus:

$$\textbf{(7.3.1)} \quad \Delta CS_{ca} = -\int_{P_{ca1}}^{P_{ca2}} (Ad_{ca} + \beta_{1-dca} * \ln P_{ca}) dP_{ca}$$

$$= -\left[Ad_{ca} * P_{ca2} + \beta_{1-dca}(P_{ca2} * \ln P_{ca2} - P_{ca2}) - (Ad_{ca} * P_{ca1} + \beta_{1-dca}(P_{ca1} * \ln P_{ca1} - P_{ca1})\right]$$

Canadian Producer Surplus:

$$\textbf{(7.3.2)} \quad \Delta PS_{ca} = -\int_{P_{ca1}}^{P_{ca2}} (As_{ca} + \beta_{1-sca} * \ln P_{ca}) dP_{ca}$$

$$= -\left[As_{ca} * P_{ca1} + \beta_{1-sca}(P_{ca2} * \ln P_{ca2} - P_{ca2}) - (As_{ca} * P_{ca1} + \beta_{1-sca}(P_{ca1} * \ln P_{ca1} - P_{ca1})\right]$$

U.S. consumer Surplus:

$$\textbf{(7.3.3)} \quad \Delta CS_{us} = -\int_{P_{us11}}^{P_{us2}} (Ad_{us} + \beta_{1-dus} * \ln P_{us}) dP_{us}$$

$$= -\left[Ad_{us} * P_{us2} + \beta_{1-dus}(P_{us2} * \ln P_{us2} - P_{us2}) - (Ad_{us} * P_{us1} + \beta_{1-dus}(P_{us1} * \ln P_{us1} - P_{us1})\right]$$

U.S. Producer Surplus:

$$\textbf{(7.4.3)} \quad \Delta PS_{us} = -\int_{P_{us11}}^{P_{us2}} (As_{us} + \beta_{1-sus} * \ln P_{us}) dP_{us}$$

$$= -\left[As_{us} * P_{us2} + \beta_{1-sus}(P_{us2} * \ln P_{us2} - P_{us2}) - (As_{us} * P_{us1} + \beta_{1-sus}(P_{us1} * \ln P_{us1} - P_{us1})\right]$$

Government revenue in the two countries depends on the particular policy. Under an import tariff (i.e., the CVDs of Lumber III, and the ADDs and CVDs of Lumber V), the U.S. government collects the import tax. Consequently, the change in revenue for the U.S. treasury will be:

$$\textbf{(7.10)} \quad \Delta GR_{us} = (t-1) * P_{ca1} * \tau * (Qd_{us} - Qs_{us})$$

And the change in total welfare effect for the U.S. will be:

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[8] Since $\int \ln(x)dx = x\ln(x) - x + c$, it follows that

$$\int_{p_1}^{p_2} D(P)dp = \int_{p_1}^{p_2} (a + b\ln P)dp = [aP_2 + b(P_2 \ln P_2 - P_2)] - [aP_1 + b(P_1 \ln P_1 - P_1)]$$

(7.11) $\Delta TS_{us} = \Delta PS_{us} + \Delta CS_{us} + \Delta GR_{us}$

Under Lumber III and Lumber V, the change in Canada's total welfare is simply the summation of the consumer surplus and the producer surplus because there is no government revenue for Canada.

Under the simple export tax in the MOU (i.e., Lumber II), Canadian government got the export revenue as below:

(7.12) $\Delta GR_{ca} = (t-1) * P_{ca1} * \tau * (Qd_{ca} - Qs_{ca})$

Unlike the SLA, Canadian producers do not get any rents from restricted trade, so the change in producer welfare effect is simply equal to the change in producer surplus. Canada's change in total welfare is the summation of changes in consumer surplus, producer surplus and government revenue.

(7.13) $\Delta TS_{ca} = \Delta PS_{ca} + \Delta CS_{ca} + \Delta GR_{ca}$

The change in U.S. total welfare under the export tax only includes the change in the consumer surplus and producer surplus.

The SLA (i.e., Lumber IV) is the most complicated policy. Under this regime, Canadian lumber producers exporting from the four provinces that are the biggest producers will get rents associated with the export quota. It happens that the lumber export volume to the U.S. falls within the upper fee base (in excess of 15.35 bbf) during the whole period. Consequently, Canadian producers in the big-four provinces earned rents on the portion of their exports below 15.35 bbf.

(7.14) $$\Delta QR_{ca} = (t^1 - 1)P_{ca1} * 14.7 + [(t^1 - 1) - (t^0 - 1)]P_{ca1} * (15.35 - 14.7)$$

(7.15) $$\Delta PR_{ca} = \Delta PS_{ca} + \Delta QR_{ca}$$

In the above equation, t^1 is the tax applied to exports falling in the upper fee base (above 15.35 bbf) and t^0 is the tax charged on exports in the lower fee base (from 14.7 bbf to 15.35 bbf). The overall change in producer welfare in Canada, ΔPR_{ca}, includes both a loss in producer surplus and a gain in trade restriction rents. Consequently, the Canadian producers may either gain or lose. The Canadian government will receive tax revenue at the low rate $t^0 - 1$ on exports in the lower fee base and at the high rate $t^1 - 1$ for exports in the upper fee base.

(7.16) $$\Delta QR_{ca} = (t^1 - 1)P_{ca1} * (Qd_{us} - Qs_{us} - 15.35) + (t^0 - 1)]P_{ca1} * (15.35 - 14.7)$$

The change in U.S. total welfare is simply the sum of the changes in consumer and producer surpluses, just as it was under the simpler export tax of the MOU.

Since no import or export restrictions were applied during the Lumber I phase, there were no policy deviations from free trade that require consideration.

CHAPTER EIGHT

POLICY ANALYSIS

8.1. Assessing the Policy Impact within Each Period

To determine the policy impact on market variables and welfare levels, we first calculate counterfactuals according to the methodology in chapter 7, and then compare them with the actual levels. Appendix D reports these changes in welfare variables on a year-by-year basis and table 4-a and 4-b shows the average results for each policy regime.

Table 4-a shows that relative to free trade all of the policies regimes lower the Canadian price and, thereby, increased Canadian consumption, decreased production and reduced exports. By contrast, all the policy regimes raised the U.S. price, reduced consumption, increased production and decreased imports. The percentage impact is systematically largest under the SLA, next largest under Lumber V, third largest under the MOU and smallest under Lumber III. These results at least roughly correspond with the sizes of the tax rates. Under the SLA (Lumber IV), the export tax on the low fee base was $50 per thousand board feet, and the tax on the high fee base was $100 per thousand board feet. Averaging over the SLA period, the equivalent *ad valorem* tax rate were 20.01% and 40.15%, respectively. Under Lumber V the combined CVD and ADD was lower and amounted to 27.22%. Under the MOU (Lumber II) the export tax rate was 15%, which in turn was higher than the CVD of 6.5% under Lumber III.

Table 4-a: The Average Market Impact

Changes in Canadian Variables				Changes in U.S. Variables			
Price	*Consumption*	*Production*	*Export*	*Price*	*Consumption*	*Production*	*Import*
Lumber II--MOU: 15% Export Tax							
-16.82	600.03	-556.09	-1156.11	11.45	-655.45	500.66	-1156.11
(-8.74)	(8.87)	(-2.3)	(-6.68)	(4.95)	(-1.38)	(1.42)	(-9.6)
Lumber III: 6.5% CVD							
-10.79	270.36	-250.57	-520.93	7.81	-295.34	225.59	-520.93
(-4.04)	(4.17)	(-1)	(-2.79)	(2.20)	(-0.62)	(0.66)	(-3.84)
Lumber IV--SLA: low export tax $50 per thousand bf (20.01%), high tax $100 per thousand bf (40.15%)							
-61.55	1445.92	-1340.04	-2785.96	42.11	-1579.48	1206.48	-2785.96
(-19.8)	(21.91)	(-4.48)	(-12.01)	(12.4)	(-2.87)	(3.44)	(-14.02)
Lumber V: 27.22% ADD/CVD							
-32.81	1033.58	-957.89	-1991.47	27.44	-1129.05	862.42	-1991.47
(-14.6)	(13.38)	(-3.18)	(-8.89)	(8.68)	(-2.03)	(2.50)	(-9.41)

Note: Price changes in 1997 U.S. dollars per thousand board feet.
Quantity changes in millions of board feet.
Variables in parentheses are percent change from the values under the free trade;
Changes in Canadian exports must be equal in magnitude to changes in U.S. imports in equilibrium, but the percent changes are different because of Canadian net exports to the rest of the world and U.S. net imports from the rest of the world.

Detailed results for changes in welfare are shown in table 4-b. As predicted by the earlier theoretical analysis in chapter 5, U.S. producers gain and U.S. consumers lose from each of the policies. In the case of the MOU and the SLA, overall welfare falls in U.S. because there is no change in government revenue to offset the net loss of the private sector. In the case of Lumber III and Lumber V, however, overall welfare in the U.S. rises because

the terms of trade gain from buying softwood lumber at lower prices exceeds the distortionary losses.

Table 4-b: Average Welfare Changes (in million 1997 U.S. dollars)

	Canada						U.S.				Total
ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II--MOU: 15%										
120.83	-402.42		-402.42	291.45	9.87	-540.32	406.64		-133.68	-123.82
Lumber III Average: 6.5%										
71.86	-271.51		-271.51		-199.65	-374.08	267.38	221.86	115.17	-84.48
Lumber IV--SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)										
455.2	-1802.83	1502.5	-300.33	201	355.87	-2281.51	1504.4		-777.11	-421.24
Lumber V---ADD/CVD Average: 27.22%										
269.98	-973.2		-973.2		-703.22	-1510.15	957.3	1003.55	450.7	-252.53

Note: ΔCS refers to the changing of the consumer surplus for both Canada and the U.S;
ΔPS refers to the changing of the producer surplus for both Canada and the U.S;
ΔQR refers to the changing of the lumber production in Canadian four covered provinces under the SLA;
ΔGR refers to the government revenue under the different kind of policies; and,
ΔTS refers to the net effects for Canadian, the U.S. and two counties' total welfare.

On the Canadian side, consumers always gain and producers always lose relative to free trade. Overall, Canada experienced welfare gains under the MOU and SLA where it collects tax revenue and/or obtains export-restrictions rents, but its welfare declines under Lumber III and Lumber V. The combined welfare of Canada and the U.S. declines in each case due to the policy distortion. Even under the SLA where the producers obtain rents from the restrictions from the export quota, the overall impact on producer involved

a loss of $300.33 million. This result, which was obtained on the basis of updated estimation of demand and supply parameters, strong contrasts with the findings of overall producer gains in Kinnucan and Zhang (2003). It should be observed, however, that Canadian producer losses amounted to average $402 million per year under the MOU and $973 million under Lumber V in 2001. Thus, Canadian producers lost less on average during the SLA even though the higher export tax, which averaged 30.3%, exceeded both the 15% export tax under the MOU and the 27.22% tariff under Lumber V.

8.2. Comparing the Four Alternative Policies Regimes in 2001

To facilitate comparisons of the policy regimes, it is useful to examine how each policy would have affected the North American economy in a common year, say 2001. Table 5-a reports market results for each regime for 2001 and table 5-b reports the corresponding welfare results. For each policy regime, the actual tax rates are used in the calculations. (Appendix E provides a similar comparison based on a hypothetical average year constructed from sample as a whole.)

Table 5-a: Market Comparisons for 2001with Actual Tax Rates

Changes in Canadian Variables				Changes in U.S. Variables			
Price	Consumption	Production	Export	Price	Consumption	Production	Import
Lumber II--MOU: 15% export tax							
-19.68	600.03	-556.09	-1156.11	15.65	-655.45	500.66	-1156.11
(-8.74)	(7.77)	(-1.85)	(-5.16)	(4.95)	(-1.18)	(1.45)	(-5.46)
Lumber III: 6.5% CVD							
-9.09	270.36	-250.57	-520.93	6.96	-295.34	225.59	-520.93
(-4.04)	(3.5)	(-0.83)	(-2.33)	(2.2)	(-0.53)	(0.65)	(-2.46)
Lumber IV--SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)							
-60.01	2033.89	-1884.96	-3918.84	56.27	2221.76	1697.09	-3918.84
(-26.65)	(26.33)	(-6.26)	(-17.49)	(17.8)	(-4)	(4.93)	(-18.52)
Lumber V: 27.22% ADD/CVD							
-32.81	1033.58	-957.89	-1991.47	27.44	-1129.05	862.42	-1991.47
(-14.57)	(13.38)	(-3.18)	(-8.89)	(8.68)	(-2.03)	(2.50)	(-9.41)

Note: Price changes in 1997 U.S. dollars per thousand board feet.
Quantity changes in millions of board feet.
Variables in Parentheses are percent change from the values under the free trade;
Export and Imports refers to the Canadian lumber Export Supply to the U.S. and those two variables supposed to be same for each year.

For a common year, the market effects depend exclusively on the size of tax rate. Consequently, the SLA has a greatest market effect because the tax on the high fee base would have amounted to 60.6% given the circumstances in 2001. This far exceeds 27.22% ADD/CVD under Lumber V, the 15% export tax under the MOU and the 6.5% CVD under Lumber II.

Table 5-b shows that U.S. producers would have experienced the largest gain under the SLA $1987 million, the next largest gain under the ADD/CVD regime of Lumber V $957 million, the third largest gain under the MOU of Lumber II $543 and the smallest gain under the CVD of Lumber III $240 million. Analogously, U.S. (Canadian) consumers would have received the largest loss (gain) under the SLA, the next largest loss (gain) under Lumber V, the third largest loss (gain) under the MOU and the smallest loss (gain) under Lumber III.

Table 5-b: Welfare Comparisons for 2001 with Actual Tax Rates (in million U.S. dollars)

	Canada					U.S.				Total
ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II—MOU Average: 15% export tax										
157.8	-587.34		-587.3	616.54	187.00	-865.14	543.13	-322.02	-135.02	
Lumber III Average: 6.5% CVD										
71.42	-272.66		-272.7		-201.2	-385.92	240.51	289.85	144.45	-56.79
Lumber IV-- SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)										
521.43	-1754.2	1504.03	-221.4	250.14	492.68	-3064.4	1987.31		1077.12	
Lumber V---ADD Average: 27.22% ADD/CVD										
269.98	-973.2		-973.2		-703.2	-1510	957.3	1003.55	450.7	-252.5

Note: ΔCS refers to the changing of the consumer surplus for both Canada and the U.S;
ΔPS refers to the changing of the producer surplus for both Canada and the U.S;
ΔQR refers to the changing of the lumber production in Canadian four covered provinces under the SLA;
ΔGR refers to the government revenue under the different kind of policies; and,
ΔTS refers to the net effects for Canadian, the U.S. and two counties' total welfare.

The impact on Canadian producers, however, is complicated by the export quota rents under the SLA. Even though the SLA tax is the highest, Canadian producers would have experienced the smallest overall loss, $221 million, under the SLA. Thereafter, the losses to Canadian producers escalate as we consider regimes with higher tax rates. Under

Lumber III, the loss would have been $272 million; under the MOU, it would have been $587 million; and under Lumber V, it would have been $973 million. Ironically, Canadian producers who lobbied aggressively for the termination of the SLA on March 31, 2001, found themselves in the least favorable regime rather than the most favorable regime.

Relative to free trade, overall Canadian welfare in 2001 would have been highest under the SLA, still positive under the MOU, negative under Lumber III and more negative under Lumber V. The opposite pattern holds for overall U.S. welfare. The distortionary loss to North America as a whole escalates with the tax rate. Thus, the overall loss in North America is lowest under Lumber III, rises under Lumber II, rises further under Lumber V and is highest under Lumber IV.

8.3 Comparing the Four Alternative Policies Regimes in 2001 Using a Common Tax Rate

The differing structures of the four policies regimes make it worthwhile to draw comparisons with a common tax rate. In Tables 6-a and 6-b, we examine the situation that would have prevailed in 2001 if the tax rate had been at the Lumber V rate, 27.22%, in all four regimes. For the SLA 27.22% is taken to be the rate on the high fee base above 15.35 bbf and 13.61% is the rate on the low fee base between 14.7 bbf and 15.35 bbf.

Table 6-a: Market Comparison for 2001 with a Common Tax Rate

Changes in Canadian Variables				Changes in U.S. Variables			
Price	Consumption	Production	Export	Price	Consumption	Production	Import
Lumber II--MOU: 27.22% export tax							
-32.81	1033.56	-957.89	-1911.47	27.44	-1129.05	862.42	-1911.47
(-14.57)	(13.38)	(-3.18)	(-8.89)	(8.68)	(-2.03)	(2.5)	(-9.41)
Lumber III: 27.22% CVD							
-32.81	1033.56	-957.89	-1911.47	27.44	-1129.05	862.42	-1911.47
(-14.57)	(13.38)	(-3.18)	(-8.89)	(8.68)	(-2.03)	(2.5)	(-9.41)
Lumber IV--SLA: 13.61% low export tax, 27.22% high							
-32.81	1033.56	-957.89	-1911.47	27.44	-1129.05	862.42	-1911.47
(-14.57)	(13.38)	(-3.18)	(-8.89)	(8.68)	(-2.03)	(2.5)	(-9.41)
Lumber V: 27.22% ADD/CVD							
-32.81	1033.56	-957.89	-1911.47	27.44	-1129.05	862.42	-1911.47
(-14.57)	(13.38)	(-3.18)	(-8.89)	(8.68)	(-2.03)	(2.5)	(-9.41)

Note: Price changes in 1997 U.S. dollars per thousand board feet.
Quantity changes in millions of board feet.
Variables in Parentheses are percent change from the values under the free trade;
Export and Imports refers to the Canadian lumber Export Supply to the U.S. and those two variables supposed to be same for each year.

With identical tax rate in all regimes, of course, the market effects are identical in all regimes as reported in table 6-a. Similarly in table 6-b, the impacts on U.S producers, U.S. consumers, Canadian consumers and joint North America welfare is identical across the regimes.

Table 6-b: Welfare Comparisons with a Common Tax Rate (in million U.S. dollars)

	Canada					U.S.				Total
ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II--MOU: 27.22% export tax										
269.98	-973.2		-973.2	1003.55	300.33	-1510.15	957.3		-552.86	-252.53
Lumber III: 27.22% CVD										
269.98	-973.2		-973.2		-703.22	-1510.15	957.3	1003.55	450.7	-252.53
Lumber IV-- SLA Average: 27.22%										
269.98	-973.2	786.81	-186.4	216.75	300.33	-1510.15	957.3		-552.86	-252.53
Lumber V: 27.22% ADD/CVD										
269.98	-973.2		-973.2		-703.22	-1510.15	957.3	1003.55	450.7	-252.53

Note: ΔCS refers to the changing of the consumer surplus for both Canada and the U.S;
ΔPS refers to the changing of the producer surplus for both Canada and the U.S;
ΔQR refers to the changing of the lumber production in Canadian four covered provinces under the SLA;
ΔGR refers to the government revenue under the different kind of policies; and,
ΔTS refers to the net effects for Canadian, the U.S. and two counties' total welfare.

Since the U.S. government obtains the tax revenue in Lumber III and Lumber V overall U.S. welfare is equal and positive for these two regimes. By contrast, the Canadian government does not collect any revenue in these cases. As a result, Canada experiences negative but equal overall welfare changes in Lumber III or V. The situation is reversed in Lumber II and IV. Here, the U.S. government does not obtain any revenue, resulting in negative but equal overall welfare changes in Lumber II and IV. For Canada the export tax revenue under the MOU (Lumber II) is exactly equal to the sum of export tax revenue and export quota rents under the SLA (Lumber IV). Consequently, the overall effect of the MOU and the SLA on Canadian welfare is the same and positive.

The impact of the alternative policy regime on Canadian producers is more interesting. While Canadian producers lose the same amount, $973 million, under Lumber II, III and V with the common 27.22% tax rates, they experience a much smaller loss, $186 million, under Lumber IV because they receive substantive export quota rents of, $786 million. This suggests that, in terms of basic structure, an export tax quota regime styled after the SLA should be strongly preferred by Canadian producers. Of course, the calculated effects on Canadian producers show that pure free trade may be even better than any such export tax quota regime. Recall that on average Canadian producers lost $300 million per year relative to free trade under the actual SLA (see Table 4-b), they would have lost $221 million in 2001 if the SLA had still been in effect (see Table 5-b), and they would have lost $186 million in 2001 if the high and low tax rates had been reduced to 27.22% and 13.61% from 60.6% and 30.3% (see Table 6-b). Given political realities in U.S., however, it appears problematic for Canadian producers to expect the U.S. to trade freely with a high probability. If free trade is an unlikely outcome, Canadian producers may wish to reconsider the relative merits of new export tax quota regime with the similar structure to the SLA, hopefully at lower tax rates. It should be emphasized that, while U.S producers always prefer higher tax rates, they are indifferent between regimes with equal tax rates. For them, an export tax quota regime is no better or worse than any other regime.

8.4. Sensitivity Analysis

Sensitivity analyses are performed by considering alternative values for some demand and supply parameters, while keeping the other parameters at their estimated values. As shown in table 3, Kinnucan and Zhang (2003) suggest that most reasonable estimates of

demand and supply elasticities are 0.17 and 0.40 respectively based on previously empirical work for the U.S. Similarly, they suggest that an elasticity of U.S. import demand of 1.28 and a Canadian elasticity of export supply of 0.90 are a reasonable reflection of the earlier empirical literature. Four types of sensitivity tests are performed based on these elasticities and the results are reported in Appendix F. In the first tests, we keep the estimated supply parameters, but recalibrate the demand side of the model to yield an average elasticity of demand of 0.17 in both countries over the SLA years. [9] In the second tests, the demand parameters are left unchanged but the supply side is changed so that the average elasticities of supply are 0.4 in both countries in the SLA years. In the third tests, we recalibrate the model so that both demand elasticities are 0.17 and both supply elasticities are 0.4. In the fourth tests, both countries demand elasticities are 0.17, but the supply parameters of the model are changed such that Canada's elasticity of export supply is 0.90 and the U.S. elasticity of import demand is 1.28. This fourth sensitivity tests calibrates the model to provide a reasonable close replication of Kinnucan and Zhang (2003). For all four types of tests, we consider alternative results both for the period that each policy was actually in place and for the effect the each policy would have had in 2001.

While the sensitivity tests do not cause qualitative changes in the impact of the policies on market prices and quantities, Table F1 in Appendix F shows that there are frequently substantive quantitative changes. This is especially true with respect to Canadian consumption where the quantitative impact of the various policies tends to be much

[9] In the current log-linear formulation of demand and supply, we search for alternative price coefficients until we obtain the target elasticity using equation (6.7) when average over the SLA period. We average over the SLA period rather than the sample as a whole so as to provide the closest possible comparisons to Kinnucan and Zhang (2003).

smaller in tests 1, 3 and 4 because of the significant reduction in Canada's elasticity of demand from 0.82 in the SLA years to 0.17. The impact of the policies on U.S. consumption in tests 1, 3 and 4 also tends to be smaller because the U.S. elasticity of demand is reduced from 0.25 to 0.17. By contrast, the impact of policy on U.S. production tends to be larger in tests 2, 3 and 4 because the U.S. elasticity of supply is increased from 0.29 to 0.40 in test 2 and 3 and to 0.35 in test 4. The increase in the Canadian elasticity of supply from 0.21 to 0.40 in tests 2 and 3 leads to a greater policy impact on Canadian production. This is even more dramatic in test 4 where the elasticity increases to 0.60 and the policy impact on Canadian production more than double.

In spite of the fact that market prices and quantities are quite sensitive to variations in demand and supply parameters, the welfare results in Table F2 in Appendix F appear to be much less sensitive. Wear and Lee (1993) and Zhang (2001) also contend that the welfare results are not highly sensitive to changes in demand and supply parameters. Changes in the parameters generally cause changes in welfare gains and losses of less than 20%. The impact of variations in the demand and supply parameters, however, does have a more substantive impact on the overall losses of Canadian producers under the SLA. While the variations in producer surplus *per se* under the SLA remain minimal, the addition of substantive and invariant export quota rents leads to larger percentage variations in overall producer welfare. Nevertheless, the overall impact on producers generally remains negative regardless of the demand and supply parameters. This is true even with the Kinnucan and Zhang (2003) parameters in test 4 where producers are predicted to have experienced a small overall loss of an average of $9.21 million per year during the SLA period. This contrasts with the gain of $450 million reported by

Kinnucan and Zhang (2003). If the SLA had remained in place in 2001, however, Canadian producers would have an experienced a small overall gain of $88 million under the parameter values of test 4.

CHAPTER NINE

CONCLUSION

During the Canada-U.S. softwood lumber dispute, three broad types of trade policy instruments have been used: tariffs or import taxes; export taxes; and quantitative export restrictions, which have similarities with Voluntary Export Restraints (VERs). The dispute has gone through five distinct phases. During Lumber I (1982-1983), U.S. authorities ruled against countervailing duties, and free trade remained in effect despite the protest of U.S. producers. In Lumber II (1986-1991), Canada and U.S. reached a Memorandum of Understanding (MOU), which required Canada to impose an export tax. In Lumber III (1991-1996), the U.S. imposed a tariff in the form of a countervailing duty. During Lumber IV (1996-2001), the Softwood Lumber Agreement (SLA) resulted in an export tax quota system that blended features of export taxes and VERs. Lumber V (2001-present) saw the return of a U.S. tariff, which consisted of an Antidumping Duty (ADD) and Countervailing Duty (CVD). The policies of the Lumber II-V phases have succeeded in restricting Canadian softwood lumber exports to U.S. market. Since this has caused increases in U.S. lumber prices, there have been subsequent increases in U.S. softwood lumber production and increased substitution of other materials such as steel and concrete in U.S. housing construction.

The primary contribution of this thesis has been to provide a systematic analysis of each phase of the Canada-U.S. softwood lumber dispute. Under Lumber III and Lumber V, welfare was transferred from Canadian producers and U.S. consumers to U.S. producers and the U.S. treasury. The U.S. is a large country that affects lumber prices throughout

the world and could potentially experience an overall welfare gain from restricting imports. The quantitative analysis shows that, relative to free trade, U.S. welfare did rise by an average of $115 million per year under Lumber III and by $450 million in 2001 under Lumber V. Under the MOU of Lumber II, the Canadian treasury rather than the U.S. treasury gained. Welfare was transferred from Canadian producers and U.S. consumers to the Canadian treasury and U.S. producers. Due to the influence of export taxation on U.S., as well as Canadian, lumber prices Canadian welfare rose by an average of $9.87 million per year.

The analysis of the Lumber IV phase from 1996 to 2001 when the Softwood Lumber Agreement (SLA) was in effect is of particular importance. Recent works by Zhang (2001) and Kinnucan and Zhang (2003) have shown that is theoretically possible for Canadian producers to have gained under the SLA. While Canadian producers are harmed by a lower Canadian price, they gain rents from quota system governing exports. Further, Kinnucan and Zhang (2003) argue that the Canadian producers did experience overall gains during the SLA phase, but they used elasticities of demand and supply that they admit could now be out of date. This analysis suggests that is very unlikely that Canadian producers gained relative to free trade from the SLA policy during the Lumber IV phase. While Canadian welfare rose by an average of $356 million per year during Lumber IV, Canadian producers experienced an average overall loss of $300 million per year.

Kinnucan and Zhang (2003) suggest the importance of re-estimating demand and supply parameters for Canada and the U.S. This thesis has provided major step in this direction

using simultaneous equation methods rather than ordinary least squares. Nevertheless, the unexpectedly large difference between Canadian and U.S. elasticities of demand indicates that there is still further empirical research necessary. It would also be very helpful to return to the sub-national approach used by Adams and Haynes (1996), but expand it to allow supply side difference between provinces in Canada. This could be particularly important to our understanding of the SLA because only the four largest exporting provinces were subjected to export restrictions. Further research might also be useful in addressing whether there is substance to U.S. claims of dumping and subsidization. Certainly, this thesis suggests that there may be significant rent seeking, as well as lobbying, by both Canadian and U.S. lumber producers.

This thesis has important implications for policy formulation in both Canada and the U.S. Whatever the merit of U.S. claims of dumping and subsidization, it may be naïve to expect free trade in softwood lumber in the near future. Even if trade is likely to be driven by producer interests on both sides of border, there appear to be grounds for consensus as well as conflict. On the one hand, for given taxes, U.S. producers are no worse off with an export tax regime such as the SLA. On the other hand, Canadian producers are much better off with an export tax quota regime where they obtain the export restrictions rents. For example, it is estimated that Canadian producers lost $973 million in 2001 under the 27.22% antidumping and countervailing duties of the Lumber V regime. By contrast, the Canadian producers would have only lost $186 million in 2001 under an export tax quota regime similar to the SLA but with a high export tax of 27.22%. In both cases U.S. producers would have gained $957 million relative to free trade. Consequently, in the face of current political reality, a new agreement similar to the SLA may be the best way

to manage Canada-U.S. softwood lumber trade. Of course, Canadian producers would prefer the lowest possible tax rate on Canada-U.S. softwood lumber trade, but U.S. producers would clearly prefer the high possible rate.

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Appendix A:

Glossary

The notation in the figures:

P_{ca0} = the Canadian Autarky lumber price

P_{ca1} = the Canadian domestic lumber price under free trade

P_{ca2} = the Canadian domestic lumber price under trade restrictions

P_{ca3} = the Canadian domestic lumber price under the SLA

$\tilde{P}$ = the international market (export/import market between Canada and U.S.) lumber price under trade restrictions

P_{us0} = the U.S. Autarky lumber price

P_{us1} = the U.S. domestic lumber price under free trade

P_{us2} = the U.S. domestic lumber price under trade restrictions

P_{us3} = the U.S. domestic lumber price under the SLA

$P_{ca3}+50$ = the U.S. domestic lumber price under the SLA when lumber imports are between 14.7bbf and 15.35 bbf

$P_{us3}= P_{ca3}+100$ = the U.S. domestic lumber price under the SLA when lumber imports are above 15.35 bbf

D_{ca} = the Canadian domestic lumber demand curve

S_{ca} = the Canadian domestic lumber supply curve

DM_{us} = the Excess Demand curve in the international lumber market (also means the U.S. import demand)

SX_{ca} = the Excess Supply curve in the international lumber market (also means the Canadian export supply)

D_{us} = the U.S. domestic demand curve

S_{us} = the U.S. domestic supply curve

t = the tax rate

Qd_{ca1}, Qs_{ca1} = the Canadian domestic demand and supply quantities respectively under free trade

Qd_{ca2}, Qs_{ca2} = the Canadian domestic demand and supply quantities respectively under the trade restrictions

Qd_{ca3}, Qs_{ca3} = the Canadian domestic demand and supply quantities respectively under the SLA

Qs_{us1}, Qd_{us1} = the U.S. domestic supply and demand quantities respectively under free trade

Qs_{us2}, Qd_{us2} = the U.S. domestic supply and demand quantities respectively under the trade restrictions

Qs_{us3}, Qd_{us3} = the U.S. domestic supply and demand quantities respectively under the trade restrictions

Qt_1 = the quantity of the Excess Supply in the international lumber market under free trade

Qt_2 = the quantity of the Excess Demand in the international lumber market under trade restrictions

Qt_3 = the quantity of the Excess Demand in the international lumber market under the SLA

Where:

$\mathbf{Qt_2 = Qs_{ca2} - Qd_{ca2} = Qd_{us2} - Qs_{us2}}$ and $\mathbf{Qt_1 - Qt_2 = (Qd_{ca2} - Qd_{ca1}) + (Qs_{ca1} - Qs_{us2})}$ $\mathbf{= (Qs_{us2} - Qs_{us1}) + (Qd_{us1} - Qd_{us2})}$ if we ignore trade with the rest of the world.

Appendix B:

The Stationary Test

Table B1: Stationary test

Variables	First Order Difference		Levels	
Canada	**-2.989(5%)**	**-2.625(10%)**	**-2.986(5%)**	**-2.624(10%)**
Production	-5.263		-1.107	
Consumption	-6.285		-1.857	
Lumber Price	-6.326		-2.332	
5-Year Mortgage Rate	-4.024		-1.352	
Housing Starts	-5.934		-1.981	
Disposable Income	-3.189		-1.056	
Hourly Earnings	-3.532		-2.321	
Steel Price	-2.678		-1.98	
U.S.	**-2.989(5%)**	**-2.625(10%)**	**-2.986(5%)**	**-2.624(10%)**
Production	-4.115		-1.728	
Consumption	-3.66		-0.941	
Lumber Price	-4.889		-1.517	
30-Year Mortgage Rate	-3.631		-1.162	
Housing Starts	-6.698		-3.757	
Disposable Income	-3.001		-6.583	
Hourly Earnings	-2.787		-1.801	
Steel Price	-3.082		-3.158	

Natural Log From:	First Order Difference		Levels	
Canada	**-3.000(5%)**	**-2.630(10%)**	**-2.986(5%)**	**-2.624(10%)**
ln-lumber Price	-1.261		-2.59	
Ln-5-year Mortgage Rate	-1.65		-1.315	
ln-housing starts	-0.917		-2.13	

ln-Disposable incomes	-2.739	-4.981
ln-Hourly Earnings	-5.094	-4.758
ln-Steel Price	-9.59	-4.15
U.S.	**-3.000(5%) -2.630(10%)**	**-2.986(5%) -2.624(10%)**
ln-lumber Price	-4.502	-2.697
Ln-30-year Mortgage Rate	-5.156	-1.145
ln-housing starts	-2.951	-3.536
ln-Disposable incomes	-3.308	-6.713
ln-Hourly Earnings	-2.71	-5.811
ln-Steel Price	-3.231	-4.797

The above table shows that most of the variables are non-stationary in both levels and natural logarithms. In first-order differences, however, all of the variables are shown to be stationary at least at 10% level. It is possible to avoid the difficulties of formulating and interpreting a demand and supply system in first difference because there exists a co-integrating relationship between the independent variables. Thus, in the text, we continue to formulate the demand and supply model in levels.

Co-Integrating Test

1. Regress Price on all other independent variables and get the residuals. (Cross Canada-U.S. refers to regress Canadian price on all Canadian and U.S. predetermined variables.

2. Take a unit root test on the residuals. If the residuals are stationary, there is a co-integrating relationship among all explanatory variables in the demand and supply system in the model used in this paper.

Table B2: Co-integrating test result

	-2.986(5%)	-2.624(10%)
Canada	-4.50	
Cross (Canada-U.S.)	-4.575	
U.S.	-2.627	
Cross(U.S.-Canada)	-3.937	

From the above results we can see that all test values are greater than the critical values at least at 10% level. Consequently, there exists a co-integrating relationship among all explanatory variables in the demand and supply system.

Appendix C:

Comparison of 3SLS and 2SLS Estimates of Parameters

Table C: Covariance Comparison between 3SLS and 2SLS

		3SLS		2SLS	
Eqaution	**Coefficient of**	**Coefficient Estimate**	**Covariance of Coefficient Estimator with Lumber Price**	**Coefficient Estimate**	**Covariance of Coefficient Estimator with Lumber Price**
Canadian Consumption	5-Year Mortgage rate	-75801.15	0.0014	-69983.25	0.9122
	Housing Starts	443.4063	0.0135	548.498	0.6435
	Disposable Income	-9277.204	0.0099	-5951.324	0.6754
	Steel Price	16818.78	-0.0073	12351.03	-0.7549
	Constants	34701.12	-0.008	25352.34	-0.8629
Canadian Production	Sawmill Worker's Hourly Earnings	8163.591	-0.7737	7372.691	-0.7807
	Constants	-34769.7	-0.9685	-48852.38	-0.9698
U.S. Consumption	30-Year Mortgage rate	-142846.3	0.5183	-117680.1	0.908
	Housing Starts	13708.85	-0.5221	15758.8	-0.8018
	Disposable Income	10931.06	-0.5015	12153.42	-0.8192
	Steel Price	11268.96	-0.7074	6418.652	-0.9527
	Constants	-122274.4	0.2544	-143925.1	0.419
U.S. Production	Sawmill Worker's Hourly Earnings	-5711.78	-0.9665	-19606.06	-0.9785
	Constants	-12391.86	-0.9899	-70777.15	-0.9936

From above table we can see that in all cases three stage least squares (3SLS) parameter estimates have smaller covariance with parameter estimates of the domestic lumber price than do their two stage least squares (2SLS) counterparts. The 3SLS method can be shown to yield more efficient parameter estimates than does 2SLS because 3SLS takes into account cross-equation correlation. The gain in efficiency associated with 3SLS is

usually in the neighborhood 5 percent (See table 2 in this paper). In the current paper, therefore, 3SLS is selected to estimate the model.

Appendix D:

The annually estimated welfare effects

Table D: The estimated welfare effects for Canada and the U.S. (In million U.S. dollars)

	Canada						U.S.				Total
	ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II—MOU:											
1986	83.3	-323.22		-323.22	280.21	40.3	-493.93	357.05		-136.88	-96.58
1987	127.8	-409.69		-409.69	326.72	44.83	-562.93	411.13		-151.8	-106.98
1988	134.8	-426.11		-426.11	306.15	14.84	-558.45	418.48		-139.98	-125.14
1989	141.54	-457.78		-457.78	345.25	29.01	-584.98	433.49		-151.49	-122.48
1990	122.32	-397.71		-397.71	238.31	-37.09	-534.73	424.4		-110.33	-147.42
1991	115.25	-399.99		-399.99	252.07	-32.67	-506.92	395.29		-111.63	-144.3
Average:											
	120.83	402.42		-402.42	291.45	33.56	-540.32	406.64		-133.69	-123.82
Lumber III:											
1992	62.27	-217.99		-217.99		-155.72	-287.92	217.68	153.56	83.32	-72.4
1993	83.72	-311.09		-311.09		-227.37	-401.79	290.64	250.68	139.52	-87.85
1994	83.93	-310.66		-310.66		-226.73	-429.17	305.48	259.5	135.81	-90.92
1995	57.5	-246.29		-246.29		-188.79	-377.43	255.74	223.72	102.03	-86.76
Average:											
	71.86	-271.51		-271.51		-199.65	-374.08	267.38	221.86	115.17	-84.48
Lumber IV--- SLA											
1996:	353.83	-1717.7	1502.5	-215.2	113.89	252.52	-1879.83	1238.87		-640.96	-388.44
1997:	435.69	-1745.81	1502.5	-243.31	105.07	297.45	-2174.89	1464.31		-710.59	-413.14
1998:	429.05	-1699.04	1502.5	-196.54	227.18	459.69	-2448.55	1595.75		-852.8	-393.12
1999:	498.95	-1947.18	1502.5	-444.68	265.2	319.48	-2367.13	1570.84		-796.29	-476.82
2000:	558.48	-1904.4	1502.5	-401.9	293.67	450.24	-2537.17	1652.25		-884.91	-434.67

	Canada						U.S.				Total
	ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Average:											
	455.2	-1802.83	1502.5	-300.33	201	355.87	-2281.52	1504.4		-777.11	-421.24
Lumber V---ADD:											
2001:	269.98	-973.2		-973.2		-703.22	-1510.15	957.3	1003.55	450.7	-252.53

Note: ΔCS refers to the changing of the consumer surplus for both Canada and the U.S.
ΔPS refers to the changing of the producer surplus for both Canada and the U.S.
ΔPR refers to the changing of the production in Canada.
ΔQR refers to the changing of the lumber production in Canadian four covered provices under the SLA
ΔGR refers to the government revenue under the different kind of policies.
ΔTS refers to the Canadian, the U.S. and both two counties' total welfare changing.

Appendix E:

Market impacts and welfare effects for a typical year

In the text, we compare how each of the policies would have affected the economy of North America in 2001. We can also compare policies for a typical year constructed by averaging over the sample. Table D1 reports markets results for each regime for a typical year, and table D2 reports the corresponding welfare results. For each policy regime, the actual tax rates are used in the calculations.

TableE1: The Market Impact for a Typical Year

Canada				U.S.			
Price	**Consumption**	**Production**	**Exports**	**Price**	**Consumption**	**Production**	**Import**
Lumber II : 15% export tax rate							
-15.11	600.03	-556.09	-1156.11	12.02	-655.45	500.66	-1156.1
-8.74	-8.76	-2.65	-8.16	-4.95	-1.52	1.52	-11.33
Lumber III: 6.5% CVD							
-6.98	270.36	-250.57	-520.93	5.34	-295.34	225.59	-520.93
-4.04	-3.95	-1.19	-3.68	-2.2	-0.68	0.68	-5.11
Lumber IV--SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)							
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
Lumber V: 27.22% ADD/CVD							
-25.19	1033.58	-957.89	-1991.47	21.07	-1129.05	862.42	-1911.5
-14.57	15.09	-4.56	-14.06	-8.68	-2.61	-2.61	-19.52

Note: Price changes in 1997 U.S. dollars per thousand board feet.
Quantity changes in millions of board feet.
Variables on the second line are percent change from the values under the free trade;
Export and Imports refers to the Canadian lumber Export Supply to the U.S. and those two variables supposed to be same for each year.

It is interesting to note that free trade imports of softwood lumber into the U.S. amounted to 10.2 bbf for a typical constructed by averaging over the sample. This would imply that even the low 14.7 bbf quota on imports from Canada would be non-binding.

Consequently the actual configuration of the SLA would allow free trade to continue in a typical year. As a result tables E1 and E2 show that the SLA has no impact on market and welfare variables in such a typical year.

Table E2: Welfare Changes for a Typical Year (in million U.S. dollars)

	Canada					U.S.				Total
ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II—MOU Average: 15% export tax										
107.92	-313.31		-313.31	214.13	8.74	-515.55	399.94		-1.16	-106.87
Lumber III Average: 6.5% CVD										
48.73	-145.77		-145.77		-97.04	-230.19	177.07	104.42	51.3	-45.74
Lumber IV-- SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)										
0	0	0	0	0	0	0	0	0	0	0
Lumber V---ADD Average: 27.22% ADD/CVD										
185.22	-517.67		-517.67		-332.45	-898.79	705.08	330.15	136.45	-196.01

Note: ΔCS refers to the changing of the consumer surplus for both Canada and the U.S;
ΔPS refers to the changing of the producer surplus for both Canada and the U.S;
ΔQR refers to the changing of the lumber production in Canadian four covered provinces under the SLA;
ΔGR refers to the government revenue under the different kind of policies; and,
ΔTS refers to the net effects for Canadian, the U.S. and two counties' total welfare.

Appendix F:

Sensitivity Test on the market impacts

Table F1: the sensitivity of the estimated average market impact under the different policies and the comparison (in U.S. 1997 dollars, mbf)

	Canada				U.S.			
	Price	Consumption	Production	Exports	Price	Consumption	Production	Imports
Lumber II : 15% export tax rate								
Basic:								
	-16.82	600.03	-556.09	-1156.11	11.45	-655.45	500.66	-1156.11
	-8.74%	8.73%	-2.30%	-6.66%	4.95%	-1.38%	1.42%	-9.39%
Test 1								
	-18.68	136.91	-614.57	-751.48	9.22	-350.41	401.07	-751.48
	-9.61%	1.87%	-2.53%	-4.43%	3.95%	-0.74%	1.13%	-6.31%
Test 2								
	-15.62	559.24	-971.44	-1530.68	12.88	-739.73	790.95	-1530.68
	-8.17%	8.09%	-3.94%	-8.64%	5.61%	-1.55%	2.26%	-12.06%
Test 3								
	-16.67	122.84	-1033.52	-1156.36	11.63	-444.38	711.99	-1156.36
	-8.67%	1.67%	-4.18%	-6.67%	5.03%	-0.94%	2.03%	-9.39%
Test 4								
	-13.84	102.75	-1289.08	-1391.83	15.03	-578.60	813.23	-1391.83
	-7.30%	1.39%	-5.17%	-7.92%	6.60%	-1.22%	2.33%	-11.09%
Lumber III: 6.5% CVD								
Basic:								
	-10.79	270.36	-250.57	-520.93	7.81	-295.34	225.59	-520.93
	-4.04%	4.16%	-0.99%	-2.78%	2.20%	-0.62%	0.66%	-3.78%
Test 1:								
	-11.95	61.69	-276.92	-338.61	6.27	-157.89	180.72	-338.61
	-4.45%	0.92%	-1.10%	-1.82%	1.76%	-0.33%	0.53%	-2.49%
Test 2:								
	-10.05	251.99	-437.72	-689.70	8.80	-333.31	356.39	-689.70
	-3.77%	3.87%	-1.72%	-3.65%	2.49%	-0.70%	1.05%	-4.94%
Test 3:								
	-10.70	55.35	-465.69	-521.04	7.93	-200.23	320.81	-521.04
	-4.00%	0.83%	-1.83%	-2.78%	2.24%	-0.42%	0.94%	-3.78%
Test 4:								
	-13.84	102.75	-1289.08	-1391.83	15.03	-578.60	813.23	-1391.83
	-7.30%	1.39%	-5.17%	-7.92%	6.60%	-1.22%	2.33%	-11.09%
Lumber IV—SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)								
Basic:								
	-61.55	1445.92	-1340.04	-2785.96	42.11	-1579.48	1206.48	-2785.96
	-19.52%	21.56%	-4.48%	-11.99%	12.28%	-2.88%	3.44%	-14.06%
Test 1:								
	-68.84	329.93	-1480.96	-1810.89	34.12	-844.40	966.49	-1810.89
	-21.34%	4.22%	-4.92%	-8.14%	9.72%	-1.56%	2.74%	-9.61%

Test 2:								
	-10.05	251.99	-437.72	-689.70	8.80	-333.31	356.39	-689.70
	-3.77%	3.87%	-1.72%	-3.65%	2.49%	-0.70%	1.05%	-4.94%
Test 3:								
	-60.97	296.02	-2490.53	-2786.56	42.74	-1070.84	1715.71	-2786.56
	-19.37%	3.77%	-8.01%	-11.99%	12.49%	-1.97%	4.97%	-14.06%
Test 4:								
	-50.07	247.60	-3106.38	-3353.98	54.68	-1394.28	1959.70	-3353.98
	-16.48%	3.13%	-9.80%	-14.09%	16.55%	-2.55%	5.71%	-16.45%
Lumber V: 27.22% ADD/CVD								
Basic:								
	-32.81	1033.58	-957.89	-1991.47	27.44	-1129.05	862.42	-1991.47
	-14.57%	13.38%	-3.18%	-8.89%	8.68%	-2.03%	2.50%	-9.41%
Test 1								
	-36.58	235.84	-1058.63	-1294.47	22.16	-603.60	690.87	-1294.47
	-15.97%	2.77%	-3.50%	-5.96%	6.90%	2.77%	2.00%	-6.33%
Test 2								
	-30.42	963.32	-1673.35	-2636.67	30.81	-1274.22	1362.45	-2636.67
	-13.65%	12.36%	-5.43%	-11.44%	9.85%	-2.29%	4.01%	-12.09%
Test 3								
	-32.52	211.60	-1780.29	-1991.90	27.86	-765.46	1226.43	-1991.90
	-14.46%	2.48%	-5.75%	-8.89%	8.83%	-1.39%	3.60%	-9.42%
Test 4								
	-26.84	176.99	-2220.52	-2397.51	35.82	-996.67	1400.84	-2397.51
	-12.24%	2.06%	-7.07%	-10.51%	11.64%	-1.80%	4.13%	-11.12%

Table F1': the sensitivity of the estimated average market impact under the different policies and the comparison in 2001 actual tax rate (in U.S. 1997 dollars, mbf)

	Canada				U.S.			
	Price	**Consumption**	**Production**	**Exports**	**Price**	**Consumption**	**Production**	**Imports**
Lumber II : 15% export tax rate								
Test 1:								
	-22.00	28433.64	-614.57	-29048.20	12.69	25689.36	401.07	25288.29
	-9.61%	-143.79%	-2.03%	-58.10%	3.95%	88.47%	1.16%	-453.09%
Test 2:								
	-18.20	559.24	27777.79	27218.55	17.53	-739.73	24584.95	-25324.68
	-8.17%	7.17%	1328.95%	-477.17%	5.61%	-1.33%	242.16%	-55.54%
Test 3:								
	-19.49	28326.42	27765.59	-560.83	15.89	25514.71	24544.84	969.87
	-8.67%	-144.10%	1293.07%	-2.57%	5.03%	87.14%	239.47%	5.10%
Test 4:								
	-16.01	28173.28	57558.75	29385.47	20.31	25265.25	14342.44	10922.80
	-7.30%	-144.55%	-209.60%	-368.63%	6.60%	85.28%	70.38%	118.12%
Lumber III : 6.5% CVD								
Test 1:								
	-10.19	28358.42	-276.92	-28635.33	5.66	25881.88	180.72	25701.16
	-4.45%	-143.41%	-0.92%	-57.27%	1.76%	89.13%	0.52%	-460.49%
Test 2:								
	-8.39	251.99	28311.51	28059.52	7.78	-333.31	24150.39	-24483.70
	-3.77%	3.23%	1354.48%	-491.91%	2.49%	-0.60%	237.88%	-53.70%
Test 3:								
	-9.00	28258.93	28333.42	74.49	7.06	25758.86	24153.66	1605.19
	-4.00%	-143.76%	1319.51%	0.34%	2.24%	87.98%	235.65%	8.44%
Test 4:								
	-7.36	28116.83	58266.99	30150.16	8.99	25583.14	13895.64	11687.49
	-3.36%	-144.26%	-212.18%	-378.23%	2.92%	86.35%	68.19%	126.39%
Lumber IV--SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)								
Test 1:								
	-66.40	28760.81	-2083.18	-30843.99	45.07	24852.00	1359.50	23492.50
	-29.00%	-145.44%	-6.89%	-61.69%	14.02%	85.59%	3.93%	-420.92%
Test 2:								
	-55.89	1895.64	25456.38	23560.74	63.51	-2507.43	26475.06	-28982.49
	-25.09%	24.32%	1217.89%	-413.04%	20.31%	-4.50%	260.77%	-63.57%
Test 3:								
	-59.50	28619.98	25295.83	-3324.15	57.16	24452.80	26246.24	-1793.45
	-26.46%	-145.59%	1178.05%	-15.25%	18.11%	83.52%	256.07%	-9.42%
Test 4:								
	-49.69	28418.81	54478.26	26059.45	74.46	23882.59	16285.80	7596.79
	-22.67%	-145.81%	-198.38%	-326.91%	24.20%	80.61%	79.91%	82.16%
Lumber V: 27.22% ADD/CVD								
Test 1:								
	-36.58	28532.56	-1058.63	-29591.19	22.16	25436.17	690.87	24745.30

	-15.97%	-144.29%	-3.50%	-59.18%	6.90%	87.60%	2.00%	-443.36%
Test 2:								
	-30.42	963.32	27075.87	26112.55	30.81	-1274.22	25156.46	-26430.68
	-13.65%	12.36%	1295.37%	-457.78%	9.85%	-2.29%	247.78%	-57.97%
Test 3:								
	-32.52	28415.18	27018.82	-1396.37	27.86	25193.62	25059.29	134.34
	-14.46%	-144.55%	1258.29%	-6.40%	8.83%	86.05%	244.49%	0.71%
Test 4 :								
	-26.84	28247.52	56627.31	28379.79	35.82	24847.18	14930.05	9917.13
	-12.24%	-144.94%	-206.21%	-356.02%	11.64%	83.87%	73.26%	107.25%

Table F2: The sensitivity of the estimated welfare effects for Canada and the U.S. (1997 million U.S. dollars)

	Canada						U.S.				Total
	ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II : 15% export tax rate											
Basic:	120.83	-402.42		-402.42	291.45	9.87	-540.32	-402.42		-133.68	-123.82
Test 1:	138.58	-447.48		-447.48	291.45	-17.44	-433.52	327.76		-105.76	-123.20
Test 2:	112.59	-377.17		-377.17	291.45	26.88	-608.45	455.66		-152.79	-125.92
Test 3:	123.81	-402.92		-402.92	291.45	12.34	-547.49	411.73		-135.76	-123.42
Test 4:	102.92	-336.25		-336.25	291.45	58.12	-708.63	531.43		-177.20	-119.08
Lumber III: 6.5% CVD											
Basic:	71.86	-271.51		-271.51		-199.65	-374.08	-271.51	221.86	115.17	-84.48
Test 1:	80.84	-300.88		-300.88		-220.03	-299.88	214.80	221.86	136.78	-83.25
Test 2:	66.97	-253.64		-253.64		-186.67	-421.75	300.77	221.86	100.88	-85.79
Test 3:	72.40	-270.34		-270.34		-197.94	-379.59	271.21	221.86	113.49	-84.45
Test 4:	60.39	-225.87		-225.87		-165.48	-492.90	351.73	221.86	80.69	-84.79
Lumber IV--SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)											
Basic:	455.20	-1802.83	1502.50	-300.33	201.00	355.87	-2281.51	-1802.83		-777.11	-421.24
Test 1:	549.00	-2021.81	1502.50	-519.31	201.00	230.70	-1836.48	1223.05		-613.43	-382.73
Test 2:	423.94	-1696.63	1502.50	-194.13	201.00	430.81	-2560.49	1669.14		-891.35	-460.54
Test 3:	487.26	-1822.27	1502.50	-319.77	201.00	368.49	-2304.94	1516.20		-788.74	-420.25
Test 4:	401.30	-1511.71	1502.50	-9.21	201.00	593.08	-2957.16	1933.43		-1023.74	-430.65
Lumber V: 27.22% ADD/CVD											
Basic:	269.98	-973.20		-973.20		-703.22	-1510.15	-973.20	1003.55	450.70	-252.53
Test 1:	315.88	-1086.68		-1086.68		-770.80	-1213.96	775.02	1003.55	564.61	-206.19
Test 2:	251.37	-913.21		-913.21		-661.83	-1697.53	1067.14	1003.55	373.16	-288.67
Test 3:	281.24	-978.08		-978.08		-696.83	-1528.18	966.89	1003.55	442.27	-254.57
Test 4:	232.66	-813.38		-813.38		-580.71	-1968.91	1240.24	1003.55	274.88	-305.83

Table F2': the sensitivity of the estimated average welfare effects under the different policies and the comparison in 2001 actual tax rate (in U.S. 1997 dollars)

	Canada						U.S.				Total
	ΔCS	ΔPS	ΔQR	ΔPR	ΔGR	ΔTS	ΔCS	ΔPS	ΔGR	ΔTS	ΔTS
Lumber II : 15% export tax rate											
Test 1:	189.00	-658.42		-658.42	611.76	142.34	-696.50	441.75		-254.75	-112.41
Test 2:	146.87	-552.54		-552.54	622.09	216.42	-970.81	602.14		-368.67	-152.25
Test 3:	167.76	-593.29		-593.29	616.21	190.67	-873.99	547.16		-326.83	-136.16
Test 4:	138.18	-492.28		-492.28	614.82	260.73	-1120.91	697.18		-423.73	-163.00
Lumber III: 6.5% CVD											
Test 1:	87.15	-306.60		-306.60		-219.45	-311.05	196.30	286.10	171.36	-48.09
Test 2:	66.46	-256.99		-256.99		-190.53	-432.49	265.54	294.21	127.27	-63.26
Test 3:	77.18	-276.50		-276.50		-199.32	-389.37	241.82	289.58	142.02	-57.29
Test 4:	63.36	-229.00		-229.00		-165.64	-497.66	306.59	288.29	97.22	-68.42
Lumber IV--SLA: low export tax $50 per thousand bf (30.3%), high tax $100 per thousand bf (60.6%)											
Test 1:	580.38	-1941.68	1480.11	-461.57	284.32	403.13	-2454.92	1591.53		-863.40	-460.27
Test 2:	486.09	-1636.14	1519.69	-116.45	160.54	530.18	-3458.53	2243.77		-1214.76	-684.58
Test 3:	520.27	-1742.49	1505.96	-236.53	221.63	505.37	-3113.42	2019.20		-1094.22	-588.85
Test 4:	434.65	-1455.66	1543.66	88.00	186.85	709.50	-4054.59	2631.12		-1423.48	-713.98
Lumber V: 27.22% ADD/CVD											
Test 1:	315.88	-1086.68		-1086.68		-770.80	-1213.96	775.02	1003.55	564.61	-206.19
Test 2:	251.37	-913.21		-913.21		-661.83	-1697.53	1067.14	1003.55	373.16	-288.67
Test 3:	281.24	-978.08		-978.08		-696.83	-1528.18	966.89	1003.55	442.27	-254.57
Test 4:	232.66	-813.38		-813.38		-580.71	-1968.91	1240.24	1003.55	274.88	-305.83

Note: Test 1: Demand elasticity is 0.17 over SLA period and supply elasticity kept unchanged for both Canada and the U.S.
Test 2: Supply elasticity is 0.40 over SLA period and demand elasticity kept unchanged for both Canada and the U.S.
Test 3: Demand elasticity is 0.17 and supply elasticity is 0.40 for both Canada and the U.S.
Test 4: Demand elasticity is 0.17, but supply parameters are changed and let Canada's elasticity of export supply is 0.90 and the U.S. elasticity of import demand is 1.28
ΔCS refers to the changing of the consumer surplus for both Canada and the U.S.
ΔPS refers to the changing of the producer surplus for both Canada and the U.S.
ΔPR refers to the changing of the production in Canada.
ΔQR refers to the changing of the lumber production in Canadian four covered provinces under the SLA.
ΔGR refers to the government revenue under the different kind of policies.
ΔTS refers to the net effects for Canadian, the U.S. and two counties' total welfare.

Appendix G:

Comparison of three different models for demand-supply function

Table G1: The sensitivity of the Econometric Specification:

	Log -Linear Model	Log-Log Model	Linear-Linear Model
Canada			
Demand Elasticity:	-1.072	-0.8748	-0.9532
Supply Elasticity:	0.3074	0.2249	0.2415
Export Supply Elasticity:	1.107	0.7246	0.7845
U.S.			
Demand Elasticity:	-0.3203	-0.4057	-0.1686
Supply Elasticity:	0.3208	0.3509	0.2159
Import Demand Elasticity:	-2.0941	-3.219	-1.4564

Table G2: The Results of the Three-Stage-Least-Squares regression of price as a function of Canadian and U.S. supply and demand (Log-Log form)

Variables	**Corfficient**		**|p| > z**
Canada:			
Supply			
Canadian Softwood Lumber Price:	0.22		0.127
Canadian Sawmill Plant Workers' hourly earning:	0.47***		0.000
Constant:	7.36***		0.000
R-squared:		0.8162	
Demand			
Canadian Softwood Lumber Price:	-0.87**		0.025
Canadian Housing Starts:	0.14		0.413

Canadian Personal Disposable Income:	-1.66 ***		0.001
Canadian 5-year Mortgage Rate:	-11.45 ***		0.000
Canadian Steel Price:	2.88***		0.000
Constants:	12.77***		0.000
R-squared:		0.4600	
United States:			
Supply			
U.S. Softwood Lumber Price:	0.35*		0.031
U.S. Sawmill Plant Worker's hourly earning :	-0.21		0.191
Constant:	8.89***		0.000
R-squared:		0.3295	
Demand			
U.S. Softwood Lumber Price:	-0.41**		0.009
U.S. Housing Starts:	0.35***		0.000
U.S. Personal Disposable Income:	0.24***		0.000
U.S. 30-year Mortgage Rate:	-4.04***		0.000
U.S. Steel Price:	0.39**		0.009
Constant:	6.69***		0.000
R-squared:		0.8780	

Note: All variables are in natural log form except the Canadian and the U.S. lumber production and consumption;
*** indicates the explanatory variables are significant at the 1% level;
** means the explanatory variables are at the 5% level, and
* refers to the explanatory variables are significant at the 10% level.

Table G3: The Results of the Three-Stage-Least-Squares regression of price as a function of Canadian and U.S. supply and demand (Linear-Linear form)

Variables	**Corfficient**		**|p| > z**
Canada:			
Supply			
Canadian Softwood Lumber Price:	26.80		0.130
Canadian Sawmill Plant Workers' hourly earning:	494.34***		0.000
Constant:	5611.31**		0.008
R-squared:		0.7810	
Demand			

Canadian Softwood Lumber Price:	-32.31*		0.064
Canadian Housing Starts:	-9.35		0.448
Canadian Personal Disposable Income:	-0.04 *		0.040
Canadian 5-year Mortgage Rate:	-70495.88**		0.014
Canadian Steel Price:	9.77**		0.008
Constants:	84629.7**		0.015
R-squared:		0.3245	
United States:			
Supply			
U.S. Softwood Lumber Price:	27.13		0.099
U.S. Sawmill Plant Worker's hourly earning :	-186.46		0.735
Constant:	27313.09***		0.000
R-squared:		0.3904	
Demand			
U.S. Softwood Lumber Price:	-29.62		0.130
U.S. Housing Starts:	8.26***		0.000
U.S. Personal Disposable Income:	0.45**		0.004
U.S. 30-year Mortgage Rate:	-111224.9***		0.000
U.S. Steel Price:	191.46***		0.000
Constant:	136035.4***		0.000
R-squared:		0.9194	

Note: All variables are in natural log form except the Canadian and the U.S. lumber production and consumption;
*** indicates the explanatory variables are significant at the 1% level;
** means the explanatory variables are at the 5% level, and
* refers to the explanatory variables are significant at the 10% level.