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Game Theoretic Analyses of the United States-Canada Softwood Lumber Trade

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GAME THEORETIC ANALYSES OF THE UNITED STATES-CANADA SOFTWOOD LUMBER TRADE

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I dedicate this dissertation to my late mother.

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Abstract

The ongoing softwood lumber trade dispute between the United States (U.S.) and Canada is one of the most contentious and largest bilateral trade battles over the recent decades. The bilateral trade debate is mostly because of the different forestland ownership systems in the U.S. and Canada, and the alleged timber subsidies by provincial governments to Canadian lumber producers. The Softwood Lumber Agreement (SLA) 2006 between the U.S. and Canada is the latest transitory solution of this dispute, entailing Canada to impose mandatory export charges on its lumber shipments to the U.S. In order to understand this trade dispute from a strategic policy perspective, this study analyzes SLA 2006 using game-theoretic frameworks. A Cournot-Nash duopoly model is developed to assess the possible effects of the export tax on overall lumber price and production of softwood lumber in both countries. The empirical econometric models are estimated to uncover the findings of the Cournot-Nash duopoly model by employing the historical time-series data of the softwood lumber market. Even though the game-theoretic model suggests that the export tax under SLA 2006 could decrease Canadian lumber exports to the U.S., the empirical estimation reveals that SLA 2006 is quite ineffective in restricting the lumber trade between the two countries. This study also develops a two-country two-stage game, and concludes that the optimum export tax under the framework of SLA 2006 is mainly determined by the level of Canadian lumber production costs and the U.S. lumber production capacity. Unlike the actual export tax of 0-15%, the empirical estimation reveals that the monthly optimal export tax ranges from -23% to 30%. Given that SLA 2006 is scheduled to expire in October 2015 and that both countries already started looking for ways forward, this study provides useful information in country-level bargaining and trade negotiations between the two countries.

Chapter 1
Introduction

1.1 Softwood Lumber Market in Canada and the United States

Canada has 348 million hectare of forests, which represent 9% of the world's forests, and 24% of the world's boreal forests (Natural Resources Canada 2014). The forestry sector in Canada contributes substantially to the domestic employment and gross domestic product, and provides a wide range of social and environmental benefits. The solid wood products particularly softwood lumber and structural panels industry represent the largest share of the forest product industry in Canada.

As one of the major producers and exporters of softwood lumber in the world, the Canadian lumber industry exports a large portion of its production to foreign markets. In terms of the international forest product trade, Canada accounted for the world's largest forest product trade balance of C$19.3 billion in 2013 (Natural Resources Canada 2014). Besides Canadian domestic consumption, the key destinations for Canadian softwood lumber are the United States (U.S.) followed by overseas markets specifically China and Japan.

Figure 1.1 presents the annual quantity of Canadian lumber shipments, and its exports to the U.S. and overseas markets. Over the last 25 years, the annual average quantity of softwood lumber production in Canada has been around 27 billion board feet (bbf) with the maximum quantity of 36 bbf in 2005 and the lowest production of 20 bbf in 2009. As Figure 1.1 depicts, Canada exports a major portion of its softwood lumber production to the U.S. with an annual average quantity of 15 bbf. The amount of the Canadian lumber shipments to the U.S. was trending upward in the early 2000s and reached its peak of 22 bbf in 2005. Besides the U.S., overseas markets are key destinations for Canadian softwood lumber. Over the last five years, lumber exports to Asian markets particularly China and Japan have grown remarkably, which significantly influences a century-long U.S.-Canada softwood lumber trade. In 2013, Canada shipped more than 5 bbf of softwood lumber to overseas markets (Figure 1.1).

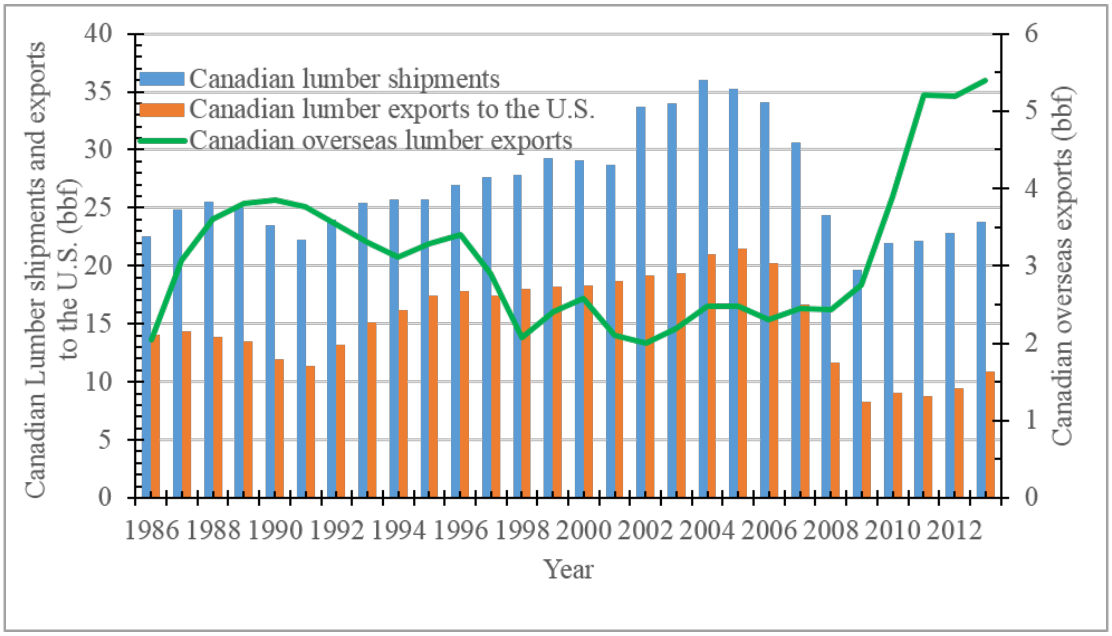

Figure 1.1: Annual Canadian softwood lumber shipments, and exports to the U.S. and overseas (Data source: Random Lengths)

Like Canada, the U.S. is also rich in forest resources, which cover 766 million acres of the land (Oswalt et al. 2014). Softwood lumber is a key forest product which represents the largest share of the industrial production in the U.S. Figure 1.2 reports the annual regional softwood lumber production in the U.S. over the last three decades. The U.S. South is a major softwood lumber producing region along with the inland and coastal regions of the U.S. West. The U.S. had a significant amount of domestic lumber production with an annual average of over 30 bbf during the late 1980s and 1990s. The lumber production reached a peak of 38 bbf in 2005 right before the housing market bust, and dropped to around 22 bbf during the great financial crisis of 2008-09. In the recent years, the U.S. domestic softwood lumber production has increased, yet the annual production is well below the production level of the early 2000s (Figure 1.2).

Even though the U.S. is the largest lumber producer in the world, its domestic lumber production is not sufficient to satisfy the entire U.S. lumber demand. More than 95% of the U.S. softwood lumber imports come from Canada, which represents roughly one-third of the

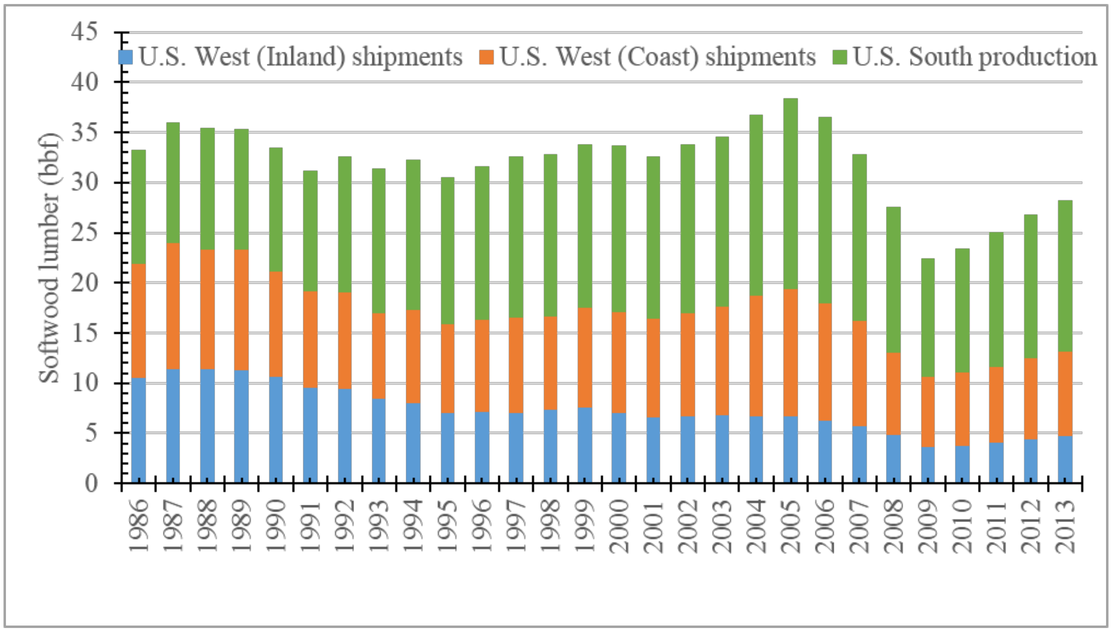

Figure 1.2: Annual regional softwood lumber production in the U.S. (Data source: Random Lengths)

total U.S. consumption (Random Lengths 2014). The U.S. also imports small quantities of softwood lumber from European countries such as Sweden and Germany, and Latin American countries such as Chile and Brazil. Figure 1.1 specifically depicts the historical trend of the U.S. lumber imports from Canada.

1.2 The Softwood Lumber Trade Dispute

The ongoing softwood lumber trade dispute between the U.S. and Canada is one of the largest and most contentious trade battles in international trade history. The underlying causes behind this decades-long bilateral trade dispute include the public ownership of forest land in Canada, and alleged timber subsidies by provincial governments to Canadian lumber producers (Lindsey et al. 2000). Unlike in the U.S. where 58% of the forests are owned by the private sector (Oswalt et al. 2014), almost 94% of the Canadian forests are under the ownership of federal and provincial governments (Natural Resources Canada 2014). Further, U.S. lumber producers argue that provincial governments in Canada provide subsidies to the lumber industries in harvesting the standing timber, and that subsidized Canadian lumber exports are dumped in the U.S. Canadian provincial governments determine the stumpage price administratively rather than through a competitive auction bid (Zhang 2007). The governments set the stumpage price based on the non-market approach, and employ a variety of formulas to determine the province-specific timber harvesting fees (Lindsey et al. 2000; Rahman and Devadoss 2002). The difference in softwood timber resource endowments between the two countries is another main cause of this dispute (Zhang 2007). The softwood lumber inventories in Canada remarkably outweigh the total softwood growing stock in the U.S. (Random Lengths).

Softwood lumber trade between the U.S. and Canada is an important inter-country political issue, as billions of dollars are transacted in the lumber trade each year. The complexity of this trade issue is mainly explained by interest group politics and institutional arrangements (Zhang 2007). Major players involved in the softwood lumber trade in the U.S. are lumber producers (including timber producers), consumers (home builders and home buyers) and the U.S. federal government (Zhang 2007). On the Canadian side, lumber producers and federal and provincial governments are major players in this trade battle. In the political bargaining and lobbying process, U.S. lumber producers are a small but well-organized and active group. They have formed a group consisting of lumber producers from the U.S. West, South and Northeast called the Coalition for Fair Lumber Imports–currently The U.S. Lumber Coalition– which has been very active in trade negotiation and political lobbying since 1982 (Random Lengths 2015). However, the Canadian lumber industry is fragmented and not well-organized at the provincial levels. The lack of consistent and united position of Canadian provincial governments to deal with the trade issue also helps extend the dispute without a permanent solution.

In order to resolve the trade dispute, there have been several temporary bilateral agreements between the two countries including the five-year Memorandum of Understanding (MOU) for the period of 1987-1991, the Softwood Lumber Agreement (SLA) 1996 for the period of 1996-2001, and SLA 2006 for the period of 2006-2015. The SLA 2006 is the latest transitory agreement between the U.S. and Canada to limit Canadian lumber exports to the

U.S. It is a price-driven ad-valorem export tax rate coupled with a quota system. According to the agreement, Canada has to apply the measures of either Option A or Option B in the softwood lumber exports to the U.S. Option A is solely an export charge ranging from 0-15% of the prevailing monthly price; whereas option B is an export charge of 0-5% combined with a volume restraint (Table 1.1). Alberta and British Columbia provinces choose the option A, and other lumber producing provinces such as Manitoba, Saskatchewan, Ontario and Quebec choose option B of the agreement. Alberta and British Columbia are the major lumber-producing provinces in Canada. As explained in Table 1.1, the rate of Canadian export tax depends on the prevailing monthly price. The free trade of softwood lumber prevails if the prevailing monthly price is more than $US 355 per thousand board feet. The export tax and/or volume restraint is a function of prevailing monthly price; the higher the price of lumber, the less (or no) barriers to lumber exports to the U.S.

Table 1.1: U.S.-Canada Softwood Lumber Agreement 2006: Export charge and export charge plus volume restraint

Lumber price*	Option A (AB and BC) -Export tax as a % of price	Option B (MB, SK, ON and QC)- Export tax as a % of price, with export allocation
Over $US355	No export charge	No export charge and no volume restraint
$US336-355	5%	2.5% export charge + regional share of 34% of U.S. Consumption
$US316-335	10%	3% export charge + regional share of 32% of U.S. Consumption
$US315 or under	15%	5% export charge + regional share of 30% of U.S. Consumption

*Four-week average of Random Lengths Framing Lumber Composite price (Source: SLA 2006)

The prevailing monthly price, as defined in the SLA 2006, is a four-week weighted average of the Random Lengths (RL) Framing Lumber Composite price available three weeks before the beginning of the month to which the prevailing monthly price will be applied. The RL Composite price is a weighted index of 15 framing lumber price series in the U.S. and Canada. The index which is comprised of 33% Southern Pine prices, 33% Western U.S. prices and 34% Canadian lumber prices, measures the price movement in the overall lumber market. Figure 1.3 presents the monthly RL Framing Lumber Composite price throughout the period of the SLA 2006. The price index remained below $315 until late 2012, hence Canadian lumber producers paid 15% export tax for their lumber shipments to the U.S. Since late 2012 (except in June-August 2013), because the lumber composite price is above $355, free trade prevails, and Canada has not collected any export duties on its exports to the U.S.

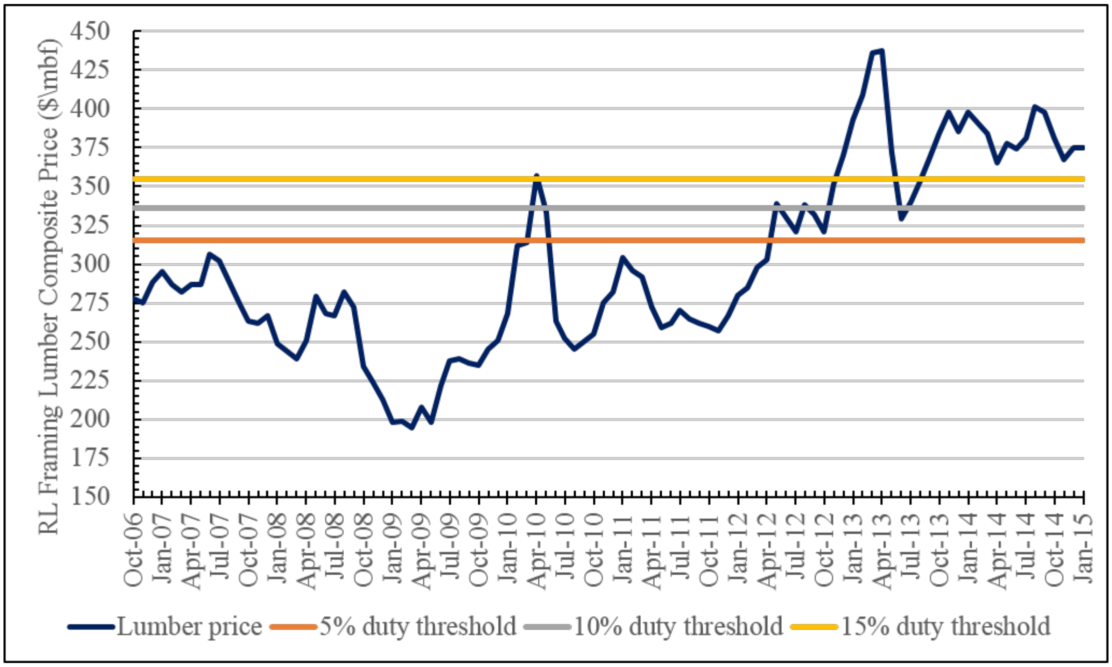

Figure 1.3: Random Lengths Framing Lumber Composite Price compared with SLA 2006 duty/quota trigger prices (Data source: Random Lengths)

1.3 Dissertation Overview

The main purpose of this dissertation is to examine the effects of SLA 2006 on the softwood lumber trade between the two countries under game-theoretic frameworks. This dissertation also determines the optimal level of export tax under the framework of the SLA 2006. Besides game-theoretic analyses, this study also estimates the U.S.-Canada softwood lumber market by employing historical monthly data from the softwood lumber market. While several past studies have analyzed the U.S.-Canada softwood lumber dispute, none of them specifically assessed the strategic effects of past agreements on softwood lumber production in the two countries. Despite several rounds of temporary negotiations and agreements between the U.S. and Canada, both countries are unable to solve this trade issue permanently. Given that the SLA 2006 is scheduled to expire in October 2015, interest groups in both countries already started looking for ways forward. Canada is reported to favor extending the SLA 2006, but the U.S. counterparts are against the continuation of the current agreement (Campbell Global 2014). Under these circumstances, this dissertation sheds light on the decades-long trade issue, and provides useful information to both parties in country-level bargaining and trade negotiations.

The dissertation is divided into seven chapters. The first chapter provides a brief introduction to the softwood lumber production and the historical trend of the softwood lumber trade between the two countries. Chapter 2 briefly summarizes the historical events associated with the softwood lumber dispute during the modern era. It also explains every bilateral agreement and litigation process during that period. Then, chapter 3 extensively reviews past research studies on the softwood lumber market and the trade dispute.

Chapter 4 develops a two-player Cournot-Nash equilibrium model to analyze the effects of the export tax on softwood lumber production in both countries, profits of both U.S. and Canadian firms, and the overall softwood lumber price under the framework of the SLA 2006. The theoretical results are consistent with traditional trade theories: an export tax leads to higher overall lumber prices, more U.S. domestic production and greater profits of U.S. lumber companies, but decreases Canadian lumber shipments to the U.S. and their profit level. All results hold true in the case of a linear inverse demand equation, hence the theoretical results are robust.

Chapter 5 estimates demand and supply equations for the U.S. softwood lumber market using the monthly historical time-series data during the period of SLA 2006. Notwithstanding the theoretical results in chapter 4, the results of the Limited Information Maximum Likelihood (LIML) approach reveals that the effects of the export tax on the softwood lumber trade is minimal. The estimated coefficient of export tax in the model of Canadian exports supply to the U.S. is statistically insignificant. Further, the Canadian overseas exports play an important role in the U.S.-Canada softwood lumber trade.

Likewise, chapter 6 develops a two-stage two-player game to examine the optimal level of the export tax under the framework of SLA 2006. The results suggest that lumber production costs in Canada, U.S. lumber production capacity, and linear demand parameters determine the optimal rate of export tax. The empirical estimation reveals that the monthly optimal export tax during the SLA 2006 period ranges widely from -23% to 30%. Chapter 7 presents the summary and conclusions of the dissertation.

Chapter 2
A Historical Overview of the Softwood Lumber Dispute

The softwood lumber trade between the United States and Canada has witnessed frequent contentious battles over the last two centuries. The first ever lumber tariff of five percent against the Canadian lumber shipments to the U.S. was reported to be placed in 1789 (Reed 2001). The modern version of the conflict erupted since early 1980s, and we primarily focus here on the battle during this period. Reed (2001) provided a detailed history of the dispute prior to the 1980s; and Zhang (2007) described in detail events of more recent decades. Based on the chronological development in this trade issue, the softwood lumber trade dispute in the modern era has been classified into four periods: Lumber I to Lumber IV (Reed 2001; Rahman and Devasoss 2002; Zhang 2007).

2.1 Lumber I

During the period between the mid 1970s and mid 1980s, Canadian softwood lumber imports rose sharply by about 136% and captured about one-third of the U.S. lumber market (Buongiorno et al. 1988). The increasing Canadian share in the early 1980s diminished the competitive position of the U.S. domestic lumber industry. In response, U.S. lumber producers alleged that the Canadian provinces, particularly British Columbia, Alberta, Ontario and Quebec, unfairly subsidized their lumber industry through the administrative policies which facilitated Canadian lumber firms to harvest timber from public forest lands at a nominal stumpage fee. In 1982, U.S. producers from the U.S. West, South, and Northeast formed a lobbying group, the Coalition for Fair Canadian Lumber Imports (CFCLI). It filed a petition with the U.S. Department of Commerce(DOC) and U.S. International Trade Commission (ITC) asking for a countervailing duty (CVD) of 65% on Canadian lumber imports (Zhang 2007). So started the trade dispute between these two countries in the modern era. CFLI posited four arguments to support their claim of material injury from Canadian imports: a rapid rise in the market share of Canadian lumber in the U.S., a decline in domestic sawmill capacity and employment, a reduction in the profitability of the U.S. lumber industry, and falling U.S. real lumber prices (Myneni et al. 1994). After a full investigation of the allegation in May 1983, the International Trade Administration (ITA) of the DOC rejected the petition stating that the amount of subsidies was less than 0.5% (Rahman and Devadoss 2002; Zhang 2007). The DOC also concluded that the Canadian system of setting the stumpage price did not vary substantially from the U.S. pricing system, and in some cases the Canadian prices were higher (Zhang 2007). DOC's ruling was challenged by CFCLI at the U.S. Court of International Trade, but the Court upheld the DOC's decision (Lindsey et al. 2000).

2.2 Lumber II: The Memorandum of Understanding

Despite failing in its petition in 1983, U.S. lumber producers asked the U.S. ITC again in 1986 to conduct another Section 322 investigation based on a 1985 court decision about the definition of an industry (Zhang 2007). The ITC found that major costs for Canadian lumber producers were lower than those in the U.S., and later ruled that the Canadian lumber imports injured the domestic lumber market. In the meantime, the CFCLI was able to politicize the issue effectively, and started lobbying for trade restriction measures against the Canadian lumber imports. While several formal and informal bilateral talks between the U.S. and Canadian governments were intensifying to solve this trade issue, the Coalition filed its petition again in 1986, requesting a 27% CVD on Canadian lumber shipments to the U.S. As a preliminary ruling, the ITA of DOC found that Canadian lumber industry was subsidized, and announced a 15% interim duty as a trade sanction on Canadian lumber imports in October 1986. However, Zhang (2007) stated that the method of stumpage fee calculation used by DOC was contrary to economic theory, and suffered from several theoretical and empirical flaws.

Before a final ruling on the import tariff duty of 15% in December 1986, Canada sped up the negotiation process with the U.S. counterparts and proposed to place a 15% export tax instead. Although the Coalition of U.S. lumber producers wanted a higher rate of

CVD, they also decided to settle on a 15% export tax because of high legal fees, lack of supporting data, as well as risk and uncertainty that the DOC ruling might get overruled in the court (Zhang 2007). Both parties reached an agreement and signed a Memorandum of Understanding (MOU). The MOU was a five-year bilateral trade agreement between the U.S. and Canada, starting from January 1987. It required Canada to impose 15% export duties on lumber shipments to the U.S. The MOU transferred the collection mechanism of the proposed CVDs by the U.S. (importer) to the export tax by Canada (exporter). The primary goal of the MOU was to reduce the Canadian market share of the U.S. lumber market by increasing the price of Canadian lumber in the U.S. market. As expected, the Canadian share of the U.S. market dropped to 25% from 33% in the five years of the agreement (Myneni et al. 1994).

The MOU also provisioned that the Canadian provinces could reduce and/or eliminate the rate of export tax by increasing their prevailing stumpage fees. Eventually, this option of stumpage fee adjustment in the MOU turned out to be an underlying reason of escalating the debate between the two countries throughout the period of MOU. British Columbia (B.C.) government, immediately after the implementation of the MOU, raised the stumpage fees by revising the residual approach in calculating stumpage fees (Zhang 2007). The B.C. government led to increase annual stumpage and other forest fees by $100 million from $580 million, and stopped collecting the export tax from December 1987. Likewise, Quebec's government also adjusted their stumpage fee, and reduced the rate of export tax to 6.2% (Random Lengths 2014). Later in 1988, as the B.C. government lowered its stumpage price in Prince George region of the province, the U.S. Coalition of lumber producers alleged that the B.C. government violated the MOU, and started intensifying the trade debate again. Moreover, since all four major lumber producing provinces in Canada increased the level of stumpage and other fees, and also changed their forest management policies, they were against the MOU and they started lobbying for a change or termination of the MOU. Despite some economic benefits from the MOU, the Canadian government unilaterally terminated the MOU on October 1991, because of the increasing lumber demand, provincial politics and province-federal dynamics (Zhang 2007).

2.3 Lumber III: The Softwood Lumber Agreement 1996

Right after the termination of the MOU by Canada, the U.S. reacted immediately by imposing self-initiated provisional import duties on Canadian exports to the U.S. under the provision of Section 301 of the Trade Act 1974. A duty of 15% was imposed on lumber from most of the provinces except B.C. (Random Lengths 2014). The U.S. trade representative (USTR) investigated and found that forest management programs in Canadian provinces, and log export restrictions from Canadian forests were countervailable subsidies (Rahman and Devadoss 2002). Likewise, ITC found that Canadian imports injured the U.S. industry. In March 1992, citing the subsidies in stumpage programs and log export restrictions, the ITA of the Department of Commerce made a preliminary ruling that there would be a provisional ad valorem duty of 14.48% on Canadian lumber imports from all provinces except the Maritimes and a few small firms. It was reduced, however, to a permanent rate of 6.51%, which was later approved by the ITC voting in June 1992.

Strongly disagreeing with the U.S. imposition of the CVD, Canada filed one appeal under the terms of the General Agreement on Tariffs and Trade (GATT) and two other appeals against the U.S. claims of subsidy and injury under the terms of the Canada-U.S. Free Trade Agreement (FTA) (Random Lengths 2014). The GATT panel issued a report supporting the U.S. action of self-initiation of the investigation, but the report stated that the U.S. improperly imposed interim duties prior to a preliminary investigation of subsidy and injury (Zhang 2007). The GATT panel also recommended the U.S. to refund the cash collected when the bonding requirements were in effect.

A bi-national panel of dispute settlement procedures under Chapter 19 of FTA (the FTA subsidy panel hereafter) was appointed to investigate the U.S. allegation of Canadian subsidies, and another bi-national panel (the FTA injury panel hereafter) considered an appeal of the injury finding. Both panels ruled that the evidences provided by ITA and the

ITC to justify their findings were not sufficient to conclude the Canadian subsidies and the injury to the U.S. industry respectively (Zhang 2007). The FTA subsidy panel reported that the ITA had failed to consider major market factors while examining Canadian stumpage programs, and that ITA should have conducted a market distortion test. Likewise, the FTA injury panel concluded that the ITC's determination of material injury caused by Canadian lumber imports was not fully supported by substantial evidence. Since both bi-national panels asked to further examine the findings of both allegations, in September 1993, the ITA of the DOC determined a nearly doubled rate of CVD of 11.54%, and the ITC also reaffirmed its earlier finding of material injury of the domestic lumber industry due to Canadian lumber imports (Random Lengths 2014). Both bi-national panels again rejected the findings of both ITA and ITC pointing out the lack of substantial evidence on the remand determination.

In order to challenge the decisions of the FTA subsidy panel, the U.S. formally appealed to an Extraordinary Challenge Committee (ECC) to review the decisions of the panel under the provision of Article 1904 of Chapter 19 of the FTA (Rahman and Devadoss 2002). The ECC also rejected the appeal of the U.S. and the Coalition of Fair Lumber Imports in the CVD case, finding that the decision was binding and non-appealable. Consequently, the ITA of the DOC terminated the CVD in August 1994, and the US$800 million collected by the U.S. as CVDs was returned to Canada (Lindsey 2000). Both countries agreed to establish a consultative mechanism including representatives of the softwood lumber industries and governments to discuss areas of mutual concerns regarding their forest industries (Random Lengths 2014).

Even though Canada won the legal cases and both parties agreed to establish a consultative mechanism, the trade issue remained heated in 1995. Representatives of the two countries met several times to resolve the trade contention. After several rounds of consultation and negotiation, both countries agreed to impose a restricted trade policy governing imports of Canadian softwood lumber. With a continuous threat of imposing another CVD by the U.S. coalition of lumber producers, a final agreement, known as the Softwood Lumber Agreement (SLA) 1996 was reached in April 1996. SLA 1996 described the Canadian fee-free export limit, quota allocation of the fee-free export amount, fee level, fee collection and trigger-price mechanism in detail (Zhang 2001). According to SLA 1996, four Canadian provinces– B.C., Alberta, Ontario, and Quebec–had a annual free lumber export quota of 14,700 million board feet (mmbf) to export to the U.S. (Random Lengths 2014). Additional exports of 650 mmbf above the free quota limit were subject to $50 per thousand board feet (mbf) of penalties, and the lumber exports above both limits were subject to a fee of $100/mbf. The fee levels of $50 and $100 were adjusted annually for inflation in both countries. The Canadian lumber industry collected the quota rents. Further, the SLA 1996 also specified the trigger price mechanism; if the average quarterly price of eastern spruce-pine-fir (S-P-F), kiln-dried 2X4s, std&Btr, delivered to the Great Lake area were above US$405/mbf, 92 million board feet of additional fee-free bonus exports would be allocated over the following five subsequent quarters (Zhang 2001). Moreover, lumber exports from Manitoba and Saskatchewan as well as maritime provinces were exempt from the agreement.

During the SLA 1996 period, there were several trade frictions over the U.S. reclassification of pre-drilled S-P-F, rougher-header lumber, and notched studs within the definition of softwood lumber. However, the World Customs Organization overturned the claims of U.S. Customs, and ruled that all pre-drilled studs would be classified as joinery and carpentry, and excluded from SLA 1996. On the other hand, as B.C. reduced its stumpage fees by $C3.50-8.10 per cubic meter in May 1998 because of plummeting Asian markets, the U.S. coalition of the producers (CFLI) charged that B.C. provided a new subsidy to its producers, and therefore, had breached SLA 1996 (Random Lengths 2014). Both countries again began formal consultations on the B.C. stumpage issue, but they failed to reach any meaningful agreement. Despite SLA 1996 and continuous trade debates, 18,030 mmbf of Canadian softwood lumber was shipped to the U.S. in 1998, and the exports quantity mounted to 18,240 mmbf in 1999, well above the par of the free quota limit of 14,700 mmbf (Random Lengths 2014).

As the expiration of SLA 1996 was approaching, both parties were against the extension of the agreement beyond March 2001. Canadian and U.S. lumber consumers, specifically Canada's Free Trade Lumber Council and the National Lumber and Building Materials Dealers Association (NLBMDA) in the U.S., were in favor of lobbying for free trade, while the U.S. CFLI still criticized the so-called Canadian subsidies on timber production, and vowed to continue their fight. Meanwhile, softwood lumber prices were falling in 2001 mainly because of falling demand in the U.S. caused by declining housing starts, and oversupply of Canadian lumber due to the structure of SLA 1996 (Zhang 2007). Without any proposition to resolve the issue further from both sides, SLA 1996 expired on its scheduled date, March 31, 2001.

2.4 Lumber IV

Lumber IV is all about five years of legal fights and litigation between the U.S. and Canada. On the very next business day after the expiration of SLA 1996, the U.S. CFLI filed two petitions to the ITA of the U.S. DOC and U.S. ITC requesting 40% of CVD and 28-38% of anti-dumping (AD) cases against Canadian lumber imports. In its 5000-page petition, CFLI alleged that Canadian provincial governments provided subsidies to domestic producers and that subsidized lumber was dumped in the U.S. The DOC took quick action, examined the several Canadian market factors and government regulations including the Canadian stumpage fees, log export restrictions programs, the Western Economic Diversification program, the Federal Economic Development Initiative for Northern Ontario, and the Industry, Trade and Economics program of the Canadian Forest Service (Rahman and Devadoss 2002). From the lengthy investigation, the U.S. DOC found a positive affirmation of the alleged subsidy, and levied a 19.31% preliminary CVD against the Canadian lumber shipments to the U.S. Similarly, as the ITC reported that the U.S. lumber industry was threatened with material injury by Canadian subsidized lumber imports, the

DOC imposed a 12.58% of AD on Canadian lumber imports including those from Maritime provinces. Later in April 2002, the CVD was lowered to 18.79% and a company-specific rate of 8.42% AD were imposed on Canadian imports (Random Lengths 2014).

While several bilateral talks couldn't make any progress toward the resolution of the dispute, Canada filed three petitions to the World Trade Organization (WTO) and North American Free Trade Agreement (NAFTA) challenging the U.S. actions of the CVD and AD. Since the WTO issued its final confidential reports to each government, both countries interpreted the decision in their favor. Canada claimed that it had won the case referring the WTO's finding of no subsidy. Whereas the U.S. stated that the ruling meant the existence of Canadian subsidy to domestic producers, but the method used to determine the level of subsidy was improper (Random Lengths 2014). Likewise, the WTO injury panel also concluded that the ITC violated WTO rules while claiming the injury threat to the U.S. industry from Canadian lumber imports.

On Canada's challenge of the CVD, a NAFTA panel ruled in August 2003 that the method used by the U.S. DOC to measure the Canadian subsidy was flawed, and asked it to use a different approach to examine the Canadian stumpage programs (Random Lengths 2014). The DOC reviewed its method of investigation by using Canadian log prices to determine subsidy levels instead of using cross-border price comparisons. The DOC responded to the remand of the NAFTA panel by reducing the level of CVD to 7.8% in August 2004. The DOC lowered the total duties from 27.2% to 21.2% in December 2004. After back and forth remands and responses to remands between the DOC and the NAFTA panel five times, the DOC dropped its subsidy calculation to 0.8% in November 2005, which was *de minimis*.

Likewise, by stating extensive lack of analysis, another NAFTA injury panel also remanded the ITC case of injury to the U.S. industry caused by Canadian lumber imports. ITC revised the analysis and came up with 8.1% of AD as an answer to the remand by the NAFTA injury panel. The injury panel again, however, rejected most of the ITC's arguments, and concluded that ITC's remand determination of threat injury was not supported by substantial evidence. After a series of rejections of the ITC's remand determinations by the NAFTA injury panel, ITC, in August 2004, finally declared that lumber imports from Canada didn't threaten the injury of the U.S. industry. With strong complaint to the decision of the NAFTA injury panel, the U.S. government appealed to an Extraordinary Challenge Committee (ECC) in November 2004 accusing the NAFTA panel of having violated the ethics rules and departing from fundamental rules of procedure (Random Lengths 2014). The ECC panel, however, also ruled in line with the NAFTA injury panel that the U.S. lumber industry wasn't threatened with injury by Canadian lumber imports in August 2005. Contrary to the ITC's allegations, the ECC concluded that the NAFTA panel had not overused its powers, authority or jurisdiction to reject the U.S. injury claim.

Trade officials from both countries actively engaged in bilateral talks and negotiations throughout this tumultuous period, and offered several proposals and counter-proposals. Various interest groups and events, however, prevented the countries from reaching a bilateral agreement. The U.S. CFLI proposed a couple of solutions with tariff-regulated quota systems to regulate the Canadian share of the U.S. lumber market below 30%, but those proposals were denied by Canadian producers. The trade battle took a turn when the U.S. lost both allegations of Canadian subsidy and injury to the U.S. industry in NAFTA panels. After numerous rounds of talks and negotiations between the two counterparts, both countries reached a tentative seven to nine-year deal in April 2006, the Softwood Lumber Agreement 2006. According to SLA 2006, the U.S. withdrew all import duties imposed on Canadian lumber imports, and Canada was obliged to impose variable-rate export charges ranging from 5-15% and/or quotas on its lumber shipments to the U.S. The free trade of softwood lumber is allowed if the prevailing monthly price is above $355/mbf. Each province was free to select option A–tax only or option B–lower tax coupled with a quota. As a part of the deal, the U.S. agreed not to self-initiate an AD or CVD investigation during the SLA period, and to return the collected CVDs and ADs of $4 billion to Canadian exporters. \$1 billion of the collected duties was kept in the U.S., half of which was provided to the U.S. CFLI. Both Countries signed the Agreement which was effective from October 2006 on September 12, 2006.

Along with the export charges and quota restraints, the SLA 2006 also specified other boarder measures including a third country adjustment, and an anti-surge mechanism (SLA 2006; Zhang 2007). The article entitled third country adjustment in SLA 2006 states that Canada would refund export charges to exporters during any two consecutive quarters if (a) the non-Canadian imports (the share of third country market) increased by at least 20% in the U.S.; (b) Canadian market share of U.S. consumption declined and; (c) the share of the U.S. domestic lumber production increased. Moreover, the surge mechanism stated that if the volume of exports from particular Canadian regions exceeded 111% of its allocated share in any period, Canada should increase the export charge by 50% on shipments from that region. Imports from the Maritime provinces and some companies were excluded from SLA 2006.

2.5 The Softwood Lumber Agreement 2006

Even after the implementation of SLA 2006, trade conflict persisted between the two countries in terms of interpretations of the surge-trigger mechanism and quota allotments. The U.S. trade representatives claimed that Canada didn't specifically follow the SLA and allowed too much lumber to ship to the U.S. Within a couple of months of SLA 2006 coming into effect, the U.S. also complained about the action of the Quebec and Ontario provinces to provide aid packages to their forest industries (Random Lengths 2014). Consequently, U.S. officials filed two arbitration cases to the London Court of International Arbitration (LCIA) claiming that Canada did not implement the export surge mechanism properly, and that Quebec and Ontario subsidized their forest industries which violated SLA's anti-circumvention rules. The three-person LCIA panel ruled in a split decision that B.C. and Alberta did not violate SLA 2006, but Quebec, Ontario, Manitoba and Saskatchewan had not properly implemented their quota allotments during the first half of 2007. The LCIA panel later concluded that Canada should impose an additional 10% export tax on the lumber exports from those four eastern provinces until C$68.26 million had been collected. Instead of an additional 10% export tax, Canada offered a lump sum payment of C$46.7 million. The U.S. rejected the Canadian offer, and implemented a 10% duty on lumber shipments from those provinces from April 2009 to September 2010 (Random Lengths 2015). Canada finally complied with LCIA's decision and started imposing additional 10% export tax on exports from those provinces (U.S. Lumber Coalition 2012).

As per another allegation of Quebec and Ontario's subsidy program, the LCIA panel ruled in 2011 that those Canadian provinces violated SLA 2006, hence Quebec and Ontario had to place additional export charges of 2.6% and 0.1% respectively (Random Lengths 2015). Moreover, in 2011, the U.S. also questioned the timber pricing practices in B.C. and claimed that B.C. assigned public timber to salvage grade, and sold it to domestic producers at a very cheap rate. However, later in July 2012, the LCIA panel ruled a negative determination of the U.S. claims stating that SLA 2006 and the action of B.C. government were not directly related. In January 2012, despite the several concerns and challenges about SLA 2006, both countries happily agreed to extend SLA 2006 through October 2015 without a single amendment to the original agreement. Since January 2013, except from August to October 2013, free trade of softwood lumber prevailed between the countries as the prevailing monthly lumber price has been above US$355. SLA 2006 is set to terminate on October 12. 2015.

Chapter 3
Literature Review

The softwood lumber trade dispute has received considerable attention as an important research topic since the 1980s. Most of reports expounded the U.S. softwood lumber market considering lumber imports from Canada, and effects of past trade restriction measures on the overall market as well as total social welfare in both countries. Several studies used a reduced-form equation approach to estimate the lumber market empirically, and some of the studies employed spatial and partial equilibrium models to estimate the welfare effects of trade restriction measures.

Several early studies examined the underlying factors of U.S. softwood lumber market using different modeling approaches and econometric estimation techniques. Buongiorno (1979) developed a monthly softwood lumber imports model for the U.S., and estimated the model using data from January 1965 to August 1978. They found that importers' expectations regarding future levels of construction activity, domestic and foreign prices of softwood lumber and domestic prices of other goods were the primary determinants of lumber imports in the U.S. Numerous other studies employed historical data on housing starts, the price of other building materials, and U.S. per capita disposable income to examine the domestic lumber demand scenario in the U.S. (Uri and Boyd 1991; Myneni et al. 1994; Baek and Yin 2006; Baek 2011). The most extensive demand and supply models for the U.S. softwood lumber market were developed and estimated by Song et al. (2011). Based on the Cobb-Douglas cost function, they derived the demand equation as a function of factors of production, price of substitute goods, lumber price and housing starts. They derived the supply equation for the softwood lumber market as a function of prices of input goods, level of inventory, and lumber price.

A number of studies evaluated the impact of the exchange rate (C$/US$) on the lumber trade between two countries. McCarl and Haynes (1985) assessed the effects of exchange rates on softwood lumber trade between the United States and its trading partners particularly Canada and Japan. Based on the comparison among the exchange rates, real lumber prices, and softwood lumber flows in those three countries, they concluded that the prevailing Canadian-U.S. exchange rate led to increase Canadian lumber exports to the U.S, indicating that the appreciation of U.S. dollars acted as an import subsidy for Canadian producers. However, based on the econometric estimation and simulation results using annual data for the 1950-1983 period, Adams et al. (1986) reported that exchange rate had significant but not prominent effects on the Canadian-U.S. lumber trade. Likewise, Buongiorno et al. (1988) also examined the effects of exchange rates on Canadian lumber imports by employing a time-series analysis. Based on the monthly data from January 1974 to January 1986, they found statistically insignificant effects of the exchange rate on imports. Rather, their results revealed that the increase in the domestic softwood lumber price in the U.S. led to rise in Canadian imports by 68%. The findings of a vector autoregression analysis in Jennings et al. (1991) also supported the results of Buongiorno et al. (1998). Later, Sarkar (1993) used Johansen's maximum likelihood cointegration analysis to investigate the long-run and short-run casual relationship between Canadian lumber exports to the U.S., the U.S. lumber price, U.S. housing starts and the bilateral exchange rate. The findings of the maximum likelihood cointegration analysis revealed that the exchange rate had a significant long-run positive effect on lumber exports to the U.S., but the pass-through of exchange rate effects was incomplete indicating the possibility of an oligopolistic lumber market structure between the U.S. and Canada. However, the effect of the exchange rate in short-run was found to be insignificant. A recent study by Baek (2012) also found an insignificant effect of the exchange rate on Canadian lumber exports to the U.S.

On the other hand, several studies used cointegration testing procedures to examine the law of one price for the softwood lumber market in the U.S. and Canada. Uri and Boyd (1990) concluded that there exists a single national market for softwood lumber in the U.S. as depicted by a strong connection between the demand and prices. Using the multivariate

Johansen cointegration test, Jung and Doroodian (1994) also substantiated the existence of a single long-run equilibrium price for four softwood lumber regional markets in the United Stated during the period 1950-1985. Likewise, with the most disaggregated data and a large number of price combinations for different products, regions and species, Yin and Baek (2005) found an existence of the law of one price for the entire United States softwood lumber market. However, based on a multivariate cointegration test, Nanang (2000) revealed that the law of one price doesn't hold for five regional markets of softwood lumber in Canada. Shahi et al. (2006) tested the law of one price in the ten North American regional markets for aggregate softwood lumber and homogenous softwood lumber markets, and showed that the law of one price doesn't exist in the North American aggregate market. They also revealed that the law of one price does not hold for any combination of a Canadian regional market with all five regional markets of the U.S. In striking contrast, Baek (2006) found that the North American lumber market is integrated, and the U.S. market plays a dominant role in price setting in the North American lumber market. Baek (2006) considered different regional markets, softwood lumber types, and data period that Shahi et al. (2006) selected, which primarily explained the difference in the results between these two studies.

3.1 The Memorandum of Understanding (MOU)

Based on simulation and projection approaches, a couple of early studies evaluated production and welfare impacts of possible U.S trade restriction measures on Canadian lumber shipments to the U.S. prior to the implementation of the MOU. Using a spatial equilibrium model, Boyd and Krutilla (1987) projected that net U.S. gain would be positive with a 10% ad-valorem tariff, but voluntary restraint agreements might boost Canadian profits by 40%. Similarly, Chen et al. (1988) estimated a four-equation simultaneous system by two-stage least squares and reported that an imposition of an import tariff or Canadian export tax on lumber imports resulted in a significant drop in Canadian lumber imports with little effect on total lumber consumption in the U.S.

Besides these projections, several studies examined market distortions and welfare effects of the export tax and a stumpage fee adjustments, the two instruments specified in the MOU on the softwood lumber markets in both countries. By incorporating annual MOU dummy variables in the model of Canadian market share, Wear and Lee (1993) estimated the market and welfare impacts of the MOU. They found significant effects of the MOU on Canadian market share in the U.S. lumber market, and estimated that U.S. lumber producers gained almost US$2.6 billion in 1982 dollars with a substantial cost of US$3.8 billion incurred by U.S. consumers. The MOU led to reduce the profits of Canadian producers by $136 million, but Canadian provinces were able to collect $301 million in export tax revenue.

Similarly, by estimating a four-equation system of demand and supply equations for the U.S. softwood lumber market, Myneni et al. (1994) also evaluated the welfare impacts of a 15% export tax as specified in the MOU on both countries. Their estimation showed that the loss incurred by U.S. consumers was 35% larger than the benefits realized by U.S. producers. Further, Canadian producers incurred the largest loss of almost $400 million in 1982 dollars followed by U.S. consumers with a mean loss of $150 million. Among the two policy options specified in the MOU, Bernard et al. (1997) revealed that the export charges were more effective instruments in redirecting lumber trade than were increases in stumpage prices by Canadian provinces. Likwise, Baek and Yin (2006) also reported that the MOU was able to reduce the Canadian lumber exports by 8.4-9%, and increase the U.S. lumber production by 3%. However, Zhang (2001; 2006) estimated a statistically insignificant impact of the MOU on the overall lumber price in the U.S. Similarly, using advanced time-series econometrics on the longer monthly dataset, recent studies by Song et al. (2011) and Nagubadi and Zhang (2013) estimated that the MOU had a statistically insignificant effect on Canadian lumber exports to the U.S. The latter two studies explained that due to the larger sample period and several policy and market events, their models might have overlooked the smaller market variations caused by the MOU.

3.2 The Softwood Lumber Agreement 1996

A number of studies investigated the effects of the Softwood Lumber Agreement (SLA) 1996 on the lumber markets and total social welfare in both countries. Using the regression estimates of an overall softwood lumber market in the U.S., Lindsey et al. (2000) estimated that due to the imposition of SLA 1996, U.S. consumers had to bear an additional $50 to $80 per mbf to the real price of lumber, which increased home costs by $800 to $1300. Likewise, estimating an aggregate lumber price model, Zhang (2001) estimated an anticipated change in the lumber price of $59 per mbf in 1997 U.S. dollars due to the imposition of SLA 1996. Zhang (2001) reported that the loss incurred by U.S. consumers clearly overshadowed the gain realized by U.S. producers, and SLA 1996 resulted in a dead weight loss of around $1 billion. In the meantime, Canada realized more than $3 billion in benefits. Zhang (2006) re-estimated Zhang(2001)'s aggregate price model with a longer data set covering the complete period of SLA 1996, and revealed that the price effect of SLA 1996 was $30 per mbf instead. Compared with estimates of Zhang (2001), the estimated figures in each category were relatively smaller in Zhang (2006).

Several recent studies with a large data sample, however, found a statistically insignificant effect of SLA 1996 on the softwood lumber trade between the two countries. Using advanced time-series econometric estimation approaches, Baek and Yin (2006), Song et al. (2011) and Nagubadi and Zhang (2013) revealed that SLA 1996 had no significant effects on Canadian lumber exports to the U.S. Baek and Yin (2006) pointed to the structure of SLA 1996, which consisted of a duty-free quota, a trigger price mechanism, and other excluded categories, had no effect on the lumber trade between the two countries.

3.3 The Lumber IV period

Right after the termination of SLA 1996, employing the quota rent concept, van Kooten (2002) developed a theoretical model of the Canada-U.S. softwood lumber trade to explore the effects of possible trade restrictions including import quota, import tariff and export tax on the distribution of economic rents in the U.S. and Canada. Using numerical illustrations, he concluded that Canada should prefer export quotas to both free trade or an export/import tax. If the U.S. lumber imports from other regions could be restricted, Canadian lumber producers were able to increase their overall wellbeing by voluntarily restricting lumber exports to the U.S. He also revealed that forming a cartel of Canadian lumber producers to sell lumber to the U.S. would benefit both Canadian and U.S. lumber producers. Considering the fact that U.S. and Canadian lumber products have different quality, Mogus et al. (2006) used a spatial price equilibrium model to examine the effects of import duties on Canadian lumber. They found that after controlling for substitution bias, Canadian producers would suffer less from the trade restrictions.

Similarly, several studies projected the market scenarios of the U.S.-Canada softwood lumber trade in the post-SLA 1996 period. Adams (2003) projected a 7% average annual reduction in imports from Canada over the period from 2002 to 2010 due to the imposition of 27.2% import tariffs on lumber imports from Canada. He predicted that Canadian old-growth timber harvest would decline with an increase in the timber harvest on private lands in the U.S. Likewise, by developing multi-regional spatial equilibrium models, Devadoss et al. (2005) and Devadoss (2006) concluded that the U.S. retaliatory tariff of 27.2% on Canadian lumber imports affected lumber markets all around the world. U.S. producers realized the largest benefits with a 8.16% rise in domestic production, and consumers in the U.S. South incurred the greatest loss due to the restrictions on the Canadian lumber imports. Canadian producers could compensate their loss from the U.S. trade restriction policies by redirecting their exports to Japan and European countries.

Based on historical actual time-series data, a couple of studies evaluated the effects of CVDs and ADs imposed by the U.S. during the period of 2001-early 2006. Employing a 2SLS approach of estimating dynamic supply and demand equations, Song et al. (2011) revealed that the impact of such tariffs between August 2001 and October 2006 was fairly limited because of the low price elasticity of Canadian softwood lumber. Unlike previous studies which used indicator dummy variables to capture the effects of trade restrictions, Song et al. (2011) calculated the actual rate of monthly CVDs and ADs placed by the U.S., and incorporated it into their empirical analysis. Using the multivariate vector error correction model, however, Nagubadi and Zhang (2013) estimated a 13% reduction in softwood lumber imports from Canada due to the imposition of CVDs and ADs by the U.S. Unlike Song et al. (2011), they used an indicator dummy variable to specify import duties in their empirical model.

As an important contribution to the literature, Zhang (2007) published a comprehensive book on the lumber trade dispute between the U.S. and Canada, examining the dispute from analytical, political, and economic perspectives. The softwood lumber dispute and legal proceedings were so intense that Zhang (2007) ironically regarded the trade dispute as "the softwood lumber war" between two otherwise friendly nations. He scrutinized each and every historical and political event that kept this trade issue in hot contention throughout the last three decades. The first eight chapters of the book explained each of the trade dispute in the modern era from Lumber I to Lumber IV. Zhang (2007) also presented a detailed comparative political economy of the softwood lumber war and the Newsprint tariff battle between the two countries. The book, as a final chapter, also expounded on the lessons learned from the past, the underlying causes of the lumber dispute, and possible solutions and potential routes. Zhang (2007) stated that an increase in American ownership of Canadian lumber mills (and vice versa), and a significant drop in Canada's comparative advantage in softwood resource endowments could lead to a long-term and durable solution, which would ultimately guide the trade war towards a natural ending.

3.4 The Softwood Lumber Agreement 2006

Only a few studies have evaluated the impacts of SLA 2006 on softwood lumber trade between two countries. Baek (2011) calculated the welfare effects of SLA 2006 by estimating an econometric model of U.S. lumber imports from Canada. He found that SLA 2006 has a significant negative effect on lumber imports during the period of July 2007-October 2009. His econometric approach of estimating the model, however, is relatively weak. Using the fully modified ordinary least square (FM-OLS) approach of estimating a time-series model, Baek (2012) also estimated a significant negative long-term effect of SLA 2006 on U.S. lumber imports from Canada from January 2007 to June 2009. A recent study by Nagubadi and Zhang (2013) also reported that, during the period of October 2006 - March 2013, SLA 2006 had reduced U.S. imports of softwood lumber by 11.2%. Since both Baek(2012) and Nagubadi and Zhang (2013) employed an indicator dummy to capture the effect of SLA 2006, the dummy variable could reflect the joint effects of both SLA 2006 and the housing market bust. One could argue that the reduction in U.S. lumber demand during the SLA 2006 period was primarily the result of the U.S. housing market bust. Moreover, using the simulation approach of the world lumber market, van Kooten and Johnston (2014) projected that with the removal of the export tax on Canadian lumber exports to the U.S., Canadian lumber production would rise by 3.2 million m^3. But the change in welfare would be moderate: the net loss to U.S. lumber producers would be $112 million, but the U.S. consumers could gain $107 million.

Chapter 4
The United States-Canada Softwood Lumber Agreement 2006: A Cournot-Nash Duopoly Model

4.1 Introduction: Strategic Trade Policy Models

The strategic aspects of trade policy were first introduced by Brander (1981) as an important tool to investigate trade policy debates. Strategic trade policy is an application of oligopoly theory, which affects the outcome of strategic interactions between firms in actual or potential international trade markets (Spencer and Brander 2008). It considers an application of non-cooperative game theory and uses the Nash equilibrium concept on the sequential structure of decision-making (Brander 1997). Brander (1981) first applied the concept of the strategic trade policy to explain intra-industry trade in identical goods. Later, a number of papers applied strategic trade policy to assess the strategic interactions between a domestic and a foreign firm under international duopoly and monopolistic competition. Brander and Spencer (1981) developed a model of entry deterrence to analyze the effectiveness of tariffs to extract monopoly rents from imperfectly competitive foreign firms. Spencer and Brander (1983) developed a three-stage subgame perfect model to study the behavior of governments and firms, and revealed that industrial strategies such as R&D or export subsidies can increase domestic welfare by shifting profits from foreign to domestic firms. Brander and Spencer (1984a, 1984b) determined the specific optimum tariff rate for extracting rent from imperfectly competitive foreign firms. Another notable application of strategic trade policy is Brander and Spencer (1985), which considered a Cournot-Nash equilibrium model to depict the profit-shifting role of export subsidies to a domestic firm.

Under the framework of strategic trade policy, several studies examined the trade intervention and welfare effects of trade policies under olilogpoly (Dixit 1984; Krugman 1984; Eaton and Grossman 1986), and revealed that trade restriction policies can raise national welfare in imperfectly competitive markets. Eaton and Grossman (1986) analyzed the effects of industrial policies including production taxes and subsidies, and found that such domestic policies are also effective in shifting oligopolistic profits from foreign firms. Dixit (1988) examined the optimum domestic policies in response to foreign export subsidies under oligopoly, and concluded that countervailing tariffs could be an effective domestic measure to offset part of a foreign export subsidy. By developing a basic homogenous Cournot oligopoly model between two countries, Colie (1991) also analyzed various domestic retaliation measures which affect the profit-shifting argument for foreign export subsidies. Following Brander and Spencer (1984, 1985) and Colie (1991), this study develops a two-country homogenous Cournot-Nash duopoly model of softwood lumber production in the U.S. and Canada.

4.2 The Cournot-Nash Duopoly Model

This study considers a basic model of two-country homogenous Cournot-Nash duopoly as a strategic trade policy model to investigate the strategic interactions of lumber trade between the U.S. and Canada. We assume that the U.S. is the home country and Canada the foreign country. Let x be the quantity of softwood lumber produced by the U.S. firm, and the Canadian firm produces and sells y units of softwood lumber in the U.S. market. The Canadian consumption of softwood lumber is ignored, since two thirds of Canadian lumber production is shipped to international markets. Total sales in the U.S. lumber market are $Q = x + y$. Let the linear inverse demand function be given by $P = P(Q) = p(x + y)$. The U.S. firm has a constant production cost of c_{us} per mbf, and the Canadian firm has a constant cost of c_{ca} per mbf. The difference in marginal costs of production accounts for the national differences in production efficiency of sawmills as well as resource endowments. Transportation costs are ignored for simplicity. We assume that both Canadian and U.S. firms produce identical softwood lumber of homogenous quality. Consequently, consumers in the U.S. are indifferent to the lumber source, and a single representative price (P) represents the entire softwood lumber market.

According to SLA 2006, the magnitude of the export tax is a function of the prevailing monthly price of softwood lumber. Since Alberta and British Columbia, the two major lumber exporting Canadian provinces accounting for almost 66% of Canadian exports to the U.S. follow option A of the agreement, this study only considers option A and ignores option B. Let t be the export tax which decreases with increasing market price of softwood lumber.

A non-cooperative equilibrium exists when each country is maximizing its profit with respect to its own strategy variable i.e. quantity of softwood lumber, given the level of the quantity of lumber produced by another country. The strategy space of both firms is $[0, \infty)$, which indicates that both countries can alter their level of softwood production freely, given the level of their rival country. Given that $P(Q)$ is decreasing, twice continuously differentiable, and $QP(Q)$ is bounded, there exists a unique Cournot equilibrium (Colie, 1991). The profit functions for the U.S. and Canadian firms (π and π^*) are specified as:

$$\pi = Px - c_{us}x \tag{4.1}$$

$$\pi^* = Py - c_{ca}y - tPy \tag{4.2}$$

where, asterisk denotes the profit function associated with the Canadian firm

Assuming that an interior solution where both firms produce positive quantity of softwood lumber exists, the first-order conditions (FOCs) for the U.S. and Canadian firms are:

$$\pi_x = P + xP' - c_{us} = 0 \tag{4.3}$$

$$\pi_y^* = (1 - t)P + y(1 - t)P' - c_{ca} = 0 \tag{4.4}$$

Likewise, second-order condition of both profit functions are:

$$\pi_{xx} = 2P' + xP'' < 0 \tag{4.5}$$

$$\pi_{yy}^* = 2(1 - t)P' + y(1 - t)P'' < 0 \tag{4.6}$$

where, primes and subscripts denote the derivatives; and $P' < 0$. These FOCs define the reaction functions of U.S. and Canadian lumber-producing firms. Each firm shows its best response to the output chosen by another firm in the implicit form. The simultaneous solution of equations (4.3) and (4.4) for the optimum quantity of softwood lumber production is a Cournot-Nash equilibrium.

We also use the following conditions:

$$\pi_{xy} \equiv P' + xP'' < 0; \qquad \pi^*_{yx} \equiv (1-t)P' + y(1-t)P'' < 0 \tag{4.7}$$

Condition (4.7) implies that the marginal revenue of each firm declines with increases in the quantity of the other firm, which is equivalent to reaction functions being downward sloping (Brander and Krugman 1983; Brander and Spencer 1985). It implies that both U.S. and Canadian softwood lumber are strategic substitutes to each other.

From condition (4.5) - (4.7), we have:

$$\pi_{xx} < \pi_{xy}; \qquad \pi^*_{yy} < \pi^*_{yx} \tag{4.8}$$

$$D = \pi_{xx}\pi^*_{yy} - \pi^*_{yx}\pi_{xy} > 0 \tag{4.9}$$

Comparative Static Analyses

In order to obtain the comparative static results for the effects of the agreement on production of softwood lumber by both firms, we employ the total differentiation of the FOCs (4.3) and (4.4), which yields:

$$\begin{bmatrix} \pi_{xx} & \pi_{xy} \\ \pi^*_{yx} & \pi^*_{yy} \end{bmatrix} \begin{bmatrix} dx \\ dy \end{bmatrix} = \begin{bmatrix} -\pi_{xt}dt \\ -\pi^*_{yt}dt \end{bmatrix} \tag{4.10}$$

Using (4.3) and (4.4), we have $\pi_{xt} = 0$ and $\pi^*_{yt} = -(P + P'y)$. As P is always positive and P' is always negative, the sign of the π^*_{yt} is ambiguous. However, we show that the sign of π^*_{yt} is negative[1]. With this note, we derive the dx/dt and dy/dt using Cramer's rule[2].

$$x_t \equiv dx/dt = \pi_{xy}\pi^*_{yt}/D > 0 \tag{4.11}$$

[1]We prove it by contradiction. Suppose, a linear inverse demand function $P = a + P'y$ as in Brander and Spencer (1985), and let $P'y > P$. Then, $P'y > a + P'y$, which suggests that $0 > a$. But, in linear demand, there must be $a > 0$. So we can conclude that $P > P'y$, and $\pi^*_{yt} < 0$.

[2]See Appendix A for detailed derivation.

$$y_t \equiv dy/dt = -\pi_{xx}\pi^*_{yt}/D < 0 \qquad (4.12)$$

Using (4.5), (4.7) and (4.9), we derive an important proposition from (4.11) and (4.12) that an increase in the Canadian export tax increases U.S. production and decreases Canadian softwood lumber production.

Effects of export tax on overall lumber price, and profits of U.S. and Canadian firms

We assess the effects of export tax on overall price of softwood lumber, and the profits of both U.S. and Canadian firms [3].

1. Effects on the lumber price

$$\begin{aligned} P_t = dP(x+y)/dt &= P'(x_t + y_t) \\ &= P'[(\pi_{xy}\pi^*_{yt}) - (\pi_{xx}\pi^*_{yt})]/D, \quad \text{using (11) and (12)} \\ &= > 0, \quad \text{using (8) and (9)} \end{aligned} \qquad (4.13)$$

Condition (4.13) depicts that the overall price of softwood lumber increases with an increase in export tax.

2. Effects on the profit of a U.S. firm

To analyze the effect of export tax on the profit of a U.S. firm, we totally differentiate the condition (4.1) with respect to t. Then, we have:

$$\pi_t \equiv d\pi/dt = \pi_x x_t + \pi_y y_t$$

Using $\pi_x = 0$ from (3), $\pi_y = xP'$ and $y_t = -\pi_{xx}\pi^*_{yt}/D < 0$ from (4.12);

$$\pi_t = -xP'\pi_{xx}\pi^*_{yt}/D > 0 \qquad (4.14)$$

We can see that an increase in the export tax imposed by Canada on softwood lumber exports increases profits of a U.S. firm.

3. Effects on the profit of a Canadian firm

[3] We closely follow Brander and Spencer (1985) to derive the proofs.

Using the same procedure, the effect of export tax on the profit of Canadian firm:

$$\pi_t^* \equiv d\pi^*/dt = \pi_x^* x_t + \pi_y^* y_t + \delta\pi^*/\delta t$$

Using $\pi_y^* = 0$ from (4.4), $\pi_x^* = (1-t)yP'$, $x_t = \pi_{xy}\pi_{yt}^*/D > 0$ from (4.11), and $\delta\pi^*/\delta t = -Py$;

$$\pi_t^* = (1-t)yP'\pi_{xy}\pi_{yt}^*/D - Py < 0 \tag{4.15}$$

We found that an export tax decreases the overall profit of Canadian firms.

Conditions (4.13) - (4.15) depict that an obligatory imposition of export tax on softwood lumber exports increases overall lumber price and the profit of U.S. lumber-producing firms, but reduces the profit of Canadian firms. These results are consistent with the trade theory that an export tax in a single-market hurt the producers in the exporting country, whereas it favors the producers in the importing country (Appleyard et al., 2011).

4.3 Linear demand-An illustration

let's assume the special case that the demand function is linear as:

$$P = P(Q) = a - b(x+y) \tag{4.16}$$

where a and b are demand parameters and always positive, and $p(Q) = 0$ for $Q \geq a$.

Now, profit functions of U.S. and Canadian firms are simplified as:

$$\pi = (a - bx - by)x - c_{us}x \tag{4.17}$$

$$\pi^* = (1-t)(a - bx - by)y - c_{ca}y \tag{4.18}$$

Then, FOCs for the U.S. and Canadian firms are:

$$\pi_x = \frac{\delta\pi_{us}}{\delta x} = a - 2bx - by - c_{us} = 0 \tag{4.19}$$

$$\pi_y^* = \frac{\delta\pi_{ca}}{\delta y} = (1-t)(a - bx - 2by) - c_{ca} = 0 \tag{4.20}$$

Likewise, SOCs of the profit functions (4.17) and (4.18) are:

$$\pi_{xx} = \frac{\delta^2 \pi_{us}}{\delta x^2} = -2b \tag{4.21}$$

$$\pi^*_{yy} = \frac{\delta^2 \pi_{ca}}{\delta y^2} = -2b(1-t) \tag{4.22}$$

Solving two FOCs, the Cournot equilibrium quantities (x^c, y^c) for the U.S. and Canadian firms under the agreement are:

$$x^c = \frac{a - 2c_{us}}{3b} + \frac{c_{ca}}{3b(1-t)} \tag{4.23}$$

$$y^c = \frac{a + c_{us}}{3b} - \frac{2c_{ca}}{3b(1-t)} \tag{4.24}$$

where, superscript ^{c} denotes the Cournot-Nash equilibrium, and $\left(\frac{a+c_{us}}{3b}\right) > \left(\frac{2c_{ca}}{3b(1-t)}\right)$ in equation (4.24).

Likewise, the market equilibrium output $(Q = x + y)$, lumber price and the profits of both firms are:

$$Q^c = \frac{2a - c_{us}}{3b} - \frac{c_{ca}}{3b(1-t)} \tag{4.25}$$

$$P^c = \frac{a + c_{us}}{3} + \frac{c_{ca}}{3(1-t)} \tag{4.26}$$

$$\pi^c_{us} = \frac{1}{b}\left[\frac{a - 2c_{us}}{3} + \frac{c_{ca}}{3(1-t)}\right]^2 \tag{4.27}$$

$$\pi^c_{ca} = \frac{[(a + c_{us})(1-t) - 2c_{ca}]^2}{9b(1-t)} \tag{4.28}$$

It can be inferred from equations (4.25)- (4.28), the equilibrium quantity of softwood lumber production, overall lumber price, and profits of both firms are primarily determined by the values of the linear demand parameters a and b, the lumber production costs in the U.S. and Canada, and the level of the export tax as specified in SLA 2006.

In order to examine the effects of the export tax t on softwood lumber production, lumber price and profits of firms, the first derivatives of conditions (4.23) – (4.28) are evaluated. Consistent with the results concluded in equations (4.13)- (4.15), the special case of the linear demand also shows that the values of $\frac{dx^c}{dt}$, $\frac{dP}{dt}$ and $\frac{d\pi_{us}^c}{dt}$ are always positive, whereas $\frac{dy^c}{dt}$, $\frac{dQ^c}{dt}$, and $\frac{d\pi_{ca}^c}{dt}$ are negative.

$$\frac{dx^c}{dt} = \frac{c_{ca}}{3b(1-t)^2} > 0 \tag{4.29}$$

$$\frac{dy^c}{dt} = -\frac{2c_{ca}}{3b(1-t)^2} < 0 \tag{4.30}$$

$$\frac{dP}{dt} = \frac{c_{ca}}{3(1-t)^2} > 0 \tag{4.31}$$

$$\frac{dQ^c}{dt} = -\frac{c_{ca}}{3b(1-t)^2} < 0 \tag{4.32}$$

$$\frac{d\pi_{us}^c}{dt} = \frac{2c_{ca}}{3b(1-t)^2}\left[\frac{a-2c_{us}}{3} + \frac{c_{ca}}{3(1-t)}\right] > 0 \tag{4.33}$$

$$\frac{d\pi_{ca}^c}{dt} = -\frac{1}{9b}\left[\left\{\frac{a+c_{us}}{3}\right\}^2 - \left\{\frac{2c_{ca}}{3(1-t)}\right\}^2\right] < 0 \tag{4.34}$$

From equation (4.24), we know that $(\frac{a+c_{us}}{3b}) > (\frac{2c_{ca}}{3b(1-t)})$, so the value of $\frac{d\pi_{ca}^*}{dt}$ in equation (4.34) is unambiguously negative.

Based on the equations (4.29)- (4.34), it can be concluded that the obligatory export tax on Canadian lumber exports as specified in SLA 2006 increases U.S. lumber production and decreases the quantity of Canadian lumber exports to the U.S. Likewise, it is able to increase the overall lumber price and the profits of U.S. lumber-producing firms, and reduces the profits of Canadian firms.

One useful condition that allows us to interpret the relationship between U.S. and Canadian softwood lumber is given by (identical to equation (4.7)):

$$\frac{\delta^2\pi_{us}}{\delta x\delta y} \equiv -b < 0; \quad \frac{\delta^2\pi_{ca}}{\delta x\delta y} \equiv -b(1-t) < 0 \tag{4.35}$$

Condition (4.35) implies that the marginal revenue of each firm declines with an increase in the quantity of the other firm, which is equivalent to reaction functions being downward sloping (Tirole 1988). Not surprisingly, it implies that U.S. and Canadian softwood lumber are strategic substitutes.

Chapter 5
How Effective is the United States-Canada Softwood Lumber Agreement 2006? An Econometric Study

5.1 Introduction

The ongoing softwood lumber trade dispute between the U.S. and Canada is one of the longest and most contentious trade battles in international trade history. The softwood lumber trade between these two countries is an important inter-country political issue, because it involves billions of dollars of trade each year. The underlying causes behind this dispute include the public ownership of forest land in Canada, timber subsidies by provincial governments to Canadian lumber producers (Lindsey et al. 2000), and U.S. retaliatory measures of countervailing duties (CVDs) and anti-dumping (ADs) tariffs (Devadoss 2006). Unlike in the U.S. where 58% of the forests are owned by the private sector, almost 94% of Canadian timber lands are under the ownership of federal and provincial governments (Abboushi 2010). U.S. lumber producers have been arguing that provincial governments in Canada provide subsidies to lumber industries in the form of low stumpage prices for harvesting the standing timber, and that subsidized Canadian lumber exports are dumped in the U.S. In fact, exercising their prerogative to value the public forests, Canadian provincial governments determine the stumpage price administratively rather than through a competitive auction bid (Zhang 2007).

The Softwood Lumber Agreement (SLA) 2006 is a nine-year trade agreement between the U.S. and Canada, and has been in effect since late 2006 to limit Canadian lumber shipments to the U.S. It is a price-driven ad-valorem export tax rate coupled with a quota system. According to the agreement, provinces in Canada must choose between Option A and Option B on the softwood lumber exports to the U.S. Option A is solely an export charge ranging from 0-15% of the prevailing monthly price; whereas option B is an export charge of 0-5% combined with a volume restraint (SLA 2006). Alberta and British Columbia, the two major Canadian lumber-producing provinces, follow option A, while other Canadian lumber producing provinces such as Manitoba, Saskatchewan, Ontario and Quebec follow option B of the agreement. As specified in SLA 2006, the rate of the Canadian export tax and/or volume restraint is a function of the prevailing monthly price: the higher the lumber price, the fewer (or no) export barriers to the U.S. Free trade of softwood lumber prevails if the prevailing monthly price is above $US 355 per thousand board feet (mbf), but Canada has to impose a constant 15% export tax if the monthly lumber price is under $US 315/mbf.

This paper evaluates the impact of SLA 2006 on the softwood lumber trade between the U.S. and Canada. By estimating econometric models for the U.S. softwood lumber market using monthly time-series data, this study specifically examines the effects of the export tax imposed by Canada on the U.S. domestic lumber supply as well as on Canadian exports to the U.S. Unlike the previous studies, this study primarily focuses on the SLA 2006 period, and computes the actual dollar value of the export tax collected by Canada during this period. Moreover, Canadian monthly lumber exports from Maritime provinces and SLA-excluded companies are deducted from the total Canadian lumber shipments to the U.S. More importantly, the data period of this study covers a wide spectrum of lumber prices from a low of $195/mbf to a high of $437/mbf. Consequently, the wide variation in the softwood lumber market presents an opportunity to provide a much more accurate calibration of the market, something that was not previously possible.

In stark contrast to the results from previous studies, results reveal that SLA 2006 has limited influence on the softwood lumber trade between the U.S. and Canada. Apparently, SLA 2006 is ignored by the lumber market and the lumber trade between the U.S. and Canada is instead determined by market forces. In other words, while much of this trade dispute is thought to be governed by strategic behavior leading to protracted negotiations, market forces seems simply to ignore all these so-called strategic considerations and operate freely in this arena. While SLA 2006 is going to expire in 2015, the findings of this study provide useful insights into this trade dispute between the U.S. and Canada.

5.2 A Brief History of the Trade Dispute

Table 5.1 presents the major trade barriers imposed by the U.S. on Canadian softwood lumber imports since the late 1980s.[1] The primary objective of those trade policies was to limit Canada's market share in the U.S. softwood lumber market, which would ultimately raise the domestic lumber price in the U.S. During the period between mid 1970s and mid 1980s, Canadian softwood lumber imports rose sharply by around 136% and captured more than one-third of the U.S. lumber market (Buongiorno et al. 1988). U.S. lumber producers, who argued that the Canadian government subsidized the stumpage prices for Canadian lumber industries, started lobbying for retaliatory measures against Canadian softwood lumber imports (Zhang 2007). Since the U.S. International Trade Commission estimated a 15% subsidy on Canadian softwood stumpage price in 1986, both countries endorsed a five-year memorandum of understanding (MOU) under which provincial governments in Canada either had to levy a 15% export tax on its lumber shipments to the U.S. or increase the prevailing stumpage prices.

When the Canadian government unilaterally terminated the MOU in 1991, the U.S. government immediately imposed interim duties on Canadian lumber imports. After several rounds of debates and negotiations, both countries formulated the Softwood Lumber Agreement in 1996, and that was effective for next five years. It was a tariff-regulated quota system restricting Canadian lumber imports to the U.S. for five years (Zhang 2001). SLA 1996 specified annual duty-free export quotas of 14.7 billion board feet (bbf) of softwood lumber. For export quantities of over 14.7 bbf, SLA 1996 specified US$50-$100 per mbf of the export fee on Canadian lumber shipments to the U.S. Since both U.S. and Canadian governments were reluctant to renew the agreement upon its expiration in 2001, the U.S. government again started imposing province-specific duty rates on Canadian lumber imports.

[1] Please refer to Random Lengths (2014) and Zhang (2007) for a more detailed history of the softwood lumber dispute.

Table 5.1: U.S. trade restriction measures on Canadian softwood lumber imports

Duration	Trade policies	Description
1987-1991	MOU	15% export tax or stumapge price adjustment
1991-1992	CVD and AD	Province-specific countervailing duties and antidumping tariffs: 3.1 to 15%
1992	Interim CVD	14.48%
1992-1994	CVD (Ad Valorem)	6.51%
1996-2001	SLA 1996	Tariff-rate quota
2001-2006	Various CVD and AD	AD: 2.11%–3.78%; and CVD: 8.7%–31.89%
2006-2015	SLA 2006	0–15% tax of export price or export charge of 0–5% with volume restraint

Source: Zhang(2007) and Random Lengths (2015)

The period between 2001 and late 2006 was one of turmoil during which the U.S. Department of Commerce implemented several CVDs and ADs up to a rate of 27.2%. Canada challenged all U.S. actions at the World Trade Organization (WTO) and the North American Free Trade Agreement (NAFTA), and won most of the cases. After numerous rounds of talks and negotiations between the two governments, they finally reached a tentative seven-year agreement in 2006. Following the bilateral agreement, which was implemented in October 2006, the U.S. withdrew all import duties imposed on Canadian lumber imports, and the Canadian government started imposing a 5 to 15% export tax and/or quotas on Canadian shipments to the U.S. As a part of the negotiation, the U.S. returned abou5 $5 billion to Canada as compensation for the earlier CVDs and ADs. In 2012, trade representatives from both countries signed a two-year extension of the softwood lumber agreement through 2015 without changing the structure of the 2006 agreement (Random Lengths, 2014).

5.3 Literature Review

The softwood lumber trade dispute has received considerable attention among trade economists since the late 1980s. Employing various economic tools and techniques, several studies have analyzed the effects of past trade restriction measures on the overall social welfare of both countries. Spatial price equilibrium analysis was the common approach applied to evaluate the welfare effects of the trade policies. Early studies by Boyd and

Krutilla (1987), Chen et al. (1988), Wear and Lee (1993), and Myneni et al. (1994) specifically studied the welfare effects of the 1986 MOU. They revealed that this MOU was successful in limiting Canadian lumber exports to the U.S. However, using advanced time-series econometrics on a longer monthly dataset, recent studies by Song et al. (2011) and Nagubadi and Zhang (2013) estimated that the MOU had a statistically non-significant effect on Canadian lumber exports to the U.S.

Likewise, a number of past studies evaluated the effects of SLA 1996 on the U.S. and Canadian softwood lumber markets. Based on the econometric estimation, the rise in the real lumber price due to the imposition of SLA 1996 was estimated to be between US$30 and US$80 mbf (Lindsey et al. 2000; Zhang 2001; Zhang 2006). Kinnucan and Zhang (2004) also estimated that 63% of the Canadian export tax was transferred to Canadian consumers during the SLA 1996 period. After the expiration of SLA 1996, van Kooten (2002) explored the effects of various trade restrictions including import quota, tariff and export tax on the distribution of economic rents in the U.S. and Canada, and suggested that forming a cartel of Canadian lumber producers to sell lumber in the U.S. would benefit both Canadian and U.S. lumber producers.

Similarly, several studies evaluated the effects of the U.S. CVDs and ADs on Canadian imports in the post-SLA 1996 period. Some of the notable studies that analyzed the effects of import duties on lumber imports are Adams (2003), Devadoss et al. (2005), Devadoss (2006), Mogus et al. (2006). By developing multi-regional spatial equilibrium models, Devadoss et al. (2005) and Devadoss (2006) estimated that U.S. producers realized the largest benefits, and consumers in the U.S. South incurred the greatest losses due to the restrictions on Canadian lumber imports. On the other hand, Yin and Baek (2004) and Baek and Yin (2006) focused on methodological improvements over the past studies, and estimated a non-structural vector auto-regression model of the U.S. softwood lumber market. Baek and Yin (2006) found that MOU was an effective trade agreement to restrict the Canadian lumber shipments to the U.S., but SLA 1996 was unable to work as expected. Based on time-series econometric estimation, Song et al. (2011) and Nagubadi and Zhang (2013), however, reported that SLA 1996 had a statistically non-significant effect on Canadian lumber exports to the U.S.

Only a few studies have evaluated the impact of SLA 2006 on softwood lumber trade between the two countries. Based on an analysis of the world lumber market, van Kooten (2013) projected that by removing the export tax on Canadian lumber exports to the U.S., U.S. lumber production would decrease by nearly 1 million m^3 and Canadian lumber production would rise by 3.2 million m^3. Likewise, Baek (2011; 2012) estimated a significant negative effect of SLA 2006 on U.S. lumber imports from Canada. A recent study by Nagubadi and Zhang (2013) also reported that SLA 2006 reduced U.S. imports of softwood lumber by 11.2%. Both of these studies included the Canadian export tax into their empirical models as a dummy variable for the period of SLA 2006. Specifying the dummy (indicator) variable for the SLA 2006 period could also measure the combined effects of other unknown variables. For instance, Majumdar et al. (2010) concluded that the dummy variable of SLA 2006 in the period of 2007-2009 also captured the effects of the great financial crisis on the U.S. softwood lumber production. Therefore, the previous findings on the effects of SLA 2006 based on the dummy variable might be less reliable. In lieu of the dummy variable, we compute the actual amount of monthly export tax ($/mbf) collected by Canada, and incorporate it in the empirical modeling as a continuous variable. We use the Limited Information Maximum Likelihood (LIML) approach to estimate demand and supply equations for the U.S. softwood lumber market. Since we specifically include the export tax as a continuous variable, we cannot utilize the data series prior to the SLA 2006 period.

5.4 Theoretical Framework

In order to estimate an econometric model for the U.S. softwood lumber market, we follow the theoretical framework devised by past studies, specifically, Myneni et al. (1994), Baek and Yin (2006) and Song et al. (2011). We modified model specifications of Song et al. (2011) and included our variables of interest in order to evaluate the effects of SLA 2006. Generally, a Cobb-Douglas profit function for the softwood lumber industry is considered to derive the lumber supply model, and a Cobb-Douglas cost function is taken into account to derive the lumber demand equation (Song et al. 2011). The following dynamic system of demand and supply equations for the U.S. softwood lumber market is considered.

$$\begin{aligned} qs_t =& \alpha_0 + \alpha_1 p_t + \alpha_2 etar_t + \alpha_3 coex_t + \alpha_4 ptim_{t-1} + \alpha_5 v_{t-1} + \alpha_6 ws_t + \alpha_7 r_t + \\ & \alpha_8 oct_t + \alpha_9 nov_t + \alpha_{10} dec_t + \alpha_{11} jan_t + \alpha_{12} feb_t + \alpha_{13} qs_{t-1} + \alpha_{14} qs_{t-2} \\ & + \cdots + \alpha_{24} qs_{t-12} + \epsilon s_t \end{aligned} \tag{5.1}$$

$$\begin{aligned} qc_t =& \beta_0 + \beta_1 p_t + \beta_2 etar_t + \beta_3 coex_t + \beta_4 ptimc_{t-1} + \beta_5 vc_{t-1} + \beta_6 wc_t + \beta_7 rc_t + \\ & \beta_8 xc_t + \beta_9 oct_t + \beta_{10} nov_t + \beta_{11} dec_t + \beta_{12} jan_t + \beta_{13} feb_t + \beta_{14} qc_{t-1} \\ & + \beta_{15} qc_{t-2} + \cdots + \beta_{25} qc_{t-12} + \epsilon c_t \end{aligned} \tag{5.2}$$

$$\begin{aligned} qd_t =& \gamma_0 + \gamma_1 p_t + \gamma_2 h_t + \gamma_3 pb_t + \gamma_4 rec_t + \gamma_5 oct_t + \gamma_6 nov_t + \gamma_7 dec_t + \gamma_8 jan_t \\ & + \gamma_9 feb_t + \gamma_{10} qd_{t-1} + \gamma_{11} qd_{t-2} + \cdots + \gamma_{21} qd_{t-12} + \epsilon d_t \end{aligned} \tag{5.3}$$

Table 5.2 presents a detailed description of each variable in equations (5.1) - (5.3) and their respective data sources. The terms qs_t and qd_t denote monthly supply and demand quantities of softwood lumber in the U.S, and qc_t refers to Canadian monthly softwood lumber exports from the provinces which are included in SLA 2006. The term p_t represents the Random Lengths monthly composite lumber price, which is a weighted average of 15 key framing lumber prices in the U.S. and Canada (SLA 2006); $ptim_{t-1}$ and $ptimc_{t-1}$ refer to the prices of the timber material in the U.S. and Canada in the previous month respectively; v_{t-1} and vc_{t-1} represent the softwood lumber inventory in the U.S. and Canada in previous month respectively. We included oct_t, nov_t, dec_t, jan_t and feb_t as monthly dummy variables for October, November, December, January and Februry respectively to capture the seasonal effects in all three equations. In order to address the autocorrelation issue in each equation, up to 12 lags of each dependent variable are included in each equation. Moreover, ϵs_t, ϵc_t and ϵd_t denote i.i.d. error terms in U.S. supply, Canadian export supply to the U.S., and U.S. demand equations of the softwood lumber market respectively.

Table 5.2: Variables, their descriptions and sources (2006:10 - 2014:07)

Variable	Description	Source
qs_t	U.S. lumber supply: shipments from U.S. West (Inland and Coast) + production from U.S. South	Random Lengths[a]
qd_t	U.S. lumber demand: total supply + imports – exports	Random Lengths
qc_t	Canadian lumber exports to the U.S. from SLA 2006 included provinces	Foreign Affairs, Trade Development Canada
p_t	Lumber composite price[b]	Random Lengths
$etar_t$	Export tax according to SLA 2006[c]	Random Lengths
$coex_t$	Canadian overseas lumber exports	Random Lengths
v_t	U.S. lumber inventory-U.S. west as a proxy	Random Lengths
vc_t	Canadian lumber inventory	Random Lengths
$ptim_t$	U.S. timber price-a price index of softwood logs, bolts and timber	U.S. BLS[d]
$ptimc_t$	Canadian timber price-a price index of softwood logs and bolts	Statistics Canada
ws_t	Wage rate of U.S. sawmill workers	U.S. BLS
wc_t	Wage rate of Canadian sawmill workers	Statistics Canada
r_t	U.S. three-year treasury constant maturity rates	U.S. Federal Reserve System
rc_t	Canadian three-year benchmark bond yields	Statistics Canada
h_t	Housing starts in the U.S.- seasonally adjusted annual rate	U.S. Census Bureau
pb_t	Price index of common building bricks	U.S. BLS
xc_t	Canada/U.S. foreign exchange rate	U.S. Federal Reserve System
rec_t	Global financial crisis 2008-2009	1 for 2007:12–2009:06

[a]Various monthly issues of Random Lengths Yardstick (2006-2014)
[b]Random Lengths lumber composite price
[c]Export tax rate multiplied by p_{t-2}
[d]U.S. Department of Labor, Bureau of Labor Statistics

Two variables $etar_t$ and $coex_t$ are the major variables of interest, representing the export tax per mbf of softwood lumber and the quantity of the Canadian overseas lumber exports respectively. The export tax rate is option A export charge that Canada imposes on its shipments to the U.S. According to option A of SLA 2006[2], the export tax is primarily based on the prevailing monthly lumber price p_t. The definition of prevailing monthly lumber price is somewhat complex. The prevailing monthly price, as defined in SLA 2006, is the four-week average of the Random Lengths framing lumber composite prices available 21 days before the beginning of the month to which the prevailing monthly price will be applied. In other words, the level of export tax for the current month (t) is based on the level of average monthly Random Lengths composite price from approximately two months prior ($t-2$). The Random Lengths framing lumber composite price is a broad index of the overall softwood lumber market in the U.S, which is a weighted average of fifteen structural lumber prices in the U.S and Canada (Random Lengths 2014). Therefore, the export tax rate is multiplied by the lumber composite price of two months prior (p_{t-2}) to obtain the export tax per mbf in the current month.

As the share of Canadian overseas exports (China, Japan and European countries) has been increasing substantially, particularly in last six years, this study attempts to evaluate the effects of the $coex_t$ on the lumber supply in the U.S. and Canada. The variable $coex_t$ not only captures the dynamics of the overseas softwood lumber market but also incorporates the impact of expanded Asian lumber markets. On the other hand, we include a dummy variable ($recs$) in the demand equation to capture the effects of the 2008-09 global financial crisis on the softwood lumber market. The recession was primarily triggered by the sub-prime mortgage crisis and the U.S. housing market bust. It persisted for 19 months from December 2007 to June 2009 (NBER 2010).

5.5 Model Estimation

Since demand and supply quantities (qs_t, qc_t and qd_t) and the lumber price (p_t) are endogenous, the issue of simultaneous equation bias emerges while empirically estimating the system of equations (5.1) – (5.3). The system of simultaneous equations satisfies the order conditions for identification, as each equation includes more excluded exogenous

[2]For simplicity, we model only option A in this study. Option B while being adopted by four Canadian provinces, represents on average only 19% of the monthly exports to the U.S.

variables than endogenous variables. Given that the ordinary least squares (OLS) estimator is inconsistent in the presence of simultaneous equation bias, limited information estimators and full information estimators are commonly used to consistently estimate the coefficients of the system of equations (Greene 2011, p. 326). The limited information estimators such as two-stage least squares (2SLS) and limited information maximum likelihood (LIML) are single-equation estimation approaches, whereas the full information estimators such as three-stage least squares (3SLS) and full information maximum likelihood (FIML) estimate all equations jointly. Even though full information estimators are asymptotically more efficient, any specification error in the structure of the model is transmitted throughout the system, and they usually have larger finite-sample variance (Greene 2011, p. 333). While the 2SLS method is widely applied to estimate a system of equations, the LIML approach performs better in the presence of weak and/or a large number of instruments (Hill et al. 2011, p. 470). Further, the LIML estimator has a more symmetric distribution and converges to normality faster than the 2SLS estimator. Though we have a few instruments, we employ the LIML approach as the LIML estimators converge to normality faster.

The historical monthly time-series data for all variables from October 2006 to July 2014 are obtained from several sources. The data period starting from October 2006 is chosen to evaluate the effect of SLA 2006 on the softwood lumber market in the U.S. Unlike the previous studies which included trade policy variables as time dummies, this study employs the observed monthly data of the export tax as a continuous explanatory variable. Most of the historical data on softwood lumber supply, demand, lumber composite price, export tax, Canadian overseas lumber exports, and lumber inventories are gathered from various monthly issues of Random Lengths Yardstick from 2006 to 2014. Canadian lumber exports only from SLA included provinces, i.e., Option A and B provinces are incorporated into the analysis. All nominal series of prices and wage rates are deflated by producer price indices to derive real prices and wage rates. Table 5.3 tabulates the summary statistics of the data employed to estimate equations (5.1) - (5.3). The average monthly export tax collected by Canada is US$16.63/mbf in 1982 dollars, which is roughly 11% of the average lumber price in the SLA 2006 period. The Canadian lumber producers paid the maximum export tax of 15% most of the months from the beginning of SLA 2006 to mid 2012. As the prevailing monthly price has been more than $355 since January 2013 (except August, September and October 2013), free trade of softwood lumber prevails for most months from the last two years.

Table 5.3: Summary statistics of the data (before log-transformation)

Variable	**Unit**	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
qs_t	mmbf	94	2255.18	342.16	1558.00	3041.00
qd_t	mmbf	94	3068.01	583.14	2185.00	4648.00
qc_t	mmbf	94	789.65	239.83	510.00	1534.79
p_t	$/mbf	94	154.84	24.28	115.65	214.74
$etar_t$	$/mbf	94	16.63	8.66	0.00	27.37
$coex_t$	mmbf	94	327.71	118.71	122.00	561.00
v_t	mmbf	94	1242.83	83.00	1022.00	1401.00
vc_t	mmbf	94	2927.98	402.26	2401.00	3940.00
$ptim_t$	1982=100	94	220.34	16.27	181.30	242.00
$ptimc_t$	2002=100	94	93.40	6.99	85.30	111.30
ws_t	$/hour	94	8.98	0.65	8.13	10.43
wc_t	C$/hour	94	30.16	3.20	23.91	39.20
r_t	%	94	1.59	1.39	0.33	5.00
rc_t	%	94	2.08	1.08	0.99	4.67
h_t	1000s	94	851.27	295.93	478.00	1649.00
pb_t	1982=100	94	189.72	5.67	179.60	197.10
xc_t	C$/US$	94	1.05	0.07	0.96	1.26
rec_t	0 or 1	94	0.20	0.40	0.00	1.00

One might wonder if there are issues involving non-stationarity and cointegration since we employ monthly time-series data to estimate the system of equations. In order to address the issue of non-stationarity, the cointegration test and multivariate vector autoregression methods are often used (Baek 2012; Nagubadi and Zhang 2013; Parajuli et al. 2015). However, as stated by Hsiao (1997a, 1997b) and Al-Ballaa (2005), the reduced-form estimation approach is perfectly valid to estimate an equation with or without non-stationary data as long as the variables are cointegrated. Song et al. (2011) also applied the similar approach to estimate the U.S. softwood lumber market using monthly time-series data without testing for unit-roots of each variable. We also follow the approach of Song et al. (2011) and apply the residual-based cointegration test in order to investigate the unit-roots of residuals in each equation.

5.6 Results and Discussion

Table 5.4 reports the LIML estimates of the simultaneous system of demand and supply equations for the U.S. softwood lumber market. Most of the variables are statistically significant at the 5% level. The associated signs of the estimated coefficients in all equations are consistent with the economic theory. Since all variables but dummy variables are log-transformed, the estimated coefficients represent the elasticity values. Among 12 lags of dependent variables specified in equation (5.1) - (5.3), only statistically significant lags are included in the final estimation of the equations.[3] In terms of model specification tests, the test for over-identifying restrictions cannot reject the hypothesis that the surplus instruments employed in each equation are valid. Moreover, the test for the white-noise of residuals indicates that the autoregressive specification of each equation addresses the problem of autocorrelation. Likewise, the residual based Augmented Dicky-Fuller test (Hsiao 1997a, 1997b, Al-Balla 2005) for the unit-root property of the residuals rejects the hypothesis that the errors are non-stationary, which clearly negates the spuriousness of our results due to data non-stationary.

The statistically significant own-price elasticity value of 0.55 (even 95% upper bound is less than one) in the U.S. supply equation suggests that the softwood lumber supply is price inelastic (Table 5.4). Other important variables which explain the supply schedule of the softwood lumber such as timber price, lumber inventory, wage rate for sawmill workers and interest rate have significant coefficient estimates with expected signs. However, the estimated coefficients associated with the Canadian export supply function are quite different. The own-price elasticity value is elastic and statistically significant with the value

[3]The significant lags of dependent variables and monthly dummies in each equation are not presented in the table 4 in order to save the space. The detailed LIML estimation results of the equation (5.1) – (5.3) are available upon request from the first author.

of 1.26. The coefficient estimate of Canadian lumber inventory is elastic with the value of 1.7. The Canadian wage rate of sawmill workers, Canadian interest rate and exchange rate are found to be statistically insignificant.

Table 5.4: LIML results of the system of equations: The U.S. softwood lumber market

Variable	U.S. supply (qs_t)	Canadian export supply (qc_t)	U.S. demand (qd_t)
p_t	$0.551^{**}(0.11)$	$1.258^{**}(0.23)$	$-0.176^{*}(0.09)$
$etar_t$	$0.018^{*}(0.01)$	0.012(0.02)	
$coex_t$	0.037(0.04)	$-0.138^{**}(0.04)$	
$ptim_{t-1}$	$-0.493^{**}(0.22)$		
v_{t-1}	$0.858^{**}(0.23)$		
ws_t	$-0.597^{**}(0.18)$		
r_t	$0.034^{**}(0.01)$		
$ptimc_{t-1}$		$-0.920^{**}(0.39)$	
vc_{t-1}		$1.696^{**}(0.31)$	
wc_t		−0.050(0.15)	
rc_t		−0.163(0.30)	
xc_t		−0.059(0.07)	
h_t			$0.384^{**}(0.06)$
pb_t			−0.240(0.25)
rec_t			$-0.066^{**}(0.02)$
Constant	0.12(1.66)	$-8.87^{**}(2.08)$	$5.46^{**}(1.44)$
R-squared	0.853	0.812	0.907
External instruments	2	2	3
Cragg-Donald F-stat[a]	15.15	18.59	15.33
Test of overidentifying restrictions[b]	0.82 [0.37]	0.63 [0.43]	1.29 [0.28]
Portmanteau test for white noise at 12 lags	16.73 [0.16]	16.52 [0.17]	5.67 [0.93]
The residual ADF test[c]	−4.74[0.00]	−3.49[0.00]	−9.40[0.00]

* and ** denote the statistical significance of the estimates at 10% and 5% level respectively Values in parenthesis and brackets are standard errors and P-values respectively.
[a]We reject the null hypothesis that instruments are weak using the test size criterion that nominal 5% test has size at most 10%.
[b]Basmann F-test.
[c]Augmented Dickey-Fuller tests of residuals.

In terms of lumber demand, the own-price elasticity of the lumber price is very inelastic with an estimated value of 0.18, which indicates that a 1% increase in the monthly lumber price leads to a drop in the U.S. lumber demand by 0.18%. Moreover, the negative and significant coefficient associated with the global financial crisis of 2008 in the U.S. lumber demand equation reveals that the financial crisis of 2008 affected the U.S. lumber market. Similarly, housing starts in the demand equation is found to be positively related with the U.S. softwood lumber demand which also captures the effects of macroeconomic conditions and the U.S. housing market.

Despite the similarity in model-setup, the magnitude of the coefficient estimates values in domestic supply and Canadian export supply equations in this study are found to be much higher than the values estimated by Song et al.(2011). The own-price elasticity value in the domestic supply model is almost three times larger here (0.55 versus 0.16) and the price elasticity value in the Canadian export supply equation is almost five times (1.26 versus 0.27) larger than the corresponding estimates in Song et al. (2011). Moreover, we find higher elasticity estimates associated with U.S. and Canadian timber prices, and U.S. and Canadian lumber inventory compared to the results of Song et al. (2011). These disparities can be attributed to the different data sample employed to estimate the models. While Song et al. (2011) included 200 monthly observations from early 1990 to 2006, our estimation mainly focused on the SLA 2006 period. Our results suggest that the softwood lumber supply schedules in the last seven years behaved quite differently. As depicted by the significant coefficient estimates of the global financial crisis and housing starts, the softwood lumber market during the study period was primarily affected by the financial crisis and the U.S. housing market.

Even though past studies reported that SLA 2006 is able to restrict the Canadian lumber shipments to the U.S., the empirical findings presented in Table 5.4 indicate that SLA 2006 had minimal eefcts on the U.S. softwood lumber market (Table 5.4). The estimated coefficient of the export tax ($etar_t$) in the U.S. domestic supply equation is statistically significant with a low value of 0.018 which indicates that the lumber supply in the U.S. increases by only 0.018% if the export tax (\$/mbf) increases by 1%. On the other hand, contrary to theory and expectation, the export tax variable in the estimated model of Canadian export supply to the U.S. is found to be statistically insignificant. While Canadian producers have paid the maximum monthly export tax of 15% on their lumber shipments to the U.S. from the beginning of SLA 2006 to mid 2012 (Random Lengths 2014), the limited effects of the export tax on the lumber supply in both countries are not as expected. The higher export tax during this period was mainly explained by the fact that the monthly prevailing lumber price in the U.S. was below the $315/mbf threshold in most of the months.

The quantity of the Canadian overseas lumber exports is found to be insignificant in the U.S. domestic lumber supply equation, indicating that Canada's other export markets do not directly influence the U.S. domestic lumber supply. It also implies that the recent expansion of Canadian lumber export markets doesn't influence the domestic lumber supply in the U.S. However, the $coex_t$ variable has a negative coefficient in the equation of the Canadian export supply to the US suggesting that a 1% increase in overseas exports ultimately decreases Canadian export supply to the U.S. by 0.14%. This is consistent with the expectation that as an increase in the Canadian overseas shipments diverts softwood lumber exports from the U.S. to overseas. It also implies that any changes in the softwood lumber market in Asia could affect Canadian lumber shipments to the U.S.

One might wonder what happened to the Canadian lumber exports from Maritime provinces and other SLA-excluded companies after the implementation of SLA 2006. We scrutinized the monthly quantity of softwood lumber shipped from SLA-excluded provinces and companies during the SLA period. We found that lumber shipments from these regions to the U.S. has not fluctuated much throughout the period. The percentage share of the exports from these regions remains to be an average of 14% with monthly export quantity of about 120 thousand mbf. The maximum percentage of lumber exports from this region was 20% in April 2011 and the lowest percentage share 9% in January 2008.

The structure of SLA 2006, and the macro-economic situations during SLA 2006 period help explain the ineffectiveness of SLA 2006 on softwood lumber trade between the U.S.

and Canada. The crux of SLA 2006 is to limit Canadian lumber shipments to the U.S. by increasing the lumber price. The variable-rate export tax was specified as a policy instrument to raise the lumber price. However, the variation in the rate of export tax from 5 to 15% is only limited to the prevailing lumber price between $315 and $355. With the same 15% export charge for the price below $315, the lower the prevailing lumber price, the lower the per mbf export charge in dollar amount incurred by the Canadian lumber producers and the less influence of the export tax on the lumber trade. On the other hand, the U.S. economy experienced a housing market bust which in turn resulted in the great financial crisis of 2008-09, and it is still recovering. The average monthly lumber price from October 2006 to March 2012 was around US$265 with the lowest value of $195 in March 2009. Given that the housing market was the major factor determining the lumber price in the U.S., even the maximum export charge of 15% specified by SLA 2006 could not raise the prevailing lumber price in the U.S.

5.7 Conclusions

In order to evaluate the effectiveness of the latest trade agreement in the softwood lumber market in the U.S. and Canada, this study estimates supply and demand models for the softwood lumber market by employing historical monthly data from October 2006 to July 2014. Given that SLA 2006 is about to expire and both countries are looking for ways forward, this study provides useful insights on the lumber trade dispute between two otherwise friendly neighboring nations.

The LIML estimates of supply and demand equations for the softwood lumber market show that the Canadian lumber exports from the SLA included provinces are price elastic, yet U.S. domestic lumber supply is price inelastic. It clearly indicates that the monthly lumber composite price alters the quantity of Canadian lumber exports to the U.S., but U.S. domestic supply schedule is less affected by the change in the lumber composite price. More importantly, the findings of this study reveal that the effects of the export tax on the U.S. softwood lumber market are quite limited. Contrary to the results of past studies, the export tax is found to be ineffective in reducing the Canadian softwood lumber shipments to the U.S. during the SLA 2006 period. Canadian overseas exports, however, suggest that, in the future these overseas markets will gain in importance while the trade dispute between the U.S. and Canada will receive less attention from Canadians.

Given that SLA 2006 is going to expire in 2015, it is time for both countries to start looking for ways forward. Once again, U.S. lumber producers will most likely argue and lobby against the free trade of softwood lumber between the two countries. Even though SLA 2006 is not able to effectively restrict Canadian exports to the U.S., both parties happily agreed to extend SLA 2006 for two more years in 2012. With the imposition of SLA 2006, both countries got essentially what they wanted. For the U.S., it appeared that the lumber prices increased as a result of the export tax. For Canada, the export tax had almost no effect on the quantity of lumber exported, thus satisfying the concerns about domestic employment. In addition, the Canadian government was able to collect a substantial amount of export charge, enabling them to do things that would not have been possible otherwise. One might speculate whether this is one of the reasons that provincial governments in Canada are reluctant to switch to an auction-bid pricing system that would once and for all solve this trade dispute. In the meantime, the minimal effects of SLA 2006 on softwood lumber trade have also been able to satisfy the National Association of Home Builders, a representative group of lumber consumers in the U.S. Under these circumstances, a continuation of SLA 2006 would be a win-win and prudent step to resolve the issue at least temporarily without substantial harm to either side in the days to come.

Chapter 6
The United States-Canada Softwood Lumber Agreement 2006: An Actual versus Optimal Export Tax

6.1 Introduction

The U.S.-Canada softwood lumber trade dispute has been a major political issue between the United States (U.S.) and Canada over the last several decades. It is one of the largest inter-county trade debates, as two to three billion dollars of softwood lumber are traded between the two countries. The different forestland ownership system in the U.S. and Canada is believed to be the main underlying reason for the trade dispute between two friendly nations. Almost 60% of forests in the U.S. are owned by the private sector, and competitive auction-bid market determines the timber price. However, around 95% of Canadian forests are under the ownership of federal and provincial governments (Abboushi 2010), and Canadian provincial governments determine the timber price administratively (Zhang 2007). Pointing to the administrative pricing system of Canada, U.S. lumber producers argue that the stumpage price in Canada has been subsidized and that subsidized Canadian lumber shipments are dumped in the U.S. market. In order to resolve this trade debate, there have been several temporary bilateral agreements since the late 1980s including the five-year Memorandum of Understanding (MOU) for the period of 1987-1991, the Softwood Lumber Agreement 1996 for the period of 1996-2001, and the Softwood Lumber Agreement (SLA) 2006 for the period of 2006-2015.

SLA 2006 is a prevailing transitory agreement between the U.S. and Canada that limits Canadian lumber exports to the U.S. It is a price-driven ad-valorem export tax rate coupled with a quota system. SLA 2006 specifies two options to Canadian lumber exporting provinces to the U.S. Option A is a variable rate of export charge ranging from 0-15% of the prevailing monthly price, and option B entails an export charge of 0-5% combined with a volume restraint (SLA 2006). Alberta and British Columbia, the two major Canadian lumber-producing provinces, choose option A, while other provinces such as Manitoba, Saskatchewan, Ontario and Quebec follow option B of SLA 2006. The rate of the Canadian export tax and/or volume restraint is primarily a function of the prevailing monthly price. The prevailing monthly price, as defined in SLA 2006, is the four-week average of the Random Lengths framing lumber composite prices available 21 days before the beginning of the month to which the prevailing monthly price will be applied. If the prevailing monthly price is more than $US 355/mbf, free trade of softwood lumber prevails between the U.S. and Canada.

The main purpose of this study is to determine the optimal export tax under the framework of SLA 2006 using game-theoretic tools and uncover empirical evidence supporting our theoretical insights. While past studies reported that SLA 2006 has been able to restrict the Canadian lumber shipments to the U.S., a recent empirical study by Parajuli et al. (2015) revealed that the export tax under SLA 2006 had no effect on the softwood lumber trade between the U.S. and Canada. Since SLA 2006 is going to expire in 2015, both countries have already started looking for ways forward. While Canada is reported to be in favor of extending SLA 2006, the U.S. counterparts are against the continuation of the current agreement (Campebll Global 2014). Under these circumstances, it seems quite pertinent to investigate whether the export tax rate of 0-15% under SLA 2006 is economically optimal from both countries' perspectives. This study first develops a two-country two-stage model by considering the capacity-constraint scenario of the U.S. domestic lumber production, and computes the optimum export tax rate of the U.S.-Canada softwood lumber trade. Further, we estimate the monthly rate of optimal export tax by using the formula devised from the theoretical analysis, and compare it with the corresponding actual monthly export tax that Canadian producers have been paying according to SLA 2006.

The two-country two-stage model developed in this article shows that the rate of optimum export tax under the framework of SLA 2006 is primarily determined by the level of U.S. softwood lumber production capacity, per unit lumber production costs in Canada, and linear demand parameters. The higher the level of U.S. production capacity and Canadian lumber production costs, the lower the level of the optimum export tax. Our empirical estimation reveals that during the period of SLA 2006 the monthly export tax ranges from negative 23% to positive 30% with an average monthly export tax of 7%. Given that SLA 2006 is going to expire in 2015, the findings of this study provide useful information in the country-level bargaining and trade negotiation process between the U.S. and Canada.

6.2 A Historical Overview of the Trade Dispute

Since the late 1980s, there have been several temporary bilateral trade agreements between the U.S. and Canada with an objective of limiting the Canadian market share in the U.S. softwood lumber market. The Memorandum of Understanding (MOU) between the U.S. and Canada was the first five-year agreement for the period of 1987-1991. It provisioned that Canadian provincial governments either had to levy a 15% export tax on their lumber shipments to the U.S. or had to increase the prevailing stumpage prices in Canada. Another short-term agreement was the Softwood Lumber Agreement 1996, which was a tariff-regulated quota system of Canadian exports for the period of 1996-2001. It specified annual duty-free export quotas of 14.7 billion board feet (bbf) of Canadian lumber shipments to the U.S. For exports quantities of over 14.7 bbf, SLA 1996 provisioned US$50-$100 per mbf of the export fee on Canadian exports. Likewise, SLA 2006 is a variable rate price-driven export tax of 0-15% coupled with an export quota system for the period of late 2006-2015. Besides these bilateral agreements, the U.S. Department of Commerce had placed various unilateral import tariff duties including Countervailing duties (CVDs) and Antidumping (AD) tariffs during the turmoil periods of 1991-1996 and 2001-2006. Those CVDs and ADs were province-specific variable rates ranging from the low of 2.11% to 32%.

A number of studies have expounded on the U.S. softwood lumber market, Canadian lumber exports to the U.S. and effects of past trade restriction measures on the overall lumber market as well as the total social welfare in both countries. Some early studies which explored the U.S. softwood lumber market and Canadian lumber exports using different modeling approaches and econometric estimation techniques were Buongiorno et al. (1979); McCarl and Haynes (1985); Adams et al. (1986); Buongiorno et al. (1988) and Sarkar et al. (1993). Likewise several studies primarily investigated how effective trade protection measures were under prevailing market conditions. Using the Spatial and partial equilibrium analysis approaches, early studies by Boyd and Krutilla (1987), Chen et al. (1988), Wear and Lee (1993), and Myneni et al. (1994) assessed the market and total welfare effects of the 1986 MOU. Likewise, Lindsey et al. (2000), Zhang (2001), Zhang (2006), and Baek and Yin (2006) specifically evaluated the market and welfare effects of SLA 1996, and reported that SLA 1996 was quite effective in limiting the Canadian lumber exports to the U.S. Similarly, several studies examined the effects of the U.S. retaliatory CVDs and ADs on Canadian lumber imports in the post-SLA 1996 period from 2001 to 2006 (Adams 2003; Devadoss et al. 2005; Devadoss 2006; Mogus et al. 2006; Song et al. 2011).

Only a few studies have evaluated the impacts of SLA 2006 on the softwood lumber trade between two countries. Baek (2011) and (2012) found a significant negative long-term effect of SLA 2006 on U.S. lumber imports from Canada. A recent study by Nagubadi and Zhang (2013) also reported that SLA 2006 has been able to reduce U.S. imports of softwood lumber by 11.2%. Moreover, using the simulation approach of the world lumber market, van Kooten and Johnston (2014) projected that with the removal of the export tax on Canadian lumber exports to the U.S., Canadian lumber production would rise by 3.2 million m^3 (1.36 billion board feet), while U.S. lumber production would decrease by 1 million m^3 (420 million board feet). A drop by 1 million m^3 is, however, only about 1.5% of the roughly 30 billion board feet annual U.S. domestic production. Likewise, the change in welfare would be moderate: the net loss to U.S. lumber producers would be $112 million, but the U.S. consumers could gain $107 million..

While most of the past studies investigated the welfare aspects of trade policies under the framework of the U.S-Canada softwood lumber trade, only a handful of studies assessed the alternative as well as optimal aspects of trade policy instruments in prevailing market scenarios. Employing the concept of forest rents and methods of rent capture, Van Kooten (2002) compared the possible market implications of SLA 1996, a Canadian export tax, and U.S. import tariffs. He revealed that the best policy option for Canadian lumber producers would be the export quota as provisioned in SLA 1996, because the quota rent they acquired would clearly outweigh the loss of producer surplus due to the imposition of the export quota limit. Van Kooten (2002) also determined the optimal level of export quota of softwood lumber from the perspectives of Canadian producers, and showed that the U.S lumber demand, Canadian lumber supply and transportation costs primarily determined the level of optimal export quota. Likewise, Kinnucan and Zhang (2004) simply defined the optimal export tax rate as the reciprocal of the excess demand elasticity in the U.S. Their empirical illustration depicted that the optimal export tax was 77% as opposed to the export tax of 35% imposed by Canada under SLA 1996. Similarly, employing a vertically interrelated log-lumber model, Devadoss (2008) examined the appropriate level of U.S. CVDs in retaliating against the presumed Canadian subsidy policies during the period of 2001-2006. His empirical findings revealed that the U.S. could levy a CVD 1.55 times the Canadian subsidy to nullify the adverse affects of the Canadian production subsidy.

6.3 Two-Stage Two-Player Game

We consider strategic aspects of trade policy to set up a two-player sequential game of the softwood lumber trade between the U.S. and Canada. Strategic trade policy is an application of oligopoly theory, which accounts for the strategic interactions between firms in actual or potential international trade markets (Spencer and Brander 2008). We develop a two-stage game of the softwood lumber trade in which the U.S. is assumed as the home country and Canada as the foreign country.

While the U.S. is the largest lumber producer in the world, it does not produce enough softwood lumber to satisfy its domestic demand. More than 95% of the U.S. softwood lumber imports come from Canada which represents roughly one-third of the total U.S.

consumption (Random Lengths 2014). Taking this situation into account, we assume that the U.S. has a capacity constraint in domestic softwood lumber production, and can produce only $\overline{x}$ amount of lumber at full capacity. In the residual demand portion of the softwood lumber market in the U.S., Canada acts as a monopolist and exports the y quantity of softwood lumber[1]. The strategy space of the U.S. firm is $[0, \overline{x})$, and the Canadian firm has a strategy space of $[0, \infty)$. We also assume that the U.S. firm has constant production cost of c_{us} per mbf, and the Canadian firm has constant cost of c_{ca} per mbf. The difference in marginal costs of production accounts for the national difference in production efficiency of sawmills as well as the resource endowments. Transportation costs are ignored for simplicity. We assume that both Canadian and U.S. firms produce similar softwood lumber of homogenous quality. Consequently, consumers in the U.S. are indifferent to the lumber source, and a single representative price (P) represents the softwood lumber market. Let the linear inverse linear demand function be:

$$P = P(Q) = a - b(\overline{x} + y) \tag{6.1}$$

where a and b are linear demand parameters and always positive, and $P(Q) = 0$ for $Q \geq a$. This game is a two-stage sequential game, in which, we assume that the U.S. plays a leader's role, and we set up the two stages of the sequential game as:

1. The two governments i.e. Canada and the U.S. negotiate and set the level of export tax t[2] imposed on the Canadian lumber shipments to the U.S. While the U.S. is no longer able to alter its level of the production above $\overline{x}$ due to its capacity-constraint, the U.S. uses the rate of export tax t as a bargaining tool during the trade negotiation process.

2. Assuming t as given, Canada maximizes the monopoly profits in the residual portion of the U.S. softwood lumber demand.

[1]We ignore the role of other import partners of the U.S., as they accounted for only 5% of the U.S. total lumber imports.

[2]For simplicity, we only consider Option A of the SLA. British Columbia and Alberta, which follows Option A of the agreement, export 66% of the total shipments during the SLA 2006 period

Following the standard backward induction method, in the second stage, Canada maximizes its monopoly profits on the residual portion of the U.S. lumber demand. The profit function of the Canadian firm is specified as:

$$\pi_{ca} = (1-t)y(a - b\overline{x} - by) - c_{ca}y \tag{6.2}$$

Solving the FOC of condition (6.2) for the level of Canadian softwood lumber (y) results in:

$$y^m = \frac{a - b\overline{x}}{2b} - \frac{c_{ca}}{2b(1-t)} \tag{6.3}$$

Replacing the value of y^m from (6.3) into equation (6.1):

$$P^m = \frac{a - b\overline{x}}{2} + \frac{c_{ca}}{2(1-t)} \tag{6.4}$$

The condition (6.4) reveals that the price of softwood lumber has a positive relationship with all three factors, $(a - b\overline{x})$, c_{ca}, and t.

Remark 1: *The lumber price and Canadian lumber exports to the U.S. depend on linear demand parameters a and b, per unit production costs of softwood lumber in Canada, and the rate of the export tax as provisioned in SLA 2006. The export tax leads to rise in the lumber price, but causes a drop in Canadian lumber exports to the U.S.*

In the first stage, two governments negotiate and set the optimal export tax under which U.S. maximizes the domestic social welfare. In order to calculate the total U.S. social welfare, we need to calculate the consumer surplus and producer profit. The total social welfare $G(US)$ in the U.S. is computed as (refer to Appendix B for the computation of U.S. consumer surplus and producer profit):

$$G(US) = \frac{1}{2b}\left[\frac{a + b\overline{x}}{2} - \frac{c_{ca}}{2(1-t)}\right]^2 + \overline{x}\left[\frac{a - b\overline{x}}{2} + \frac{c_{ca}}{2(1-t)} - c_{us}\right] \tag{6.5}$$

Solving the FOC of condition (6.5) for the optimal export tax results in:

$$t^* = 1 - \frac{c_{ca}}{a - b\overline{x}} \tag{6.6}$$

Remark 2: *The optimal rate of the export tax is mainly determined by linear demand parameters, the U.S. softwood lumber production capacity, and the per unit lumber production costs in Canada. The higher the magnitude of U.S. production capacity and the Canadian lumber production costs, the lower the level of the export tax.*

In equation (6.6), the effects of both variables, c_{ca} and $\overline{x}$ on the export tax are as expected and consistent with economic theories. Obviously, an increase in the production costs in Canada limits the relative competitive advantage of Canadian lumber producers. Further, production costs also capture the efficiency level of the industry as well as resource endowments. Being a less efficient lumber industry and a drop in the lumber inventory level would undoubtedly hurt Canada in the lumber trade with the U.S. McNabb (2004) also reported that raising Canadian lumber production costs would be a prime solution of the U.S.-Canada softwood lumber trade in the short-run. Likewise, When the U.S. domestic production capacity increases i.e. when the sawmill industry expands, they can alter their level of production as per the domestic market demand. Once the U.S. domestic consumption depends less on the Canadian softwood shipments to the U.S., the level of the restriction on the Canadian softwood lumber exports to the U.S. would be less relevant.

6.4 Empirical Estimation

This section focuses on the empirical estimation of the theoretical results presented in the previous section. Based on the historical monthly time-series data during the period of SLA 2006, we estimate the monthly optimal export tax (t^*) by employing equation (6.6). In order to calculate the monthly t^*, we require monthly data on Canadian softwood lumber production costs (c_{ca}), U.S. softwood lumber production capacity ($\overline{x}$), and linear demand parameters a and b. We use total variable costs for British Columbia (BC) Interior softwood lumber mills as a proxy of Canadian softwood lumber production costs. The historical data on total variable costs for BC mills are obtained from RISI, the leading information provider for the global forest products industry (www.risiinfo.com). Further, we generate the data series on U.S. lumber production capacity by using the capacity utilization rate of the U.S. sawmill industry (NAICS 321-1) and U.S. actual softwood lumber production (Table 6.1). The main issue of calculating the optimal export tax is the estimation of linear parameters a and b. Hence we use an econometric approach to estimate the values of a and b. By considering the framework of the aggregate softwood lumber price as specified in equation (6.1), we estimate a reduced-form econometric model of the U.S. softwood lumber market. We combine $(\overline{x})$ and q_{ca} to estimate the value of a and b which is in line with equation (6.1).

The aggregate reduced-form econometric model of the U.S. softwood lumber market is specified as:

$$\begin{aligned} p_t =& \alpha_0 + \alpha_1(\overline{x}_t + qc_t) + \alpha_2 pb_t + \alpha_3 xc_t + \alpha_4 ws_t + \alpha_5 wc_t + \alpha_6 h_t + \alpha_7 nov_t + \\ & \alpha_8 dec_t + \alpha_9 jan_t + \alpha_{10} feb_t + \alpha_{11} p_{t-1} + \alpha_{12} p_{t-2} + \cdots + \alpha_{22} p_{t-12} + \epsilon_t \end{aligned} \tag{6.7}$$

We incorporate other lumber demand and supply variables in the aggregate price model to control the effects of those variables on estimates of a and b. Table 6.1 presents the detailed description of each variable and their respective data sources. Most of the data on softwood lumber market including softwood lumber price, lumber production, Canadian lumber exports are obtained from various monthly issues of Random Lengths YardStick. p_t represents the Random Lengths monthly composite lumber price, which is a weighted average of 15 key framing lumber prices in the U.S. and Canada (Random Lengths 2013). Since data on U.S. softwood lumber production capacity $(\overline{x}_t)$ are not readily available, we generate the historical monthly data series of $(\overline{x}_t)$ by using the U.S. total softwood lumber production and the capacity utilization rate of the sawmill industry (Uti_t). As RisiInfo reports the lumber production costs data quarterly only, we use the cubic spline interpolation approach[3] to convert the quarterly data into monthly frequency. We include nov, dec, jan, and feb as monthly dummy variables for November, December, January and February respectively to capture the seasonal effects. In order to address the autocorrelation issue in

[3]We use the MATLAB built-in command 'spline' to generate monthly data of production costs based on the quarterly data.

the dynamic model, up to 12 lags of lumber price are included in the equation. As we focus our empirical estimation on the period of SLA 2006, we employed historical monthly data for all variables from October 2006 to December 2013. Table 6.2 presents the summary statistics of the monthly data employed to estimate the empirical model of equation (6.7).

Table 6.1: Variables, their descriptions and sources (2006:10 - 2013:12)

Variable	Description	Source
p_t	Lumber composite price[a]	Random Lengths[b]
qc_t	Canadian lumber exports to the U.S.	Random Lengths
$coex_t$	Canadian overseas lumber exports	Random Lengths
vc_t	Canadian lumber inventory	Random Lengths
x_t	U.S. domestic lumber production: sum of production from U.S. South, U.S. West (Inland and Coast)	Random Lengths
Uti_t	Capacity utilization rate of NAICS 321-1	U.S. Census Bureau
$\overline{x}_t$	U.S. softwood lumber production capacity	x_t/Uti_t
pb_t	Price index of common building bricks	U.S. BLS
xc_t	Canadian-U.S. dollar exchange rate	USDA Economic Research Service
ws_t	Wage rate of U.S. sawmill workers	U.S. BLS
wc_t	Wage rate of Canadian sawmill workers	Statistics Canada
h_t	Housing starts in the U.S.-seasonally adjusted annual rate	U.S. Census Bureau
cca_t	Softwood lumber production cost in B.C. interior	RISI Info

[a]Random Lengths lumber composite price
[b]Various monthly issues of Random Lengths Yardstick (2006-2013)
[c]U.S. Department of Labor, Bureau of Labor Statistics

Since Canadian export supply to the U.S. (qc_t) and softwood lumber price (p_t) are endogenously determined, the issue of endogeneity emerges while empirically estimating the equation (6.7). Since ordinary least squares (OLS) estimator is inconsistent in the presence of an endogenous regressor, several instrument variable estimation methods such as two-stage least squares (2SLS) and limited information maximum likelihood (LIML) are commonly applied to deal with the endogeneity problem. While the 2SLS method is widely applied, the LIML approach performs better in the presence of weak and/or a large number of instruments (Hill et al. 2011, p. 470). Further, the LIML estimator has a more symmetric distribution and converges to normality faster than the 2SLS estimator. Though we have few instruments, we employ the LIML approach as the LIML estimators converge to normality faster.

Table 6.2: Summary statistics of the data (2006:10-2013:12)

Variable	Unit	Obs.	Mean	Std. Dev.	Min	Max
p_t	\$/mbf	87	152.47	23.61	115.65	214.74
qc_t	mmbf	87	907.31	265.72	576.00	1715.00
$coex_t$	mmbf	87	320.98	116.81	122.00	561.00
vc_t	mmbf	87	2912.42	410.88	2401.00	3940.00
$\overline{x}_t$	mmbf	87	3632.81	405.61	2475.85	4390.08
pb_t	1982=100	87	190.09	5.74	179.60	197.10
xc_t	C\$/US\$	87	1.08	0.07	0.98	1.31
ws_t	\$/hour	87	9.00	0.66	8.14	10.43
wc_t	C\$/hour	87	30.11	3.25	23.91	39.20
h_t	1000s	87	841.26	304.83	478.00	1649.00
cca_t	\$/mbf	78	112.10	14.29	85.84	139.21

Table 6.3 reports the LIML estimates of the softwood lumber price equation. A linear functional form is used. Most of the estimated coefficients have expected signs and are statistically significant at the 5% level. Among 12 lags of dependent variables specified in equation (6.7), only statistically significant lags are included in the final estimation of the model. In terms of model specification tests, the test for over-identifying restrictions fails to reject the hypothesis that the surplus instruments employed in the model are valid. Moreover, the test for the white-noise of the residuals indicates that the autoregressive specification of the equation addresses the problem of the autocorrelation. Likewise, the residual based Augmented Dicky-Fuller test (Hsiao 1997; Al-Balla 2005) for the unit-root property of the residuals rejects the hypothesis that the errors are non-stationary.

The results show that after controlling for other supply and demand factors, the estimated values of linear demand parameters i.e. a and b are 167.19 and 0.0126 respectively. Using these estimated values of a and b in equation (6.7) , we calculate the optimal export tax rate for each month during the period of the SLA 2006. Figure 6.1 presents the monthly optimum export tax for Canadian softwood lumber exports to the U.S. For a comparison purpose, Figure 6.1 also reports the actual export tax rate that Canadian lumber producers have been paying according to SLA 2006.

Table 6.3: LIML results of the softwood lumber price equation (2006:10-2013:12)

Variable	Coefficient estimate	Std. error
Intercept	167.185**	73.42
U.S. production Capacity + Canadian export supply ($\overline{x}_t + qc_t$)	0.0126**	0.006
U.S. price of bricks (pb_t)	−1.286**	0.32
U.S.-Canada dollar Exchange rate (xc_t)	−65.046**	22.41
U.S. wage rate (ws_t)	13.556**	3.55
Canadian wage rate (wc_t)	0.272	0.37
Housing starts (h_t)	0.012*	0.006
First lag of lumber price (p_{t-1})	0.990**	0.10
Second lag of lumber price (p_{t-2})	−0.337**	0.09
November	7.835**	3.80
December	9.365**	4.78
January	5.209	4.07
February	8.527*	4.51
R-squared	0.89	
External instruments	2	
First-stage Cragg-Donald F-statistics [a]	10.93	
Test of overidentifying restrictions [b] [P-value]	0.037[0.85]	
Portmanteau (Q) test for white noise at 12 lags [P-value]	12.21[0.43]	
The residual based ADF test [c] [P-value]	−5.90[0.00]	

* and ** denote the statistical significance of the estimates at 10% and 5% level respectively.
[a]We reject the null hypothesis that instruments are weak using the test size criterion that nominal 5% test has size at most 10%.
[b]Basmann F-test.
[c]Augmented Dickey-Fuller tests of residuals.

While the actual export tax under SLA 2006 varies only from 0 to 15%, the calculated optimum export tax ranges widely from negative 23% in October 2006 to 30% in the month of December 2008. The optimum monthly export tax is found to be negative during the early period from October 2006 to December 2007 and after 2012. However, Canadian lumber producers paid a constant rate of 15% export tax from the beginning of SLA 2006 to mid 2011. Recently, the actual export tax was zero since the prevailing monthly lumber price was above US$355.

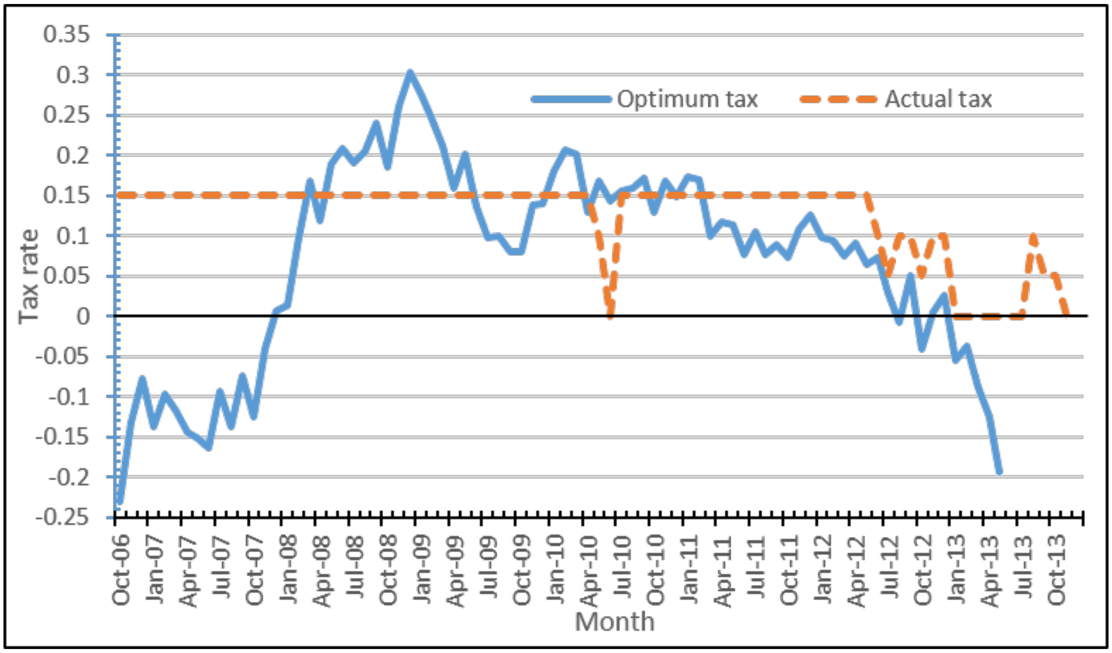

Figure 6.1: The actual export tax rate according to the SLA 2006 versus the optimum export tax rate

Since we use the constant estimated linear parameters a and b, the Canadian lumber production costs (c_{ca}) and the U.S. lumber production capacity ($\overline{x}$) are the major determinants of the optimum export tax. Of these two variables, the primary factor determining the optimum export tax is found to be c_{ca}. As we can see in Figure 6.2, the monthly value of $\overline{x}$ fluctuated around the constant mean value of approximately 3.6 billion board feet. However, the magnitude of c_{ca} was around US$136 (in 1982 dollars) in 2007, but it dropped to US$ 86 (in 1982 dollars) in 2008, and it gradually increased after 2010. Hence, it clearly indicates that the higher the Canadian production costs, the lower (or negative) the optimum export tax for Canadian exports to the U.S.

Given that the linear parameters of the inverse demand function are affected by several market factors including change in lumber consumers' preferences, forest regulations, and technological changes, we conduct the sensitivity analysis by altering the magnitudes of a and b. We consider both rise and drop in values of a and b by 20%, and calculate the optimum export tax for each scenario. Table 6.4 reports the optimal export tax associated

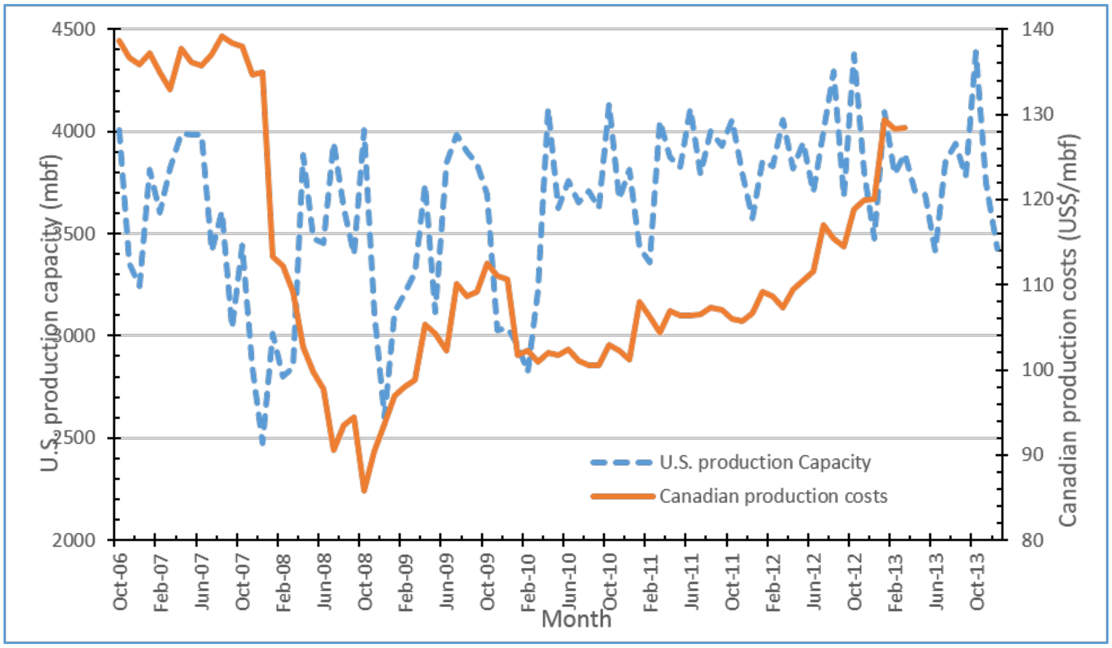

Figure 6.2: U.S. softwood lumber production capacity and the Canadian lumber production costs (2006:10-2013:12)

with several combinations of changes in the values of a and b. An upward shift in the linear demand curve leads to a rise in the optimal export tax, and a downward shift decreases the level of export tax substantially. We found that changes in the value of a have a linear effect on the optimal level of export tax. An increase in a by 20% raises the optimum export tax by around 20%, and a 20% decrease in a causes a drop in the optimal export tax by around 20%. However, changes in the slope of the demand curve have opposite effects on the optimal level of export tax. An increase in b leads to a drop, and a decrease in b causes a rise in the optimal level of export tax. Unlike the effects of changes in a, the effects of b are not linear. A 20% rise in slope of the demand curve decreases the the optimal export tax by almost 7%.

6.5 Discussion and Conclusions

This study determines the optimal level of export tax under the framework of SLA 2006 by developing a two-country two-stage game. By considering the capacity-constraint scenario of U.S. domestic production, this study assumes that Canada plays a monopoly

Table 6.4: Sensitivity analysis: changes in the optimal export tax in response to changes in a and b

Month	20% increase in a $a = 200.62$	20% decrease in a $a = 133.75$	20% increase in b $b = 0.015$	20% decrease in b $b = 0.010$
Dec-06	14.85	-46.59	-15.23	-1.14
Mar-07	12.75	-55.52	-21.67	-3.39
Jun-07	9.59	-62.99	-27.31	-7.06
Sep-07	14.71	-45.12	-14.25	-1.38
Dec-07	20.30	-31.74	-4.12	5.06
Mar-08	33.73	-11.60	12.02	21.17
Jun-08	37.72	-8.52	14.84	26.08
Sep-08	40.07	-4.10	18.27	28.86
Dec-08	44.17	7.14	26.67	33.53
Mar-09	37.78	-7.51	15.53	26.12
Jun-09	32.72	-20.17	6.01	20.28
Sep-09	28.21	-28.16	-0.24	14.95
Dec-09	31.80	-16.05	8.63	18.93
Mar-10	36.88	-8.50	14.70	25.02
Jun-10	33.09	-18.80	7.01	20.69
Sep-10	35.00	-14.45	10.31	22.92
Dec-10	33.59	-18.34	7.42	21.30
Mar-11	30.08	-26.62	1.16	17.23
Jun-11	28.40	-30.17	-1.55	15.26
Sep-11	29.07	-27.40	0.44	15.99
Dec-11	31.38	-20.47	5.55	18.61
Mar-12	28.16	-30.12	-1.57	14.97
Jun-12	27.43	-28.41	-0.56	13.96
Sep-12	25.69	-31.30	-2.85	11.89
Dec-12	23.34	-33.74	-4.94	9.03
Mar-13	15.18	-51.92	-18.77	-0.48

role on the residual portion of the U.S. domestic lumber demand. Findings reveal that the optimum export tax is determined by Canadian lumber production costs, U.S. lumber production capacity and linear demand parameters. Using the theoretical findings, this study also calculates the monthly optimal export tax during the SLA 2006 period, and compares it with the actual rate of export tax that Canadian producers have been paying according to SLA 2006. Given that SLA 2006 is expiring in 2015, and that U.S. producers are against extending SLA 2006 in its current form, this study provides useful information in the lobbying and trade negotiation process between the two countries.

Based on both theoretical findings and empirical estimation, it can be inferred that both countries should be cognizant of the level of Canadian production costs and the production capacity of U.S. sawmills along with the lumber demand parameters. Given that the state of prevailing sawmill capacity cannot be altered substantially in the short run, the level of Canadian lumber production costs plays a pivotal role in the determination of the optimum export tax under the framework of SLA 2006. McNaab (2004) also reported that the level of Canadian lumber production costs is a primary factor in the softwood lumber dispute between the two countries. The empirical results depict that the monthly optimal export tax during the period of SLA 2006 is between negative 23% and 30%, with a monthly average of 7%. The sensitivity analyses reveal that both demand parameters can alter the optimal rate of export tax substantially.

Obviously, the higher rate of the optimal export tax is just opposite of the free trade. Given that U.S. lumber producers, most probably, will argue and lobby against the free trade of softwood lumber between the two countries, we suggest both players to consider the capacity-constraint scenario of the U.S. sawmills and efficiency of the Canadian lumber industry while negotiating for a new trade agreement. As Parajuli et al. (2015) reported, the rate of export tax provisioned in SLA 2006 was ineffective in limiting the Canadian lumber exports to the U.S., the results of this study provide important insights in understanding the optimal state of the export tax.

While this paper applies a game-theoretic framework in the U.S.-Canada softwood lumber trade, some research caveats are still in order. For the sake of simplicity, this study only considers option A of SLA 2006, the export tax as a percentage of lumber price, and excludes option B, the export tax coupled with export quota, from the analysis. The provinces which follow option B of the agreement only represent around 20% of average monthly lumber exports to the U.S. We consider a linear inverse demand function to simplify our mathematical derivations, though most of the past empirical studies formulated the softwood lumber market model with a log-log model. Further, we assume a two-country trade model indicating that Canada is the only lumber trading partner of the U.S. However, around 5% of the U.S. lumber import market share is captured by Scanvandian countries, and the Canadian overseas export market has been burgeoning in recent years. On the other hand, we assume that both countries produce identical softwood lumber. The imported lumber from Canada, however, specifically the spruce-pine-fir lumber group is different from the U.S. domestic lumber in terms of quality (Nagubadi et al. 2004; Mogus et al. 2006). It is worthwhile, therefore, that further studies should consider the concept of differentiated softwood lumber while modeling the U.S.-Canada softwood lumber market. Moreover, as this study determines the optimum level of export tax, the caveats of calculating optimum tax as explained by Kinnucun and Zhang (2004) may also apply in our analysis.

Chapter 7
Summary and Conclusions

The softwood lumber trade dispute between the U.S. and Canada has been a persistent trade battle lasting more than three decades. Despite legal proceedings and arbitration rulings from various organizations including NAFTA, WTO and LCIA, a long-term or permanent resolution of this trade issue has yet to be found. The trade dispute between the two neighboring nations is primarily driven by interest group politics and institutional arrangements (Zhang 2007). The U.S. Lumber Coalition, a group of domestic lumber producers, is a well-organized interest group in the U.S., and has been actively participating in every political bargaining and negotiation process. The Canadian lumber producers, on the other hand, are fragmented by provinces, and hardly able to maintain a united and consistent position in the bilateral trade negotiation. SLA 2006 is the latest transitory bilateral agreement between the U.S. and Canada to regulate the Canadian lumber exports to the U.S, and is expiring in October 2015 unless both countries agree to extend it further.

By employing an approach of two-player game-theoretic model, this dissertation evaluates the effects of SLA 2006 on the softwood lumber trade between the U.S. and Canada. The first study of the dissertation develops the two-player homogenous Cournot-Nash equilibrium model, and examines the effects of the export tax on lumber production and trade in both countries. The second study estimates the empirical models of the U.S. softwood lumber market to uncover the results of game-theoretic analysis of the first study. And the third study determines the optimum export tax under the framework of SLA 2006 by developing a two-country two-stage game model. The optimum export tax is later estimated by using the historical monthly data and compared with the actual export tax that Canadian lumber producers have been paying according to SLA 2006.

The results of the Cournot-Nash equilibrium model reveal that the export tax provisioned in SLA 2006 is able to restrict the Canadian lumber shipments to the U.S. However, based on the historical data for the period of SLA 2006, the LIML estimates of the supply and demand equations for the U.S. softwood lumber market found that the export tax could not affect the lumber trade between the two countries. The coefficient estimate associated with the export tax is found to be statistically insignificant. The findings of the two-stage game suggest that the optimal export tax under the framework of SLA 2006 is mainly determined by the level of Canadian lumber production costs and the U.S. lumber production capacity. The empirical estimation based on actual historical lumber market data reveals that the monthly optimal export tax ranges widely from -23% to 30%. However, B.C. and Alberta have been collecting a flat export tax rate of 15% most of the time during the period of 2007-2011. Obviously, the higher rate of optimal export tax is just opposite of free trade. Given that U.S. lumber producers, most probably, will argue and lobby against free trade of softwood lumber between the two countries, both players should consider the capacity-constraint scenario of the U.S. sawmills and efficiency of the Canadian lumber industry while negotiating for the future trade agreement.

The limited influence of SLA 2006 on the lumber trade between the two countries is primarily explained by the structure of SLA 2006 and the macro-economic situations during the SLA 2006 period. The variation in the rate of export tax from 5 to 15% is only limited to the prevailing lumber price between $315 and $355. With the same 15% export charge for a price below $315, the lower the prevailing lumber price, the lower the per mbf export charge in dollar amount incurred by the Canadian lumber producers and so is the less influence of the export tax on the lumber trade. Hence, it is hard to believe that the export tax can lead to an increase in the lumber price and ultimately affect the Canadian lumber shipments to the U.S. On the other hand, the U.S. economy experienced a housing market bust which in turn triggered the great financial crisis of 2008-09. Given that the housing market is the primary determinant of the lumber price in the U.S., even the maximum export charge of 15% could not raise the lumber price in the U.S.

While this dissertation applies game-theoretic analysis and econometric estimation to evaluate the latest bilateral lumber trade agreement between the U.S. and Canada, some of the research limitations are still in order. For the sake of simplicity, this study only considers option A of SLA 2006. Further, this study considers only two-country models, though Canada exports a significant portion of its exports to overseas markets and the U.S. also imports around 5% of softwood lumber from other countries. In addition, this dissertation assumes that both countries produce identical softwood lumber, while few previous studies reported that Canadian spruce-pine-fir lumber group is of different quality than the lumber from U.S. southern yellow pines. Based on these shortcomings, following studies should be recommended in the future course of action.

- An extended strategic trade policy model incorporating option B of SLA 2006. The provinces which follow option B of the agreement represent around 20% of average monthly lumber exports to the U.S.

- Modeling the U.S.- Canada softwood lumber trade under oligopoly and oligopsony frameworks. The oligopoly and oligopsony models capture the other lumber trading partners of the U.S. and Canada, and the influences of those partners on the Canadian lumber shipments to the U.S. could be easily examined.

- A differentiated product model of the softwood lumber trade. The differential product model considers the different quality of softwood lumber and lumber prices in the two countries.

- Does the framing lumber composite price index represent the overall benchmark price for softwood lumber in the U.S. and Canada? The ineffectiveness of SLA 2006 might be that the framing lumber composite price doesn't reflect the entire softwood lumber market in the U.S. and Canada. Hence, it is worthwhile to investigate the cointegration of several lumber price series with the index of framing lumber composite price.

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Appendix A
Comparative Static Analysis

From the total differentiation of FOCs (4.3) and (4.4), we have:

$$\begin{bmatrix} \pi_{xx} & \pi_{xy} \\ \pi^*_{yx} & \pi^*_{yy} \end{bmatrix} \begin{bmatrix} dx \\ dy \end{bmatrix} = \begin{bmatrix} -\pi_{xt}dt \\ -\pi^*_{yt}dt \end{bmatrix}$$

where $\pi_{xt} = 0$. Using the Cramer's rule,

$$dx = \frac{\begin{vmatrix} 0 & \pi_{xy} \\ -\pi^*_{yt}dt & \pi^*_{yy} \end{vmatrix}}{D}$$

and

$$dy = \frac{\begin{vmatrix} \pi_{xx} & 0 \\ \pi^*_{yx} & -\pi^*_{yt}dt \end{vmatrix}}{D}$$

Then, using (4.5), (4.7) and (4.9) and ($\pi^*_{yt} < 0$)

$$x_t \equiv dx/dt = \pi_{xy}\pi^*_{yt}/D > 0$$

and

$$y_t \equiv dy/dt = -\pi_{xx}\pi^*_{yt}/D < 0$$

Appendix B
Determination of the Optimal Export Tax

The consumer surplus (CS) in the U.S. is the area under the linear demand curve, which primarily depends on the price (P^m) of softwood lumber.

$$\begin{aligned} CS(P) &= \frac{1}{2}(P(0) - P^m)Q \\ &= \frac{1}{2}\left[a - \left(\frac{a - b\overline{x}}{2} + \frac{c_{ca}}{2(1-t)}\right)\right]\left[\frac{a + b\overline{x}}{2b} - \frac{c_{ca}}{2b(1-t)}\right] \\ &= \frac{1}{2b}\left[\frac{a + b\overline{x}}{2} - \frac{c_{ca}}{2(1-t)}\right]^2 \end{aligned} \tag{B.1}$$

where $Q = (\overline{x} + y) = \left[\frac{a+b\overline{x}}{2b} - \frac{c_{ca}}{2b(1-t)}\right]$, and $P(0) = a$ is a Choke-off (reservation) price with quantity demanded equal to zero.

Likewise, the producer profit in the U.S. which also takes P^m into account:

$$\begin{aligned} \pi_{us} &= \overline{x}(P^m - c_{us}) \\ &= \overline{x}\left[\frac{a - b\overline{x}}{2} + \frac{c_{ca}}{2(1-t)} - c_{us}\right] \end{aligned} \tag{B.2}$$

Now the total U.S. social welfare, $G(US)$ is:

$$\begin{aligned} G(US) &= CS + \pi_{us} \\ &= \frac{1}{2b}\left[\frac{a + b\overline{x}}{2} - \frac{c_{ca}}{2(1-t)}\right]^2 + \overline{x}\left[\frac{a - b\overline{x}}{2} + \frac{c_{ca}}{2(1-t)} - c_{us}\right] \end{aligned} \tag{B.3}$$

The FOC of equation (B.3) to determine the optimal export tax from the U.S. perspective:

$$\begin{aligned} G_t = \frac{\delta G}{\delta t} &= \frac{\delta CS}{\delta t} + \frac{\delta \pi_{us}}{\delta t} \\ &= -\frac{c_{ca}}{2b(1-t)^2}\left[\frac{a + b\overline{x}}{2} - \frac{c_{ca}}{2(1-t)}\right] + \overline{x}\frac{c_{ca}}{2(1-t)^2} \equiv 0 \end{aligned} \tag{B.4}$$

Solving equation (B.4) to derive the optimal export tax t^* results in:

$$t^* = 1 - \frac{c_{ca}}{a - b\overline{x}} \tag{B.5}$$

Vita

After completing his secondary education, Rajan Parajuli enrolled in the Institute of Forestry, Tribhuvan University, Nepal, to pursue his intermediate and Bachelor of Science degree in forestry. He completed both degrees as a gold medalist. After completing his bachelor's degree in 2005, he worked as a consultant researcher in various forestry related organizations in Nepal. As Rajan was admitted to LSU with a research assistantship in the summer 2009, he joined the School of Renewable Natural Resources for his Master of Science degree in forestry. After the completion of a master's degree, Rajan was awarded with the Gilbert Foundation assistantship from the School of Renewable Natural Resources at LSU to pursue his doctorate in Renewable Natural Resources. He is currently a doctoral candidate, and is planning to graduate in August 2015.