ECONOMIC ANALYSES OF ONTARIO’S STUMPAGE PRICING SYSTEM

By

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ABSTRACT

The softwood lumber trade dispute between Canada and the United States has centered on the debate over the existence of a stumpage subsidy in Canada and recently on dumping by the Canadian softwood lumber producers in the U.S. markets. This thesis contains three essays that investigate the subsidy and dumping issues in this dispute. The results of these analyses indicate the economic performance of Ontario’s stumpage system.

The first essay investigates the market performance of Ontario’s stumpage system by examining the long-run equilibrium and Granger-causality relationships between the stumpage prices and the market prices of various end products (lumber, pulp and wood composites) from June 1995 to February 2005 using Johansen’s multivariate co-integration approach and the Granger-causality test. Test results indicate that in terms of SPF (spruce, pine, fir) for lumber and pulp, Ontario’s stumpage system can establish stumpage prices that have the potential to reflect the market values of timber. However, there is a need to modify the system for the other products.
In the second essay, an Enhanced Parity Bounds Model (EPBM) is developed and used to examine the discrepancy between the stumpage price of SPF timber for producing lumber and its market value from June 1995 to January 2007. The results show that in the short run, the stumpage prices were below or above the market values. However, in the long run, the underpayment and overpayment will even each other out. The results, therefore, imply that Ontario’s stumpage system has the ability to capture the full economic rents in the long run and thus does not confer a subsidy to Ontario’s softwood lumber producers.

The third paper examines the issue of whether Ontario’s softwood lumber industry had dumped softwood lumber into a major US market from April 1996 to September 2006 using the EPBM. This is a critical issue for Ontario’s stumpage system because dumping could lead to lower stumpage prices under the current stumpage system. This analysis indicates that the industry gained considerably more profit from the U.S market than from the home market and did not dump lumber in the US market during this period.
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CHAPTER I

INTRODUCTION

The United States is one of the world’s leading producers of softwood lumber and yet it is a net importer. Canada is the world’s largest exporter of softwood lumber and the United States is its largest importer. Due to market expansion resulting from population and economic growth in the United States, Canada’s share of the U.S. softwood lumber market has increased significantly during the past few decades; it was less than 15% in 1965, but increased to about 33% in 2002 (Schwindt et al. 2004, Allan 2003). In 2006, approximately 82% of Canada’s softwood lumber exports, worth $Cdn 7.3 billion, were shipped to the United States (NRC 2007). Therefore, this trade has tremendous economic and social value to both countries. However, it has been hindered by a persistent and contentious dispute between the two countries during the past two decades. Due to continuous interest group lobbying in both countries, the dispute has gone through four stages of accusation, threats, investigation, negotiation and temporary settlement (Zhang 2001) and the softwood lumber trade has become a political football subject to a number of unilateral or bilateral government actions (Schwindt et al. 2004). Various studies, for example, Yin and Baek (2004), and Zhang (2007), have summarized the history of this dispute.

Since 1982, certain US lumber producers have alleged that Canadian softwood lumber producers are subsidized by their provincial governments through low stumpage prices, which have caused material injury to U.S. lumber industry. They have filed four countervailing duty (CVD) cases against Canadian softwood lumber imports and the US Department of Commerce (USDOC) imposed CVD\(^1\) on Canadian lumber imports after the third and fourth

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\(^1\) The US trade law provides that countervailing duties will be imposed when two conditions are met: (1) the USDOC determines that the government of a country or any public entity within the territory of a country is providing, directly or indirectly, a countervailable subsidy with respect to the manufacture, production, or export of the subject merchandise that is imported or sold (or likely to be sold) for importation into the United States and (2) in the case of merchandise imported from a Subsidies Agreement country, the U.S. International Trade Commission (USITC) determines that an industry in the United States is materially injured or threatened with material injury, or that the establishment of an industry is materially retarded, by reason of imports of that merchandise (USITC 1998). Thus, according to this law, one critical step in the
petitions aiming to restrict import of Canadian softwood lumber\(^2\). In 2001, following the expiration of the Softwood Lumber Agreement signed by the two countries in 1996, the U.S. producers filed the first antidumping duty (ADD) petition claiming that Canadian lumber producers were dumping softwood lumber in the U.S. market by selling lumber at prices below the cost of production. The Canadian government and the softwood lumber industry have always argued that their stumpage pricing systems do not constitute a subsidy. In response to U.S. actions, Canada took various cases to the North American Free Trade Agreement (NAFTA) and the World Trade Organization (WTO). These petitions challenged the legitimacy of the imposition of the CVD and ADD and the US claim that the US softwood investigation for a countervailing duty is to find whether a subsidy is provided to the private sector that exports the subject merchandise to the US markets. It sounds like an easy task as in everyday parlance, a subsidy is simply considered a granting of money to an individual or firm by the government; however it is a complicated issue in many legal cases as it may be presented in many forms. Indeed, there is not even a generally accepted economic definition of subsidy although it has been used widely in economics (WTO 2007). The Oxford Online dictionary defines subsidy as, “a sum of money granted from public funds to help an industry or business keep the price of a commodity or service low”. However, some people may argue that tax concessions are also a form of subsidization. In addition, border protection, e.g. tariffs, does not involve any direct financial transfer from the government, but it enhances the fiscal revenue of import-competing industry, especially when the tariffs are wrongly imposed based on insufficient evidence of a subsidy. Therefore, defining subsidies in terms of government transfers or fiscal expenditure may not cover all the forms (WTO 2007). In the US trade law, subsidy is defined as having the same meaning as the term “bounty or grant” and it includes any export subsidy and the domestic subsidies as follows: (1) the provision of capital, loans, or loan guarantees on terms inconsistent with commercial considerations; (2) the provision of goods and services at preferential rates; (3) the grant of funds or forgiveness of debt to cover operating losses sustained by a specific industry; or (4) the assumption of any costs or expenses of manufacture, production, or distribution (Zhang 2007). Under the same law, finding of a subsidy must pass the specificity and preferentiality tests. Specificity means that the foreign government program in investigation must be specific to an enterprise or industry, or a group of enterprises or industries. Preferentiality means that the benefits conferred to the recipients are substantially higher than for nonrecipients. The degree of preference, if any, would determine the amount of the subsidy (USITC 1998).

\[^2\] The US government did not find countervailable subsidy in the first investigation in 1983 because it did not pass the test of specificity during the period covered by Lumber I; therefore, no duty was imposed on Canadian lumber imports. However, during the next three periods known as Lumber II, III and IV, due to the finding of countervailable subsidies based on cross-border comparison by the USDOC, the trade was restricted by three regimes: export tax regime from 1987 to 1991 (during Lumber II), tariff-regulated quota regimes from 1996 to 2001 (known as 1996 softwood lumber agreement, during Lumber III) and from 2006 till now (2006 softwood lumber agreement, during Lumber IV. The two agreements have different regulations on the imports of Canadian softwood lumber.), and import tariff regime from 1991 to 1994 (during Lumber III before the 1996 SLA was signed) and from 2001 to 2006 following the expiration of the 1996 SLA (during Lumber IV).
lumber industry was threatened with material injury by the alleged subsidization and dumping of Canadian softwood lumber imports.

Hence, the central issue of this dispute is whether the stumpage systems in Canada confer a subsidy to the Canadian softwood lumber industry. This issue arises as a cause of the dispute because different stumpage pricing systems are used in the United States and Canada. This difference is a result of different types of ownership of forestlands in the two countries. In Canada, a vast majority (over 90%) of forestlands is owned by the Crown. Harvest rights are generally allocated to forest product companies, which assume management responsibilities, through short-, medium- or long-term tenures (Nelson and Vertinsky 2003). Due to the Crown ownership and the historical tenure systems, conditions for competitive timber markets do not exist in most territories of Canada. As a result, stumpage prices have been historically determined administratively by the provincial governments. These stumpage prices, which are generally calculated based on residual value (RV) approach, are supposed to reflect market values. In contrast, most forestlands (about 75%) in the United States are owned by the private sector with the rest belonging to the public sector (Sedjo 2006). Timber on public and private lands is normally sold by auctions. Some US softwood lumber producers believe that the stumpage prices determined under auctions represent the market values. During the negotiations between the two countries to seek a long-term solution to the trade dispute, the

3 Although most of the rulings of these challenges by the NAFTA and WTO panels were mixed, they mainly uphold Canada’s positions on all of these three issues. In the case of CVD, the NAFTA Subsidy Panel ruled that the United States has no basis in using the US stumpage prices as the benchmark in calculating the amount of benefit accruing to the Canadian stumpage programs (NAFTA 2003a) and accepted the Department’s fifth remand determination of de minimis subsidy in March 2006. The WTO Subsidy Compliance Appellate Panel ruled that the U.S. procedures used to establish CVD on the Canadian softwood lumber imports are inconsistent with WTO rules (WTO 2005). With respect to the ADD issue, the NAFTA Dumping Panel ruled that the zeroing method used by the Department in calculating dumping margins is illegal (NAFTA 2005) and the WTO Dumping Panel ruled that the Department erred in its method for computing the ADD by using a zeroing method (WTO 2004a). The zeroing method is a practice of assigning a margin of zero to goods in transactions for which the export price exceeds the normal value. The positive difference between the export price and the normal value is also referred to as a negative dumping margin. The NAFTA Injury Panel ruled that imports from Canada did not impose threat to cause material injuries to the U.S. lumber industry (NAFTA 2004) and the WTO Injury Panel found that the US International Trade Commission (USITC) threat of injury determination violated WTO rules (WTO 2004b). The WTO ruling essentially removes the basis for the imposition of US CVD and ADD on softwood lumber imports from Canada.
U.S. has, therefore, emphasized the need to change the Canadian administrative stumpage systems to auction based systems (USDOC 2003).

Due to the economic importance of softwood lumber trade to both countries, many scholars have studied this dispute from different perspectives. Yin and Baek (2004) have provided an extensive review of the literature up to 2004, and the recent studies, which examined the market and welfare impact of various trade restrictions, include Stennes and Wilson (2005), Baek and Yin (2006), Li and Zhang (2006), Mogus, Stennes, and van Kooten (2006), and Zhang (2006). However, only a few studies have used economic methods to study whether the alleged subsidy exists. Uhler (1991) found that the administrative prices of timber on the British Columbia (BC) Coast might well have been higher than competitive levels, and in the BC Interior, the administrative prices of timber were near or less than competitive levels during the period 1969 to 1984. Grafton, Lynch, and Nelson (1998) measured the total economic rents collected between 1970 and 1994 in BC, and found that about 70% of available rents were collected with stumpage fees. Economists also estimated that the uncollected economic rents had gone to labour (e.g., Copithorne 1979; Percy 1986; Grafton, Lynch, and Nelson 1998), and uncollected resource rents have not benefited tenure holders in BC (van Kooten 2002). Therefore, most of the findings of these studies have been in favor of the Canadian argument on the subsidy issue. The cross-border comparison method used by the USDOC to determine the existence of a subsidy has been rejected by NAFTA and criticized by resource economists as it ignores the site and market characters that influence stumpage prices. However, the previous studies on stumpage prices have focused on BC. Since each province in Canada involved in this trade dispute has its own stumpage system, it will be useful to study the subsidy issue in other provinces.

In addition, no studies so far have examined whether Canadian softwood lumber producers have dumped softwood lumber in the U.S. markets. The zeroing method used by the USDOC for determining the margin of dumping has been ruled by WTO and NAFTA to be inconsistent with WTO rules and it also violates economic principles. To find a long term solution to the dispute and to improve the effectiveness of the current stumpage system to
establish competitive stumpage prices if necessary, the dumping issue needs to be addressed from an economic perspective.

In 1994, Ontario introduced the current stumpage system in response to the US complaint. This system is based on the RV approach, that is, the market prices of various end products (for example, lumber, pulp and composites) are used to determine the stumpage prices of timber used to produce those end products. Therefore, theoretically, the stumpage prices should vary with the market prices of the end products. If this is the case, stumpage prices determined administratively under this system have the potential to reflect the market values of stumpage. Hence, it would be useful to examine the responsiveness of the stumpage prices to the market prices of end products. In addition, the responsiveness of the inverse direction that is, the sensitivity of the market price of end products to the changes in the stumpage prices is also of interest to the policy makers, in the case of lumber in particular, as such relationship will reveal whether any increase or decrease in the stumpage prices determined under Ontario’s current stumpage system will be passed on to the market prices of end products. If a reduction in the stumpage price could not result in a decrease in the market price of the end product, then low stumpage prices in Ontario did not have a distortive effect on the end product market. If an increase in the stumpage price could not lead to an increase in the market price, any increase in the stumpage prices will result in higher production cost and thus affects the competitiveness of Ontario’s forest products industry in the US markets. The relationships between the market prices of end products and the relevant stumpage prices could be examined by studying the co-integration and Granger-causality between the relevant price series.

In addition, it is necessary to investigate whether administratively determined stumpage prices are different from the true market values in the short run and whether the stumpage system based on RV approach can capture the full economic rents in the long run to provide meaningful empirical evidence for the subsidy issue using some theoretically sound economic method. Furthermore, one of the critical assumptions that the theoretical RV approach could generate market level stumpage price is that the end product is sold in perfectly competitive markets and the pricing behavior of the end products producers is consistent with the
competitive market conditions. However, if lumber producers dumped lumber products in the US markets as alleged by the US lumber producers and the market price of lumber was depressed due to intended dumping, then the stumpage prices determined under the theoretical RV approach would be depressed and thus do not represent the market value. As a result, any comparison between the stumpage prices determined under Ontario’s stumpage system and the theoretical market value to determine the competitive levels of the stumpage prices would be meaningless. Therefore, it is necessary to study whether the softwood lumber producers in Ontario have dumped lumber in the US markets to provide further evidence on the competitive level of the stumpage prices. The results from these analyses would indicate whether the stumpage prices determined under Ontario’s current stumpage system reflect the true market price, in the case of lumber in particular.

Therefore, the overall objective of this study is to investigate the competitive level of the stumpage prices determined under Ontario’s current stumpage system. The specific objectives are: (i) to estimate the long-run equilibrium, indicated by co-integration, and Granger causality relationships between the stumpage prices and the market prices of various end products; (ii) to address the subsidy issue on timber prices in Ontario; and (iii) to investigate whether Ontario’s softwood lumber industry has dumped lumber into its major U.S. market. However, since 1999 the BC Ministry of Forests (MOF) has adopted a “market pricing system (MPS)” in response to the USDOC’s proposal (BCTS 2002). To infer whether Ontario should change the current stumpage system to respond to the US proposal and to improve its market performance, I will also compare the economic performance of Ontario’s RV based stumpage system with the MPS of BC and the two timber pricing systems in the US.

This dissertation is composed of three independent papers that are written in journal article style and address these issues. The first paper⁴ estimates the long-run equilibrium and Granger causality relationships between the stumpage prices of SPF timber used to produce lumber, pulp, and composites and the relevant market prices of lumber, pulp and composites using Johansen’s multivariate co-integration approach and the Granger causality test. The second

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⁴ This paper has been published in Forest Science, 2006, 52(4).
paper\textsuperscript{5} addresses the subsidy issue by examining the rent capture capacity of Ontario’s stumpage pricing system using an enhanced parity bounds model (EPBM), and comparing the market performances of the administrative stumpage system in Ontario and the market-based system in BC and the two stumpage systems in the U.S. The third paper examines whether Ontario’s softwood lumber industry has dumped softwood lumber in its major US market using the EPBM. The first paper follows the style of \textit{Forest Science} and the second and third papers follow the style of \textit{Land Economics}. Each paper is self-contained; that is, it has its own introduction, methodology, data description, results, conclusions, and policy implications.


\textsuperscript{5} This paper has been accepted by Land Economics.
CHAPTER II

A BRIEF HISTORY OF ONTARIO’S STUMPAGE PRICING SYSTEM

Ontario’s stumpage pricing system has experienced many modifications since Crown dues were initially collected (OMNR 1993).

Stumpage fees in the form of Crown dues dated back to 1826 in Ontario (Wilkes 1954). As a means of stimulating a domestic timber industry, the government began to grant the rights to harvest Crown timber to individuals and firms rights in 1826. Dues at fixed rates for the timber harvested were to be paid to the Crown. However, during the next two to three decades, the government had difficulty collecting the revenue from Crown timber, partially due to the practice of deeding land to settlers under the condition that it be cleared and improved. Many people found this to be a cheaper method of obtaining standing timber than acquiring a licence and obtaining lands for their timber.

On April 18, 1849, the first Crown Timber Act was passed in Upper Canada (the area known as Ontario today) based on the recommendations of a Select Committee which was appointed to investigate all matters concerning timber use. Under this Act, licences were issued for a period of no longer than 12 months under the conditions that Crown dues were to be paid for the timber cut. In 1851, new regulations under this Act were passed, one of which ruled that a ground rent be paid for every square mile under a licence. If the timber was not harvested during the previous licence period, the ground rent paid in the previous licence application would be doubled when the licence was renewed. This system continued until the early 1900’s, with only minor modifications and increases in the dues rates.

In the beginning of the 1900’s, the public auctions through which licences have been sold were replaced by public tenders, where the bid price was an amount exceeding the reserve price set by the Crown. At this point, in addition to the area charge, the Crown dues had three...
components: a minimum dues base rate which was set for different species, an additional amount to bring the minimum bid price up to the upset price, and a bonus amount, equivalent to the excess of the actual bid over the upset price. In 1917, an annual fire protection tax was introduced and applied on a per square mile basis.

In the 1920’s, when pulp and paper emerged as a major industrial sector, the Crown felt that sufficient long term capital investments would only be made if more secure tenure was granted. At this time, the Crown also intended to encourage development in Northern Ontario. As a result, the Crown began to issue larger licences with a twenty-year period in Northern Ontario. The dues rates were negotiated between the Crown and the company based on timber quality and distance to mill.

In 1925, the Act levied an annual ground rent on all productive timber lands under a licence. This ground rent later became known as the management charge. At this point, timber revenues can be classified into two broad categories: tenure charges and stumpage charges. Tenure charges were collected on the basis of per square mile of licensed productive timber lands. It was further divided into the ground rent and the fire protection charge. The stumpage charge consisted of the mandatory Crown dues, the bonus and in the case of Sale licences, a competitive bid exceeding the Crown dues plus bonus.

In 1950, the Logging Tax Act was adopted to provide tax revenue to the province on the profits made by woodlands operations. The purpose of this tax was to capture the value of the timber which was escaping the stumpage charges. The tax rate was initially set at 9% of the profit on woodlands operations over $10,000 and increased to 10% in 1963. It was abolished in 1972.

A major revision to the Crown Timber Act occurred in 1952. Under the new schedule of dues rates, the ground rent was reduced to $1.00 per square mile of productive forest and the fire protection charge was kept at $12.80, the level established in 1950. In 1968, the ground rent was abolished and replaced by a management charge of $2.00 per square mile of productive
timber lands. The fire protection charge was renamed forest protection charge and was doubled.

In 1971, to stimulate northern development and account for differences in transportation costs, a reduced dues rate for jack pine and spruce harvested north of the CNR rail line was introduced. But this was removed in 1974 after having no noticeable effect other than to increase the profits of already existing northern operations. In 1974, dues rates were revised again and the revised schedule recognized six kinds of roundwood for the purpose of charging stumpage rates. Due rates were listed by weight, as well as volume, in recognition of the growing popularity of weigh-scaling.

In 1978, substantive modifications were made to the system following the recommendations of a Timber Revenue Task Force which was formed to review the stumpage system. Effective April 1, 1978, all of the area-based charges (Forest Protection Charge and Management Charges) were replaced by the Area Charge, which was increased by 50% to $41.40 per square mile of productive land and was to be increased at a rate of 10% annually for the following four years. In the same year, indexing of Crown dues based on product prices was introduced. The licensees were divided into two categories: integrated companies (which owned or operated a pulp or paper mill in Quebec, Ontario or Manitoba), and non-integrated companies (all others). Dues rates were adjusted quarterly based on the price index values of the last six months. Spruce-pine-fir (SPF) conifer dues rates for integrated licensees were indexed on the basis of 75% of the pulp and paper selling price index and 25% of the commodity selling price for “Lumber, Softwood, Spruce, east of the Rockies”. The reverse weighting of the same two indices was used to index non-integrated licensee dues rates. Both price indices were calculated monthly by Statistics Canada.

In 1980, a number of long-term licences were converted to Forest Management Agreements (FMAs), under revisions to the Crown Timber Act. This revision did not change the stumpage prices that were collected for timber cut under the FMAs. The intent of this revision was to shift more of the forest management and road-building responsibilities to the industry. Within a few years, about 60% of the Crown forest used for timber production was managed under
FMAs. The remainder was organized as Crown Management Units on which the Crown issued small, short-term licences and continued to do the required road-building and silviculture. This was an effort to retain a small and medium size component to the logging and forest products industries. While the introduction of the FMAs did not affect either the royalty system or rates, it did alter the financial arrangements between large licence-holders and the Crown.

In 1984, a double-indexing formula was added to due rates which made Crown dues twice as responsive to changes in industry selling prices. In addition, both the base Crown dues rate and the area charge were increased by 25% at this time. With the exception of the increase in the base dues rate, these changes had been recommended by a Crown timber charges review undertaken in 1982 but were delayed for two years due to adverse economic conditions in the industry and economy as a whole.

In 1986, stumpage prices in Ontario (and in other provinces that were major exporters of lumber to the United States) were investigated by the U.S. Department of Commerce and stumpage pricing systems in Canada were found to confer a subsidy to lumber production. US and Canada signed a Memorandum of Understanding under which an export tax was imposed by the Canadian government on the export of softwood lumber to the US. In the same year, measurement by weight was converted to volume measure and all Crown dues rates were determined based on volume in cubic meter.

In 1988, Ontario modified the application of the integrated and non-integrated dues rates so that all softwood sawmills, regardless of ownership, paid the same rate. Timber that was taken from the forest to a pulp mill was assessed at the integrated rate. Also in 1988, the base dues rate for integrated licencees was raised by 25%. The following year, the area charge was increased by 25% and it increased by $2/square kilometer of productive area each year until 1991/92. These increases were recommended by the review conducted in 1987 by a Committee who felt that Crown revenues were too low relative to forest management expenditures. These increases were initial steps towards recovering 50% of total government forest management costs by 1992. However, dues rates in Ontario were judged to be higher
than those in Quebec by factors of anywhere from 7 – 100%. Alberta’s average stumpage charge was only about 15% of the Ontario integrated dues rate while B.C. interior rates were about 70% higher at the time of review. This situation would have limited Ontario’s ability to raise dues more significantly. In addition, the reviewers also recognized the various contributions that forest access construction provided to other users and the significance of forestry in many small communities in Northern Ontario. These considerations tempered any desires there might have been to greatly raise Crown charges.

It should be mentioned that introducing a provincial wide stumpage system is a difficult task because different conditions exist in northern and southern Ontario. These two regions differ in terms of forest type, industrial structure and land ownership patterns. Northern Ontario is dominated by boreal forests which often grow in even aged stands and supply an industry dominated by large scale pulp and paper mills, composite board mills and large softwood lumber mills. In contrast, central and southern Ontario forests grow in mixed, uneven-aged stands, provide a range of products to small sawmills and other specialty mills, and are located on relatively small land holdings. Although Crown land in southern Ontario yields only a small portion of the provincial harvest volume, its value is disproportionately high.

Different licencing systems were used in the two regions to recognize these differences. In southern and central Ontario, there were no FMAs; instead Crown land was managed by OMNR and small short-term licences were granted to small operators. Prior to 1994, a small amount of timber in south-central Ontario was auctioned by public tender. For the most part, the tendered blocks contained high valued hardwoods or red/white pine for which there were many potential buyers. Since 1995, the FMAs and Crown Management Units (CMUs) have been converted to Sustainable Forest Licences (SFLs). At the same time, OMNR transferred the responsibility of forest management to the licence holders. The CMUs in south-central Ontario were aggregated into several SFLs which are held by companies that include small operators and mill owners among their shareholders. As a result, the licensing system is now more uniform in Ontario than it has been for decades.
In summary, Ontario’s stumpage history prior to 1994, when the current system was introduced, can be divided into five periods. Prior to 1826, stumpage system was not required, thus did not exist. Between 1826 and 1849, the combination of dues and licence arrangements was ineffective in collecting dues. The modifications to terms and introduction of area-based charges during 1849-51 created a stumpage system that functioned effectively when mills were small and the majority of timber harvested consisted of valuable pines, white spruce and hardwoods in southern and central Ontario. As the pulp and paper sector developed, a secure supply of timber was required to support capital investment and the licencing system for those mills evolved to one based on negotiations. From 1826 to 1978, the stumpage system implicitly recognized some degree of difference between industry segments by virtue of there being different base rates by species and product. In 1978, the stumpage system was revised to formally recognize sectoral differences and for the first time, the dues rate was explicitly linked to market prices for manufactured timber products. In 1980, large forest companies took the responsibility for forest management and road-building, although the Crown continued to pay for it.

In 1994, following an extensive review, the stumpage system was dramatically changed. This accompanied a transfer of forest management and planning costs to industry from MNR as part of the government’s New Business Relationship. The intent was to both follow what other jurisdictions had already done and improve the provincial government’s overall financial condition, which had generated large deficits in the early 1990’s. The detailed description of this new system is provided in Chapter III.
CHAPTER III

MARKET PERFORMANCE OF THE GOVERNMENT-CONTROLLED BUT MARKET-BASED STUMPAGE SYSTEM OF ONTARIO

3.1 Introduction
The softwood lumber trade dispute has been the largest and most contentious trade dispute between the United States and Canada (Lindsey et al. 2000). The current dispute started in 1982 due to the increasing market share of Canadian softwood lumber imports in the U.S. market. Canadian softwood lumber producers have been the dominant exporter of softwood lumber to the U.S. for decades and Canada’s share of the U.S. softwood lumber market has increased from 15% in 1965 to about 33% in 2002 (Schwindt et al. 2004, Allan 2003). U.S. softwood lumber producers have argued that Canadian producers in some provinces have expanded their U.S. market share as a result of subsidies obtained from the provincial governments through low stumpage rates for the rights to harvest trees on Crown land. They have therefore sought some “remedial actions” from the U.S. government either to restrict imports of Canadian softwood lumber or to force some Canadian provinces to change their stumpage systems (Rahman and Devadoss 2002). The Canadian federal and provincial governments and producers have always argued that their stumpage pricing systems are based on market signals and do not provide any subsidy. They also argue that the increased exports are due to a competitive advantage resulting from favorable exchange rates and productivity efficiency (Uhler 1991, Sarker 1996), in which case, their stumpage pricing systems do not justify any punitive actions by the United States (Griffith et al. 2001).

Given the economic importance of softwood lumber trade between the United States and Canada, this trade dispute has drawn a great deal of attention at government, industry and academic levels. Many scholars have studied the impact of the various trade restrictions from different perspectives. Yin and Baek (2004) have provided a comprehensive review of the literature focusing on the impacts of the various U.S. trade restrictions on Canadian softwood lumber exports to the U.S. Among this literature, Haley (1980) and Irland (1986) have
discussed the structures of the forest ownership and pricing policies in both countries, Uhler (1991) has investigated alleged stumpage subsidies, and Constantino and Percy (1991) have examined the legal issues of countervailing actions. Wear and Lee (1993), Myneni et al. (1994), Lindsey et al. (2000) and Zhang (2001) have estimated the impacts of the various U.S. trade restrictions.

In 1994-95, various provinces of Canada, including Ontario, introduced new stumpage systems based on the concept of residual value in which the market prices of end products (lumber, pulp, and wood composites) are used as reference prices to determine prices of standing timber. However, despite the large body of literature on this topic, no study has explored the relationship between the stumpage prices, administratively determined under these new stumpage systems, and the market prices of end products. In analyzing a softwood lumber trade dispute centered on stumpage subsidy, it seems necessary to investigate whether the stumpage prices, administratively determined by the Canadian provincial governments, respond to the changes in the competitive market price of softwood lumber. Economic theory suggests that timber price, as an important factor price, should have an impact on forest product price. Meanwhile, the owners of standing timber, as rational economic agents, would like to capture the full rent from timber depending upon forest products markets. Therefore, in theory, the causal relationship between the final products price and the timber price paid by the industry can go either way and may vary with its uses.

In this paper, I study the relationship between the stumpage prices paid by Canadian industries and the market prices of the end products. This study includes three significant wood products – softwood lumber, pulp, and wood composites. Although the focus of this analysis is not the softwood lumber trade dispute, it will provide important inputs to the debate on softwood lumber trade dispute as well as critical inputs for the evaluation of the overall performance of the new stumpage system of Ontario. The choice of province, Ontario, is mainly influenced by the author’s particular familiarity with the Ontario stumpage system and the availability of
data. Moreover, Ontario is one of the four (British Columbia, Quebec, Ontario, and Alberta)\(^6\) most significant softwood lumber producing and exporting provinces in Canada.

In this paper, I test the stationarity properties of price series – stumpage prices and end product market prices. In the case of non-stationary price series, where each individual series under investigation is I(1) (i.e. integrated of order one), the relationship between the end product market price and the corresponding stumpage price is tested using a multivariate co-integration test suggested by Johansen (1988, 1995) and Johansen and Juselius (1990, 1992). In addition, the Granger-causality between the relevant prices is investigated for all price series. I use monthly data on the market prices of end products and stumpage rates in Ontario from June 1995 to February 2005, during which the new market-based stumpage system was implemented by the Ontario Ministry of Natural Resources (OMNR). Even though the focus of this paper is on testing these relationships between end product prices and respective stumpage prices, I have also made contributions to forest economics literature on the clarification of some theoretical issues associated with time-series analysis. For instance, I have discussed topics such as the choice of span and frequency of data, temporal and spatial aggregation of data, and power and size of unit root and co-integration tests.

The structure of the paper is as follows. The market-based stumpage system of Ontario is described in Section 3.2. Relevant theoretical concepts and empirical estimation methods are discussed in Section 3.3 and 3.4, respectively. Data is described in Section 3.5. Empirical estimation results and discussion are presented in Section 3.6. Conclusions and policy implications are discussed in Section 3.7.

### 3.2 The Market-Based Stumpage System of Ontario

The OMNR introduced the current market-based stumpage system in October 1994 after a comprehensive examination of the previously existing stumpage system. Under the new system, the total stumpage rate is composed of three separate components – a minimum base

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\(^6\) In 2004, Ontario exported about 4.5 million cubic meters, compared to 9 million cubic meters by Quebec and 26.7 million cubic meters by British Columbia, of softwood lumber to the U.S; in terms of monetary value, Ontario’s share was about $730 million as compared to $1624 million for Quebec and $5190 million for British Columbia.
rate, a renewal charge, and a residual value charge – defined for different industry sectors and
different species groups. The principle of this system is that industry should always pay a
minimum (or base) charge to ensure stable government revenue from the use of timber and a
renewal charge to ensure adequate reforestation irrespective of the forest products market
conditions. However, when forest products markets are favorable, the Crown should share the
benefits of higher product prices with the industry as they translate into higher timber value.

Since the system was introduced in October 1994, a variety of modifications have been made,
including some rate and parameter adjustments, as well as increased differentiation of species
and industrial sectors. For example, the area charge was originally retained; however, in 1998,
it was abolished and the base rate was increased by an equivalent amount. As of today, no part
of the royalty payment is based on area. However, the use of three components has remained
constant.

At present, the system calculates stumpage rates for the following seven species groups: 1) 
white and red pine quality class I; 2) white and red pine quality class II; 3) hemlock and cedar;
4) spruce, pine, and fir; 5) poplar and white birch, 6) hardwoods quality class I; and 7) 
Hardwoods quality class II; and seven industrial segments: 1) pulp (market pulp and
containerboard); 2) veneer and/or plywood; 3) sawmills; 4) composite boards (OSB,
waferboard, medium density fiberboard, particleboard and others); 5) paper (newsprint,
printing and writing paper); 6) fuelwood (commercial); and 7) NES (not in any other sector,
i.e., miscellaneous).

The stumpage rates are revised monthly (they were set quarterly during the transition period
from October 1994 to March 1995). In principle, 49 different stumpage rates are calculated.
However, only the residual value component is calculated monthly (the minimum charge and
renewal charge are determined in April each year). For the sawmill sectors, separate residual
values are calculated for white and red pine grade I, white and red pine grade II, hardwood
grade I, and spruce-pine-fir and hemlock-cedar.
The residual value component is derived from a conversion return calculation based on market price and cost data. Market prices are generally obtained from standard industry sources and cost data are obtained from the forest industry on a confidential basis and updated based on cost indices. When price levels are below a threshold value\textsuperscript{7}, determined by production costs plus the profit and risk allowance, industry pays only the minimum stumpage rate plus renewal charge. When prices exceed the threshold level, and a positive conversion return is received, industry and the Crown begin to share the conversion return. The Crown’s portion accrues through the residual value component of dues, which capture 29% of the conversion return within a specified range for most combination of species groups and product types. When the product price rises even more, an upper threshold is reached where the incremental rate of increase of the residual value component declines to 10% of the conversion return. This transition price level is known as the inflection point.

### 3.3 Some Theoretical Concepts

**Co-integration**: A \((p \times 1)\) vector of time series, \(y_t\), is *co-integrated* if each of the elements of \(y_t\) is I(1), that is, non-stationary with a unit root, while some linear combination of the series \(a' y_t\) is stationary, or I(0), for some nonzero \((p \times 1)\) vector, \(a\) (Engle and Granger 1987).

Johansen (1988, 1995) and Johansen and Juselius (1990, 1992) have suggested maximum likelihood procedures for testing of co-integration in a \(p\)-dimensional finite-order vector autoregression (VAR) model. The system is:

\[
y_t = \sum_{i=1}^{k} A_i y_{t-i} + \Phi D_t + \varepsilon_t, \quad \varepsilon_t \sim N_p(0, \Omega), \quad t = 1, \ldots, T
\]  

(3.1)

where \(y_t\) is a vector of empirical variables, \(D_t\) is the vector of deterministic terms, which can contain a constant, a linear trend, seasonal dummies, or other regressors that I consider fixed or non-stochastic, \(k\) is the lag length, \(\varepsilon_t\) is a vector of error terms assumed to be independent, identically distributed, i.e. \(N_p(0, \Omega)\), and \(T\) is the number of observations.

\textsuperscript{7} The threshold value represents the total costs associated with the production of one thousand board feet of lumber and it’s the sum of five components: (1) delivered wood cost, net of stumpage charges and residual revenues, and net of the revenue from the chips; (2) direct manufacturing costs; (3) indirect costs; (4) an allowance for profit and risk; and (5) the minimum charge and renewal charge of timber.
The VAR in (3.1) can be re-parameterized as a vector error correction (VEC) model:

$$
\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta y_{t-i} + \Phi D_t + \varepsilon_t, \quad \varepsilon_t \sim N_p(0, \Omega), \quad t = 1, \ldots, T
$$

where $\Delta$ is the first difference operator, $\Delta y_t$ is a vector of I(0) processes, $\Gamma_i = - \sum_{j=i+1}^{k} A_j$, and $\Pi = -(I - \sum_{i=1}^{k} A_i)$ is the matrix of long run coefficients and can be decomposed as $\Pi = \alpha \beta'$. The matrix $\alpha$ represents the short-run effects of disequilibria indicating the speed of adjustment to the equilibrium. The matrix $\beta$ defines long-run dynamics of the system. The columns of $\beta$ are the co-integrating vectors representing the stationary linear combination of variables $y_t$. The rank of the long-run matrix, $\Pi$, determines the number of co-integrating vectors in the system.

Johansen (1988, 1995) and Johansen and Juselius (1990, 1992) have suggested two likelihood ratio based tests that are called the trace test and the maximum-eigenvalue test for testing the rank of $\Pi$. Different values for the number of co-integration vectors have different implications:

a) if the rank of $\Pi$ is zero, the variables are not co-integrated and the relationship should be tested using ordinary least squares (OLS) in difference (Banerjee et al. 1993, p.256);

b) if the rank of $\Pi$ is full, the series $y_t$ are individually stationary and OLS in levels can be used for testing;

c) if the rank of $\Pi$ is more than zero and less than the number of variables, the series $y_t$ are co-integrated and the rank indicates the number of linearly independent co-integrating relations among the variables in $y_t$ (Dickey et al. 1991).

A few issues, related to time-series analysis, need to be considered and addressed before applying Johansen’s procedure for co-integration analysis. First, an appropriate choice regarding the span and frequency of data is essential for robust results. Second, stationarity property of each time series in the VAR system should be carefully examined using some powerful tests to draw correct inferences. Third, the specification of the dynamic model, i.e. whether to include a constant and/or time trend in the co-integration equation or in the VEC model, should be carefully considered as the asymptotic distributions of the test statistics depend on different specifications. Finally, the lag length should be properly set to ensure
Gaussian errors in each equation of the VEC model. The details of the procedures and criteria used to address these issues are discussed in the next section.

**Granger-causality**: A stationary variable is said to *Granger cause* another stationary variable if, after controlling for the past information on the dependent variable, the past information on the independent variable helps predict the present value of the dependant variable (Wooldridge 2002). In a finite order stationary VAR process\(^8\), the null hypothesis of Granger-noncausality of one variable for another variable is commonly tested by a standard \(\chi^2\)- or F-test (Lütkepohl and Reimers 1992) on the joint significance of the coefficients of the lagged hypothesized causal variable. In the case of non-stationary and co-integrated variables, Granger-causality is tested in a VEC model (Engle and Granger 1987). The null of Granger-noncausality is rejected either by the joint significance of the coefficients of the lagged differenced hypothesized causal variable, or by the significance of the co-efficient of the error correction term (adjust parameter \(\alpha\)) in the equation under study. This test for Granger-causality considers the possibility that the lagged value of the hypothesized causal factor may help explain the current change in the dependent variable, even if the past changes in the dependant variables do not (Miller and Russek 1990).

### 3.4 Empirical Estimation Methods

#### 3.4.1 The Choice of Span and Frequency of Data

Economic intuition suggests that the span of data should be as long as possible, and the frequency of data will depend upon the frequency of the observations of the variable under consideration. However, some authors have confused the issue of long-run equilibrium by interpreting it as a matter of decades. In the context of production functions, even undergraduate economics text books have clarified the basic difference between the short-run and long-run; the difference cannot be quantified by a real time period, but is instead examined in terms of the period in which factors are variable. The short-run is a period in which some factors are fixed and in the long-run all factors are variable. Hence, in the case of production process the long-run may be days, months, or years. Similarly, time series analysis can have a long-run in terms of days, months, years, or decades depending on the economic

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\(^8\) If all the variables are I(1), but not co-integrated, first-differences should be used in the VAR model.
process under consideration. For example, if the variable of interest varies every hour, its long-run may be hundreds of hours and not years. Furthermore, economic intuition suggests that the frequency of the data should be the frequency at which the variable is being observed (measured) in a real-time frame.

The literature on time-series analysis is full of conflicting views, but the conclusions seem similar to this economic intuition. For example, Shiller and Perron (1985) and Perron (1989a) have shown that the power of a unit root test depends more on the span of the data than on the frequency of observations based on the Monte Carlo studies. A similar conclusion is made for the power of co-integration test by Hakkio and Rush (1991). However, some later studies draw opposite conclusions using the same approach. For instance, Choi (1992) has found that using the data generated by aggregating subinterval data results in lower powers of unit root tests. Ng (1995) has observed in her simulation study that increasing the frequency of observation while keeping time span fixed increases power but at a diminishing rate. Choi and Chung (1995) have re-examined the studies by Shiller and Perron and Perron with the ADF and PP (Phillips-Perron) tests and shown that with the ADF tests, using data with high sampling frequency can provide significant improvement in finite sample power. Furthermore, Prestemon et al. (2004) have used Monte Carlo simulations to show that aggregating observations below their observed rate results in similar power reductions and empirical size distortions across three classes of unit root tests. With respect to co-integration tests, Zhou (2001) has proved that for studies restricted by relatively short time spans, the power of the co-integration tests and the ability to detect co-integration does not only depend on the span of the data but also on the frequency of the data. Therefore, using monthly data is better than using quarterly data, which is better than using annual data. Although it is better to use “long spans of data” for testing long-run equilibrium relationships if data allows, there is no universal answer to the question “How long is the long run?” As Hakkio and Rush (1991, p.572) has pointed out that the answer is dependent upon the economic question being raised and the nature of data used. The length of the long run may vary between different economic problems, for some issues it may be a matter of decades, while for others a matter of months (Hakkio and Rush 1991, p.579).
In this paper, as mentioned earlier, I am interested in analyzing the performance of the market-based stumpage system, which has been implemented since October 1994 by the OMNR. Since June 1995, the stumpage prices have been calculated monthly in response to changes in the market prices of relevant products in major markets in the U.S. Thus I use the monthly data from June 1995 to February 2005 to prevent the loss of power by temporal aggregation in the unit root and co-integration tests.

### 3.4.2 Unit Root Tests and Their Powers

Many unit root tests have been suggested to examine stationarity property of a time series; unfortunately, none of them is universally superior to the others: each test has high power only under certain conditions. In order to obtain reliable inference regarding the stationarity property of each series, I use three unit root tests: the Augmented Dickey-Fuller (ADF) test, the Dickey-Fuller generalized least squares (DF-GLS) test, and the Zivot-Andrews unit root test. The ADF test has been the most commonly used unit root test (Maddala and Kim 1998). It provides information on whether the variable under study has some deterministic terms in the regression, which facilitates the specification of the VEC model. However, it has been argued that the ADF test, as well as other widely used unit root tests, has low power when the root of the autoregressive parameter is close to unity (DeJong et al. 1992, Harris and Sollis 2003). A modified ADF test known as Dickey-Fuller generalized least squares (DF-GLS) detrending procedure has been proposed by Elliott et al. (1996), and this test has significantly greater power than the previous versions of the ADF test (Elliott et al. 1996, Ng and Perron 2001). Nevertheless, neither of these two tests considers the structural breaks that might have occurred in the series. Perron (1989b) has shown that a unit root test that does not take into account the break in the series will have low power. Thus, to verify the validity of the ADF and DF-GLS tests, I use the Zivot-Andrews unit root test (Zivot and Andrews 1992) to explore the possibility of structural breaks. By using these three unit root tests, I believe that the stationarity property of each series can be correctly determined.

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9 All these three unit root tests examine the null hypothesis of a unit root (with or without consideration of a structural break) against the alternative of trend or level stationarity. Due to the concern of low power of this type of tests, another type of test which imposes stationarity as the null hypothesis has been proposed. The best known test of this kind is the KPSS test proposed by Kwiatkowski, Phillips, Schmidt and Shin (1992). However, the standard KPSS test is oversized for the stationary but highly autoregressive process (Hobijn et al. 2004). To improve on its size properties, Hobijn et al. (2004) have suggested the use of a
3.4.3 Specifications and Lag Length in the VEC Model

One of the critical steps in the application of Johansen's multivariate co-integration approach is careful specification of the VEC model. Johansen (1995, 80-84) describes five specifications: (1) series $y_t$ have quadratic trends and the co-integrating equations are trend stationary; (2) both series $y_t$ and the co-integrating equations have linear trends, and the constant enters the error correction model, which implies that the first-differenced variables in the error correction models do not have the same mean (Maddala and Kim 1998); (3) series $y_t$ have linear trends and the constant enters only the co-integrating equations; (4) series $y_t$ have no deterministic trends and the co-integrating equations have intercepts, which implies that the first-different data have the same mean (Maddala and Kim 1998); (5) series $y_t$ have no deterministic trends and the co-integration equations do not have intercepts. I select the appropriate specification for the VEC model based on the results of unit root tests.

The VEC model estimation results are very sensitive to the number of lags included in the model. Inappropriate lag can distort the size of the test (Chueng and Lai 1993) and results in loss of power (Lütkepohl and Saikkonen 1999). The Akaike's information criterion (AIC)$^{10}$ is used to determine the lag length in the model, which has been proved to outperform the other lag selection criteria by Chueng and Lai (1993) and Lütkepohl and Saikkonen (1999) using Monte Carlo simulation.

3.5 The Data

In Ontario, there are three major softwood species groups: spruce-pine-fir (SPF), white pine and red pine (Pw/Pr quality class I and quality class II), and hemlock and cedar (HC), which are of significant economic value. The SPF, Pw/Pr and HC constitute about 88%, 10% and 2%

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$^{10}$ The STATA software also reports the optimal lag length selected by other criteria, for example, Schwartz’s Bayesian information criterion (SBIC), Hannan and Quinn information criterion (HQIC), and final prediction error (FPE). In most cases, they report the same optimal lag length for the VEC model.
respectively in the total softwood tree production (OMNR 1991). This analysis focuses on SPF and Pw/Pr as they together compose about 98% of the total softwood tree production in Ontario.

The data for this study consists of reference prices of three major products from SPF and Pw/Pr timber: lumber, composites, and pulp, and stumpage prices of SPF and Pw/Pr timber for these three products. These monthly data are taken from the stumpage matrix of the OMNR and cover the period from June 1995 to February 2005.

The OMNR, since the introduction of the new stumpage system, has been using the lagged monthly market price of the final product as the reference price to determine the residual value and the total stumpage price paid by each industry. These reference prices are the market prices taken from various markets in the U.S. For example, the market prices of pulp (per tonne) in the U.S. are used as reference prices for determining the stumpage prices of SPF and Pw/Pr timber used for pulp. The market prices of 7/16 inch composites of random lengths from North-central U.S. are used as reference prices for determining the stumpage prices of SPF and Pw/Pr timber used for composites. The reference prices of SPF lumber have changed over the period to reflect changing market conditions for lumber: for the period of June 1995 to March 1997, the reference prices were the market prices of one SPF softwood product SPF 2×4 Std&Btr in Chicago; for the period of April 1997 to March 1999, the market prices of SPF 2×4 Std&Btr in Great Lakes were the reference prices; and for the current period ranging from April 1999 to the end of the period, the reference prices are the lumber composites prices, which are the weighted average of the delivered prices in Toronto and Great Lakes of SPF lumbers of different grades (#2&Btr, Economy) and dimensions (2×4, 2×6, 2×8).

I carry out some transformations of the data for this analysis. The market prices of the products in U.S. dollars are first converted into Canadian dollars using the exchange rates from Bank of Canada, Wednesday noon average for that month. Then the price series are

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11 The OMNR changed the market to collect the market prices under the request of the industry and basing on the survey of the major markets of SPF softwood lumber produced in Ontario.
transformed to price indices using the prices in January 2004 as the base price. Finally I take the natural logarithm of the price indices. Table 3.1 summarizes the data.

Table 3.1 Data description for the price series of spruce, pine and fir (SPF), and white pine and red pine (Pw/Pr).

<table>
<thead>
<tr>
<th>Series</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF_{LSP}</td>
<td>stumpage price of SPF timber used for lumber</td>
</tr>
<tr>
<td>SPF_{CSP}</td>
<td>stumpage price of SPF timber used for wood composites</td>
</tr>
<tr>
<td>SPF_{PSP}</td>
<td>stumpage price of SPF timber used for pulp</td>
</tr>
<tr>
<td>SPF_{LRP}</td>
<td>reference price used for calculation of stumpage price of SPF timber for lumber</td>
</tr>
<tr>
<td>SPF_{CRP}</td>
<td>reference price used for calculation of stumpage price of SPF timber and Pw/Pr timber for wood composites</td>
</tr>
<tr>
<td>SPF_{PRP}</td>
<td>reference price used for the calculation of stumpage price of SPF timber and Pw/Pr timber for pulp</td>
</tr>
<tr>
<td>Pw/Pr_{LISP}</td>
<td>stumpage price of Pw/Pr class I timber for lumber</td>
</tr>
<tr>
<td>Pw/Pr_{L2SP}</td>
<td>stumpage price of Pw/Pr class II timber for lumber¹</td>
</tr>
<tr>
<td>Pw/Pr_{CSP}</td>
<td>stumpage price of Pw/Pr timber for composites</td>
</tr>
<tr>
<td>Pw/Pr_{PSP}</td>
<td>stumpage price of Pw/Pr timber for pulp</td>
</tr>
<tr>
<td>Pw/Pr_{LRP}</td>
<td>reference price used for calculation of stumpage price of Pw/Pr Class I and II timber for lumber</td>
</tr>
</tbody>
</table>

¹ Before April 1999, the two classes of Pw/Pr timber were not distinguished when determining the stumpage prices for various types of industrial timber. From April 1999, different stumpage prices of Pw/Pr timber for lumber are computed for these two classes, but the Pw/Pr timber for pulp and composites is not distinguished between these two classes.

The quarterly average of the SPF stumpage prices and reference prices are provided in Appendix I. Figure 3.1 depicts the transformed reference prices of SPF lumber, composites, and pulp, and their corresponding stumpage prices. The plots in Figure 3.1 show that the stumpage price generally moves together with its respective reference price. However, each

¹² I changed the nominal prices into price indices to remove the effect of different units of measurement (cubic meter for stumpage, thousand board feet for prices of lumber, and tons for prices of pulp) used in difference price series and also the significant difference between the nominal reference prices and the corresponding stumpage prices.
A pair of prices shows some unique features. Specifically, both the stumpage price of SPF timber for lumber and its reference price show fluctuation during the whole period. But from April 1996 to June 1996, which was the beginning of the SLA period, the market price of SPF lumber increased dramatically and the stumpage price of SPF timber for lumber experienced even higher percentage change. The possible reason might be that when the market condition was favorable, the RV component became positive and it accounted for a significant share of the total stumpage price. As a result, any percentage increase in the lumber price would lead to a higher percentage change in the stumpage price. Figure 3.1 also shows that from June 1996 to March 2001 which is the last month covered by the 1996 SLA, the stumpage price and the reference price increased or decreased in a similar magnitude. Afterwards, the stumpage price again showed more dramatic changes than the reference price with the exception of the period from July 2002 to April 2004 during which the market was in the downturn. With respect to the stumpage price of SPF timber for composites and its reference price, the stumpage price fluctuated slightly more than the reference price during the period April 1998 to July 2003. In the case of the stumpage price of SPF timber for pulp and its reference price, both series do not show much fluctuation during the whole period, which makes us to suspect that they might be stationary process.
Figure 3.1 SPF reference prices (lagged market prices) and the SPF stumpage prices.

(a) The natural log of SPF lumber reference price and the stumpage price of SPF timber used for lumber.

(b) The natural log of SPF composite reference price and the stumpage price of SPF timber used for composites.

(c) The natural log of SPF pulp reference price and the stumpage price of SPF timber used for pulp.
3.6 Results and Discussion

3.6.1 Tests for Unit Roots

The stationarity property of each series is first tested using the Augmented Dickey-Fuller (ADF)\textsuperscript{13} method (Dickey and Fuller 1979). It has been observed that in implementing this test it is important to choose the appropriate specification of the deterministic terms, i.e. whether a constant or time trend should be included in the model, as the deterministic trend is closely related to the power and size of the unit root tests (Maddala and Kim 1998). If a trend variable is in the true data generation process, but it is excluded from the regression, then the power of the test decreases to zero as the sample size increases (Perron 1988). On the other hand, it is also desirable to exclude unnecessary deterministic terms, which also result in severe loss of power (Maddala and Kim 1998). Hamilton (1994, 528-529) described the four different cases in which the ADF test can be used. Following the proposal of Perron (1988), I start from the most general trend specification and test down to more restrictive specifications. Another critical problem to be addressed in applying this approach is to select the proper lag length as the size and power properties of the ADF test are sensitive to the number of lags; too few lags may result in over-rejecting the null when it is true while too many lags may reduce the power of the test (Harris and Sollis 2003). The lag length is selected using the Hall (1994) general to specific criterion\textsuperscript{14} as suggested by DeJong et al. (1992) and Ng and Perron (1995) coupled with the elimination of autocorrelation in the error terms (Wooldridge 2002). The serial correlation is tested using Durbin’s alternative test for serial correlation which is valid when there are non-strictly exogenous regressors. Table 3.2 reports the ADF test statistics and the selected lag lengths for each individual price series both in level and in first-difference.

\textsuperscript{13} The ADF test has been the most commonly used procedure for testing non-stationarity property; therefore, the test procedure can be easily found in many theoretical and empirical studies, for example, Dickey and Fuller (1979), Hamilton (1994) and Wooldridge (2002).

\textsuperscript{14} The general to specific criterion is to start with a large value of lag length (k), test the significance of the last coefficient and reduce k iteratively until a significant statistic is encountered. Ng and Perron (1995) compare the information based criteria, namely the AIC, BIC with Hall’s general to specific rule by a Monte Carlo study using $T=100$ and both AR and MA errors. One of their major conclusions is Hall’s criteria has the tendency to select higher values of k, which brings about the size being at the nominal level, but with a loss of power. However, DeJong et al. (1992) shows that increasing k typically results in a modest decrease in power but a substantial decrease in size distortions.
Table 3.2 Results of the Augmented Dickey-Fuller (ADF) unit-root test for the softwood stumpage prices and the reference prices

<table>
<thead>
<tr>
<th>Price Series</th>
<th>int/time</th>
<th>Test statistic</th>
<th>Durbin’s alternative test statistics $\chi^2(1)$</th>
<th>$k$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPF_LSP</td>
<td>c</td>
<td>-2.400</td>
<td>2.187</td>
<td>2</td>
</tr>
<tr>
<td>SPF_CSP</td>
<td>c</td>
<td>-2.477</td>
<td>0.150</td>
<td>2</td>
</tr>
<tr>
<td>SPF_PSP</td>
<td>c</td>
<td>-3.799***</td>
<td>0.027</td>
<td>1</td>
</tr>
<tr>
<td>Pw/Pr_LISP</td>
<td></td>
<td>-0.023</td>
<td>0.061</td>
<td>2</td>
</tr>
<tr>
<td>Pw/Pr_L2SP</td>
<td></td>
<td>-0.476</td>
<td>0.263</td>
<td>2</td>
</tr>
<tr>
<td>Pw/Pr_CSP</td>
<td>c/t</td>
<td>-2.947</td>
<td>0.363</td>
<td>4</td>
</tr>
<tr>
<td>Pw/Pr_PSP</td>
<td>c/t</td>
<td>-3.336*</td>
<td>0.872</td>
<td>3</td>
</tr>
<tr>
<td>SPF_LRP</td>
<td>c</td>
<td>-2.299</td>
<td>0.996</td>
<td>2</td>
</tr>
<tr>
<td>SPF_CRP</td>
<td>c</td>
<td>-2.628*</td>
<td>0.068</td>
<td>2</td>
</tr>
<tr>
<td>SPF_PRP</td>
<td>c</td>
<td>-3.491***</td>
<td>0.065</td>
<td>1</td>
</tr>
<tr>
<td>Pw/Pr_LRP</td>
<td>c</td>
<td>-2.775*</td>
<td>2.806</td>
<td>3</td>
</tr>
<tr>
<td><strong>First Difference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta$(SPF_LSP)</td>
<td></td>
<td>-10.019***</td>
<td>1.286</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(SPF_CSP)</td>
<td></td>
<td>-7.798***</td>
<td>1.205</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(SPF_PSP)</td>
<td></td>
<td>-6.179***</td>
<td>0.041</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(Pw/Pr_LISP)</td>
<td></td>
<td>-7.627***</td>
<td>0.062</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(Pw/Pr_L2SP)</td>
<td></td>
<td>-7.567***</td>
<td>0.275</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(Pw/Pr_CSP)</td>
<td></td>
<td>-5.979***</td>
<td>0.043</td>
<td>3</td>
</tr>
<tr>
<td>$\Delta$(Pw/Pr_PSP)</td>
<td></td>
<td>-9.452***</td>
<td>1.649</td>
<td>2</td>
</tr>
<tr>
<td>$\Delta$(SPF_LRP)</td>
<td></td>
<td>-8.841***</td>
<td>0.320</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(SPF_CRP)</td>
<td></td>
<td>-8.565***</td>
<td>0.497</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(SPF_PRP)</td>
<td></td>
<td>-6.995***</td>
<td>0.775</td>
<td>1</td>
</tr>
<tr>
<td>$\Delta$(Pw/Pr_LRP)</td>
<td></td>
<td>-4.003***</td>
<td>0.781</td>
<td>2</td>
</tr>
</tbody>
</table>

Note:
1. In this table as well as in other tables, the symbols *, ** and *** indicate the 10%, 5% and 1% significance level, respectively.
2. For the 10%, 5% and 1% significance levels, if both the intercept and trend are significant, the critical values of the ADF test are -3.15, -3.45 and -4.03, respectively; if only the intercept is significant, the critical values are -2.58, -2.89 and -3.51, respectively; if neither is significant, the critical values are -1.61, -1.95 and -2.60, respectively.
3. The ‘int/time’ column indicates the significance of the intercept (c) and/or time trend (t).
   The 10% and 5% critical values of $\chi^2(1)$ are 2.71 and 3.84, respectively.
Out of the eleven price series, two, including $\text{SPF}_{\text{PSP}}$ and $\text{SPF}_{\text{PRP}}$, reject the null hypothesis of a unit root at the 1% significance level, which indicates that they are stationary. Three series, including $\text{Pw/PrCSP}$, $\text{SPF}_{\text{CRP}}$ and $\text{Pw/PrLRP}$, fail to reject the null hypothesis at the 5% significance level, but reject it at the 10% level. The remaining six series accept the null at the 10% significance level; thus, these price series are non-stationary. In terms of the series in first-difference, all the series reject the null hypothesis of a unit root at the 1% significance level. Therefore, the test results provide strong evidence that the first-differenced data are stationary. These results indicate that other than $\text{SPF}_{\text{PSP}}$ and $\text{SPF}_{\text{PRP}}$, all the price series are integrated of order one, i.e. I(1). The second column in Table 3.2 reports the significance of the constant and/or the time trend, which shows that all price series that have a unit root have a drift except for the stumpage price of Pw/Pr class I and class II timber for lumber. This information will be used for the specification of the VEC model. The Durbin’s alternative test results for serial correlation are presented in the fourth column, which show that for all the series in level and in first-difference, the null hypothesis of no series correlation cannot be rejected.

I then apply the DF-GLS test procedure proposed by Elliot et al. (1996) to test the stationarity property of each series. The DF-GLS test is performed by testing the null hypothesis $\alpha_0 = 0$ in the regression:

$$\Delta y_i^d = \alpha_0 y_{i-1}^d + \alpha_1 \Delta y_{i-1}^d + \cdots + \alpha_p \Delta y_{i-p}^d + u_i$$

where $y_i^d$ is the de-trended series. De-trending depends on whether the model includes only drift or a linear trend as well. Taking the latter case:

$$y_i^d = y_i - \hat{\beta}_0 - \hat{\beta}_1 t$$

where $(\hat{\beta}_0, \hat{\beta}_1)$ are obtained by regressing $\bar{y}$ on $\bar{z}$ where

$$\bar{y} = [y_1, (1 - \bar{\alpha}L) y_2, \ldots, ((1 - \bar{\alpha}L) y_T]$$
$$\bar{z} = [z_1, (1 - \bar{\alpha}L) z_2, \ldots, ((1 - \bar{\alpha}L) z_T]$$

and

$$z_i = (1, t)' \quad \bar{\alpha} = 1 + \frac{\bar{c}}{T}$$
where $T$ represents the number of observations for $y$, and $c$ be fixed at -7 in the model with drift and at -13.7 in the linear trend case. Elliott et al. (1996) have shown that de-trending in this way produces a test that has good power properties. Critical values are provided in their paper (see also Maddala and Kim 1998, p. 114). However, Ng and Perron (2001) have argued that while the power gains of the DF-GLS test are impressive, simulations also show that the test exhibits non-negligible size distortion when the moving average polynomial of the first-differenced series has a large negative root. To address the size distortion, they have suggested a modified AIC (MAIC) to select the lag length under the condition of a large negative root.

Therefore, the DF-GLS test procedure with the MAIC lag selection criterion is applied to each series for the whole period. For the variables in level, the test is performed under the second case. The test statistics and the lag lengths are reported in column 2 and 3, respectively, in Table 3.3. For the first-differenced data, as all of them have neither a significant intercept nor time trend, I believe it is unnecessary to perform this test. With respect to the variables in level, the DF-GLS test fails to reject the null of non-stationary for all the series at the 5% significance level. Therefore, these results provide further evidence that most series are I(1) processes. However, two series, i.e., the stumpage price of SPF timber for pulp and the reference price for pulp are stationary under the ADF test, but non-stationary under the DF-GLS test. Since the DF-GLS test is supposed to have higher power and less size distortion, these two series are treated as I(1) processes.

Next, I apply the Zivot-Andrews unit root test which allows for a structural break in each time series. The Zivot-Andrews procedure is an adjusted ADF test. By including dummy variables for a constant and/or trend, it is able to detect an unknown structural break in level, trend or both. The detailed procedure is provided in Zivot and Andrews (1992). As Perron (1994) has pointed out, the Zivot-Andrews approach tests the joint hypothesis of a null of a unit root and no structural break in the series. The results of using this procedure to all the series in level are reported in column 4 of Table 3.3. These results show that two series, the stumpage prices of Pw/Pr timber for composites and pulp are stationary in the presence of a significant structural break and the rest series are non-stationary in level.
Table 3.3 Results of the DF-GLS and Zivot-Andrews unit-root tests for stumpage prices of softwood timber and the reference prices.

<table>
<thead>
<tr>
<th>Price series</th>
<th>DF-GLS test</th>
<th>Zivot-Andrews test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test statistic</td>
<td>k</td>
</tr>
<tr>
<td>SPF&lt;sub&gt;LSP&lt;/sub&gt;</td>
<td>-1.661</td>
<td>2</td>
</tr>
<tr>
<td>SPF&lt;sub&gt;CSP&lt;/sub&gt;</td>
<td>-1.892</td>
<td>5</td>
</tr>
<tr>
<td>SPF&lt;sub&gt;PSP&lt;/sub&gt;</td>
<td>-1.948</td>
<td>1</td>
</tr>
<tr>
<td>Pw/Pr&lt;sub&gt;L1SP&lt;/sub&gt;</td>
<td>-1.436</td>
<td>2</td>
</tr>
<tr>
<td>Pw/Pr&lt;sub&gt;L2SP&lt;/sub&gt;</td>
<td>-1.728</td>
<td>2</td>
</tr>
<tr>
<td>Pw/Pr&lt;sub&gt;CSP&lt;/sub&gt;</td>
<td>-2.742*</td>
<td>1</td>
</tr>
<tr>
<td>Pw/Pr&lt;sub&gt;PSP&lt;/sub&gt;</td>
<td>-2.216</td>
<td>1</td>
</tr>
<tr>
<td>SPF&lt;sub&gt;LRP&lt;/sub&gt;</td>
<td>-1.903</td>
<td>4</td>
</tr>
<tr>
<td>SPF&lt;sub&gt;CRP&lt;/sub&gt;</td>
<td>-1.843</td>
<td>5</td>
</tr>
<tr>
<td>SPF&lt;sub&gt;PRP&lt;/sub&gt;</td>
<td>-1.982</td>
<td>2</td>
</tr>
<tr>
<td>Pw/Pr&lt;sub&gt;LRP&lt;/sub&gt;</td>
<td>-2.613</td>
<td>1</td>
</tr>
</tbody>
</table>

Note:
1. For the 10%, 5%, and 1% significance levels, the critical values for the DF-GLS test are -2.72, -3.01 and -3.56, respectively.
2. The critical values for the Zivot-Andrews unit root test are reported by Zivot and Andrews (1992, Tables 2, 4). For the 10%, 5% and 1% significance levels, if there is a break in the intercept, the critical values are: -4.58, -4.80 and -5.34, respectively; if there is a break in both the intercept and the trend, the critical values are: -4.82, -5.08 and -5.57, respectively.

In summary, all these above unit root tests provide strong evidence that most price series in the data are I(1) processes. However, some series are stationary under one of these tests. Based on the results from these three tests, the stumpage prices of Pw/Pr timber for composites and pulp are excluded from co-integration analysis.

3.6.2 Johansen’s Multivariate Co-integration Tests

Next, Johansen’s multivariate co-integration approach is used to test the co-integration between the reference prices and their corresponding stumpage prices. The results of the ADF test indicate that all the series (except for the stumpage prices of Pw/Pr timber for composites and pulp) do not have linear trends and all the first-differenced series are stationary without drift and linear trend. Therefore, I use the fourth specification (series y<sub>i</sub> have no deterministic
trends and the co-integrating equations have intercepts, which implies that the first-differenced data have the same mean) for the co-integration analysis. The Akaike's information criterion (AIC), as mentioned earlier, is used to determine the lag length in the model. I also conduct the diagnostic tests to check whether there is any departure from the standard assumptions on the residuals of each equation in the VEC models. Table 3.4 reports the test results.

**Table 3.4 Residual diagnostic tests for the VEC equations.**

<table>
<thead>
<tr>
<th>Equation</th>
<th>Autocorrelation $\chi^2(1)$</th>
<th>Heteroskedasticity $\chi^2_{ARCH}(2)$</th>
<th>Normality $\chi^2(2)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta SPF_{LSP}$</td>
<td>0.23</td>
<td>4.49</td>
<td>3.88</td>
</tr>
<tr>
<td>$\Delta SPF_{LRP}$</td>
<td>0.12</td>
<td>0.00</td>
<td>293.31***</td>
</tr>
<tr>
<td>$\Delta SPF_{CSP}$</td>
<td>0.01</td>
<td>0.06</td>
<td>15.68***</td>
</tr>
<tr>
<td>$\Delta SPF_{CRP}$</td>
<td>1.10</td>
<td>0.15</td>
<td>2.45</td>
</tr>
</tbody>
</table>

The critical values of $\chi^2(2)$ for 10%, 5% and 1% significance levels are 4.61, 5.99 and 9.21, respectively.

Autocorrelation of the results is tested using the Lagrange-Multiplier (LM) test described by Johansen (1995), which is valid for systems with lagged dependent variable. The null hypothesis of no autocorrelation is accepted at the 5% level in all the cases. Test for heteroskedasticity is conducted using a $\chi^2$- test for autoregressive conditional heteroskedasticity (ARCH). The null hypothesis of homoskedasticity cannot be rejected in all the cases at even the 10% significance level. Conditional Normality of the residuals is tested with the Jarque-Bera test (Jarque and Bera 1980) at the 5% significance level. The null hypothesis that errors are normally distributed is rejected in some of the tests at 5% level. However, the result of Johansen’s co-integration tests are not biased by non-normality of the residuals (Gonzalo 1994), these test results can be considered valid (Nanang 2000).

Table 3.5 reports the Johansen’s bivariate co-integration test results for five pairs of the stumpage price and corresponding reference price of SPF or Pw/Pr. The trace test, which has been shown to be more robust to both skewness and excess kurtosis in the residuals than the
maximal eigenvalue test (Chueng and Lai 1993), is used to test the null hypothesis of no co-integrating relationship (i.e. \( r = 0 \)) against the alternative \( r > 0 \).

Table 3.5 Test statistics of Johansen’s bivariate co-integration tests between the stumpage price and its reference price.

<table>
<thead>
<tr>
<th>Stumpage price and reference price</th>
<th>Null hypothesis ( H_0: )</th>
<th>Trace statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF_LSP</td>
<td>( r = 0 )</td>
<td>24.75***</td>
</tr>
<tr>
<td>SPF_LRP</td>
<td>( r \leq 1 )</td>
<td>7.07</td>
</tr>
<tr>
<td>SPF_CSP</td>
<td>( r = 0 )</td>
<td>27.34 ***</td>
</tr>
<tr>
<td>SPF_CRP</td>
<td>( r \leq 1 )</td>
<td>6.12</td>
</tr>
<tr>
<td>SPF_PSp</td>
<td>( r = 0 )</td>
<td>35.23 ***</td>
</tr>
<tr>
<td>SPF_PRP</td>
<td>( r \leq 1 )</td>
<td>13.07 ***</td>
</tr>
<tr>
<td>Pw/Pr_L1SP</td>
<td>( r = 0 )</td>
<td>14.74</td>
</tr>
<tr>
<td>Pw/Pr_L1RP</td>
<td>( r \leq 1 )</td>
<td>2.13</td>
</tr>
<tr>
<td>Pw/Pr_L2SP</td>
<td>( r = 0 )</td>
<td>9.61</td>
</tr>
<tr>
<td>Pw/Pr_L2RP</td>
<td>( r \leq 1 )</td>
<td>0.89</td>
</tr>
</tbody>
</table>

The critical values are taken from Osterwald-Lenum (1992).

<table>
<thead>
<tr>
<th>( r = 0 )</th>
<th>( r \leq 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>17.85</td>
</tr>
<tr>
<td>5%</td>
<td>19.96</td>
</tr>
<tr>
<td>1%</td>
<td>24.60</td>
</tr>
</tbody>
</table>

The trace statistics show that in two cases of SPF, including the stumpage price of SPF timber for lumber and its reference price, and the stumpage price of SPF timber for composites and its reference price, the null hypothesis of no co-integration (\( r = 0 \)) is rejected and one co-integration vector is accepted at the 1% significance level. This result implies that the stumpage prices of SPF timber for lumber and composites are co-integrated with their respective reference prices. Therefore, there is a long-run relationship between the stumpage price and its reference price for lumber and composites, respectively. In the case of the stumpage price of SPF timber for pulp and its reference price, I find two co-integrating vectors, which imply that these two series are quite stable and are more like stationary
processes\textsuperscript{15} during this whole period. Therefore, their relationship should be studied in level, instead of in first-difference. However, in both the cases of Pw/Pr, the trace statistic shows that neither of the stumpage prices of Pw/Pr class I and class II timber for lumber is co-integrated with its respective reference price.

The normalized eigenvectors ($\beta$) and their weights ($\alpha$), obtained from Johansen’s test, for the cases in which co-integration is found between stumpage and reference prices, are given in Table 3.6.

**Table 3.6 Normalized co-integrating vectors ($\beta$) and adjustment parameters ($\alpha$) estimated from the VEC models.**

<table>
<thead>
<tr>
<th>Stumpage price and reference price</th>
<th>Eigenvalues ($\lambda$)</th>
<th>Eigenvector $\beta$</th>
<th>Weights $\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF_LSP</td>
<td>0.17</td>
<td>1</td>
<td>-0.24**</td>
</tr>
<tr>
<td>SPF_LRP</td>
<td>0.05</td>
<td>-1.66**</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.09**</td>
<td></td>
</tr>
<tr>
<td>SPF_CSP</td>
<td>0.17</td>
<td>1</td>
<td>-0.08</td>
</tr>
<tr>
<td>SPF_CRP</td>
<td>0.09</td>
<td>-1.73**</td>
<td>0.14**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.50**</td>
<td></td>
</tr>
</tbody>
</table>

The co-integration eigenvector ($\beta$) is used to measure the long-run relationship between the pair of prices. The long-run equilibrium relationship between the stumpage of the SPF timber and its reference price can be represented as:

$$\text{SPF}_{\text{LSP}} = 1.66 \text{SPF}_{\text{LRP}} - 3.09$$

The positive coefficient of the reference price of lumber indicates that an increase in the market prices will result in the increase in the stumpage price in the long-run. The normalized coefficient $\alpha$ is interpreted as the weights or adjustment coefficients that measure the average speed of adjustment toward the estimated equilibrium state, and a high value $\alpha$ indicates rapid

\textsuperscript{15} This result confirms the results of ADF test and rejects the results of DF-GLS test with respect to stationarity property of SPF\_PSP and SPF\_PRP.
adjustment towards equilibrium (Hänninen 1998). Specifically, the first value of \( \alpha = -0.24 \) represents the speed at which the percentage change in the stumpage price of SPF timber for lumber adjusts toward the long-run equilibrium relationship. Therefore, when the stumpage price of SPF timber for lumber is too high, it will decrease toward the equilibrium level. The second value of \( \alpha = 0.14 \) in the VEC model for the stumpage price of SPF timber for composites and its reference price indicates the speed at which the percentage change in the reference price of SPF composites adjusts. The \( t \)-test on each \( \alpha \) value shows that the second value in the VEC model of stumpage price of SPF timber for lumber and its reference is not statistically different from zero at the 10% significance level, which implies that the reference price of SPF lumber is weakly exogenous to the co-integration vector (Harris and Sollis 2003) and the co-integration equation will not enter the short-run equation determining the percentage change in the reference price of SPF lumber. This indicates that the reference price of SPF lumber will not adjust to the equilibrium if the system is in disequilibrium. Similarly, the first value of \( \alpha = -0.08 \) in the VEC model of the stumpage price of SPF timber for composites and its reference price is not significant at the 10% significance level implies that the stumpage price of SPF timber for composites is weakly exogenous to the co-integration vector. As discussed earlier, the significance of \( \alpha \) indicates the direction of Granger-causality, but I will wait to discuss its implication in the Granger-causality test section.

However, the reliability of these test results may be suspect because they are obtained using finite samples. It has been argued that the Johansen’s approach may suffer from low power and size distortion in finite samples because the small sample properties of the trace test are different from the asymptotic properties (Chueng and Lai 1993, Toda 1995, Haug 1996, Gonzalo and Pitarakis 1999). Therefore, it is also important to use any additional information that can support the choice of the co-integration rank (Harris and Sollis 2003). Juselius (1995) has proposed to analyze the dynamics of the VAR model (system (3.1)) and particularly the eigenvalues of the companion matrix \( A \) as they provide further confirmation of how many \( (p-r) \) roots are on the unit root circle. The matrix is defined by:

\[
A = \begin{bmatrix}
A_1 & A_2 & \cdots & A_{k-1} & A_k \\
I_p & 0 & \cdots & 0 & 0 \\
0 & I_p & \cdots & 0 & 0 \\
0 & 0 & \cdots & I_p & 0 \\
\end{bmatrix}
\]
where $A_i$ is determined by (3.1) and $I_p$ is the $p$-dimensional identity matrix.

I use this approach to check whether I have correctly specified the number of co-integrating vectors or whether the co-integrating equations, which are assumed to be stationary, are not stationary in each of the VAR models. The test results, which contain the eigenvalues of the companion matrix and their associated moduli, are presented in Table 3.7. In the VAR model consisting of the stumpage price of SPF timber for lumber and its reference price, there are two (2×1) roots. The test result shows that one of the roots is 1, which indicates that there is one common trend (p-r) process, and the other root is about 0.73, which is substantially smaller than 1. Therefore, it can be concluded that the root of 0.73 supports the earlier analysis, in which there is one co-integrating vector and the predicted co-integrating equation is stationary. Similarly, in the VAR model composed of the stumpage price of SPF timber for composites and its reference price, one of the roots is 1 and the other root is 0.67, which again confirms the earlier analysis on the co-integrating rank and the stationarity property of the co-integrating equation.

<table>
<thead>
<tr>
<th>VAR model</th>
<th>Eigenvalue</th>
<th>Modulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF_{LSP}</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SPF_{LRP}</td>
<td>0.73</td>
<td>0.73</td>
</tr>
<tr>
<td>SPF_{CSP}</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SPF_{CRP}</td>
<td>0.67</td>
<td>0.67</td>
</tr>
</tbody>
</table>

### 3.6.3 Granger-causality

On the basis of the results from the unit root tests and co-integration tests, I first test the Granger-causality between the relevant stationary variables, i.e. between SPF_{PSP} and SPF_{PRP}, and between $P_{w/Pr}^{PSP}$ and SPF_{PRP} in level in a finite order VAR model. The lag length is selected to minimize the AIC and to eliminate serial correlation in the error terms. Table 3.8 reports the Granger-causality test results, which show that the Granger-causality is uni-
directional and running from SPF_{PRP} to SPF_{RSP}, which implies that after controlling for past values of the stumpage price of SPF timber for pulp, the past values of the reference price help predict the present value of the stumpage price of SPF timber for pulp. For the case of Pw/Pr_{PSP} and SPF_{PRP}, as the Zivot-Andrews unit root test indicates significant structural breaks in both the intercept and the trend of the Pw/Pr_{PSP}, dummy variables for the two sub-periods (June 1995 – March 2001 and April 20014 – February 2005) and the interaction term between the dummy variable and the lagged value of the Pw/Pr_{PSP} are included in the VAR model as exogenous variables. The test results reported in Table 3.8 show that the stumpage price of Pw/Pr timber for pulp Granger causes the reference price, but it is not true in the reverse direction.

Table 3.8 Granger-causality tests for the stumpage price and its reference price.

<table>
<thead>
<tr>
<th>Null hypothesis</th>
<th>F-test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF_{PRP} does not Granger cause SPF_{PSP}</td>
<td>3.80**1</td>
</tr>
<tr>
<td>SPF_{PSP} does not Granger cause SPF_{PRP}</td>
<td>0.74</td>
</tr>
<tr>
<td>SPF_{PRP} does not Granger cause Pw/Pr_{PSP}</td>
<td>0.78</td>
</tr>
<tr>
<td>Pw/Pr_{PSP} does not Granger cause SPF_{PRP}</td>
<td>3.13 **</td>
</tr>
<tr>
<td>Pw/Pr_{L1SP} does not Granger cause Pw/Pr_{L1SP}</td>
<td>1.36</td>
</tr>
<tr>
<td>Pw/Pr_{L1SP} does not Granger cause Pw/Pr_{LRP}</td>
<td>0.451</td>
</tr>
<tr>
<td>Pw/Pr_{L2SP} does not Granger cause Pw/Pr_{L2SP}</td>
<td>2.36</td>
</tr>
<tr>
<td>Pw/Pr_{L2SP} does not Granger cause Pw/Pr_{LRP}</td>
<td>0.031</td>
</tr>
</tbody>
</table>

1 Heteroskedasticity-robust F statistic is computed.

Next I test the Granger-causality between the non-stationary, but not co-integrated variables, i.e. between Pw/Pr_{L1SP} and Pw/Pr_{LRP}, and between Pw/Pr_{L2SP} and Pw/Pr_{LRP}. The first differenced data are used in these VAR models. The Granger-causality test results indicate that Granger-causality does not exist in either direction between the two prices in each VAR model.
The error terms in all the equations in the VAR models, for stationary as well as non-stationary variables, are subjected to diagnostic testing for serial correlation and heteroskedasticity. Serial correlation is tested using Durbin’s alternative test. The null hypothesis of no autocorrelation is accepted at the 5% level in all the cases. Autoregressive conditional heteroskedasticity (ARCH) is tested using a $\chi^2$-test. The null hypothesis of homoskedasticity is rejected at the 5% level in the cases of SPF_{PSP}, Pw/Pr_{LRP} as dependent variables. For these cases I use the heteroskedasticity-robust F-statistics to test the joint significance of the coefficients of the lagged independent variable.

The Granger-causality between the co-integrated prices (SPF_{LSP} and SPF_{LRP}, SPF_{CSP} and SPF_{CRP}), as mentioned earlier, is examined based on the VEC models. The only significant $\alpha$ value in the SPF_{LSP} and SPF_{LRP} VEC model implies that the SPF_{LRP} Granger causes SPF_{LSP}, while the only significant $\alpha$ value in the SPF_{CSP} and SPF_{CRP} VEC model suggests that the unidirectional Granger-causality is running from SPF_{CSP} to SPF_{CRP}. With respect to Pw/Pr_{CSP} and SPF_{CRP}, as they have different stationarity properties, it will make little sense to test Granger-causality between them.

### 3.7 Conclusions and Policy Implications

In this section, I test the relationships between the market prices of softwood lumber, wood composites, and pulp, and the stumpage prices of softwood timber that is used to manufacture these three products using monthly data from June 1995 to February 2005. Johansen’s multivariate co-integration approach is used to test the long-run equilibrium relationship. Furthermore, Granger-causal relationships between the relevant prices are investigated. The test results have shown different relationships for different end products (summarized in Table 3.9), and these results have many implications for Ontario stumpage system and the softwood lumber trade dispute between Canada and the U.S.
Table 3.9 Summary of the relationships between the market price of different products and the stumpage price of the concerned standing timber.

<table>
<thead>
<tr>
<th>Pair of price series</th>
<th>Stationarity</th>
<th>Co-integration</th>
<th>Granger-causality</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF_{LSP}, SPF_{LRP}</td>
<td>Both I(1)</td>
<td>Co-integrated</td>
<td>SPF_{LRP} Granger causes SPF_{LSP}</td>
</tr>
<tr>
<td>SPF_{CSP}, SPF_{CRP}</td>
<td>Both I(1)</td>
<td>Co-integrated</td>
<td>SPF_{CSP} Granger causes SPF_{CRP}</td>
</tr>
<tr>
<td>SPF_{PSP}, SPF_{PRP}</td>
<td>Both I(0)</td>
<td>N/A</td>
<td>SPF_{PRP} Granger causes SPF_{PSP}</td>
</tr>
<tr>
<td>Pw/Pr_{L1SP}, Pw/Pr_{LRP}</td>
<td>Both I(1)</td>
<td>Not co-integrated</td>
<td>No Granger-causality relationship</td>
</tr>
<tr>
<td>Pw/Pr_{L2SP}, Pw/Pr_{LRP}</td>
<td>Both I(1)</td>
<td>Not co-integrated</td>
<td>No Granger-causality relationship</td>
</tr>
<tr>
<td>Pw/Pr_{CSP}, SPF_{CRP}</td>
<td>I(0), I(1)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pw/Pr_{PSP}, SPF_{PRP}</td>
<td>Both I(0)</td>
<td>N/A</td>
<td>Pw/Pr_{PSP} Granger causes SPF_{PRP}</td>
</tr>
</tbody>
</table>

First, the stumpage price of SPF timber for lumber is found to be co-integrated with its reference price, which is a one-month lagged market price of SPF in the U.S. and Canadian markets. Moreover, Granger-causality test results show that the reference price Granger causes the stumpage price, but the inversion direction of Granger causality does not exist. These results provide evidence that the stumpage price paid by the lumber industry, for SPF, reflects the market value of SPF timber, and that any increase in the market price of SPF lumber in the U.S. and Canadian markets will be transferred to the stumpage price paid by Ontario lumber industry. Hence, if the U.S. softwood lumber prices increase due to import or export tariff regime, the stumpage price of SPF timber for lumber will increase accordingly in Ontario. This means that Ontario’s softwood lumber producers will have to pay tariffs as well as higher stumpage prices, and tariff regimes will work as a double edged sword to Ontario’s softwood lumber producers.

Second, the co-integration between the stumpage price of SPF timber for lumber and its reference prices also indicates that the government-controlled but market-based stumpage system of Ontario is performing well with respect to softwood lumber (for SPF timber), and may continue to perform well as long as there are no government induced market
imperfections in the softwood lumber market such as import or export tariffs and quota regime on softwood lumber exports.

Third, these results provide direct empirical evidence in support of the recent decision, on August 10, 2005, of the Extraordinary Challenge Panel under the North American Free Trade Agreement (NAFTA). The NAFTA panel rejected the U.S. claim that an earlier NAFTA decision, in support of Canada’s claims, was in violation of trade rules. The panel’s unanimous binding decision removes any basis for U.S. tariffs on Canada’s softwood lumber. The results of this study go one step further and demonstrate that if the U.S. continues with import tariffs, Ontario’s lumber industry will continue to face a double edged sword – one from import tariffs and the other from increased stumpage.

Fourth, the market price of composites is also co-integrated with the stumpage price of SPF timber for composites. Thus, the stumpage price of SPF timber for composites captures the market values of the end products to some degree. However, the results of composites are different from lumber in that the Granger-causality is running from the stumpage price to the market price. These two different results suggest that in the case of composites, standing timber price, as a factor price, has an impact on end product price; meanwhile, in the case of softwood lumber, the stumpage system is able to recognize the market value of the softwood lumber and captures the additional rent from timber when lumber markets are favorable.

Fifth, the Granger-causal relationship between the stumpage price of SPF timber for pulp and its market price implies that the market price Granger causes the stumpage price. Hence, in the case of pulp also, the stumpage system is able to capture the additional rent from timber when pulp markets are favorable.

Sixth, there is lack of co-integration between the stumpage prices and the market prices of lumber for white pine and red pine timber and Granger-causality does not exist between these prices, which suggest that the stumpage price does not respond with significant degree to the changes in the market price of white pine and red pine lumber. This result is disappointing, but not entirely surprising. During the transition period of this current system, OMNR
surveyed the white pine and red pine sawmills for cost data to determine the RV component. However, these mills did not provide the required data, mainly because of a lack of trust of OMNR and a desire to keep such sensitive information confidential. In addition, a number of these mills, particularly the smaller ones, could not provide cost information in the different cost categories requested in the survey. As a result, there was not sufficient data to calculate a RV and a value was estimated and assigned. This could be the reason that this system has performed poorly in this sector. To improve the performance of the current system in this sector, OMNR should impose a legislative obligation to licence holders to report annual cost data. Such obligation should not impose any financial burden to the companies as the financial statements of any company should provide sufficient cost information for the purpose of determining the RV.

Seventh, the Granger-causality test between the stumpage price of white pine and red pine timber for pulp and the market price of pulp shows that the market price does not Granger cause the stumpage price. This implies that the stumpage price will fail to capture the additional rent from timber when the market price increases, but pulp producers could also pay too much for stumpage when the market price decreases.

Eighth, I cannot make any sound inference about the relationship between the stumpage price of white pine and red pine timber for composites and the market price of composites on the basis of the different stationarity properties of the two series.

In summary, it seems that the Ontario stumpage system is working well with respect to the stumpage prices of SPF for softwood lumber and pulp while there is a need of changes and modifications in terms of revising different parameters of the system with respect to stumpage prices of SPF timber for composites, and stumpage prices of white pine and red pine timber for lumber and pulp. Furthermore, I cannot say anything conclusively about the stumpage system of white pine and red pine timber for composites.
CHAPTER IV

RENT CAPTURE ANALYSIS OF ONTARIO’S STUMPAGE SYSTEM USING AN ENHANCED PARITY BOUNDS MODEL

4.1 Introduction

In Canada, most forestlands are owned by the Crown and harvesting rights are allocated by provincial governments to private forestry firms, through different forms of forest tenures, which pay stumpage price. Generally, perfectly competitive timber markets are absent in most territories of Canada due to the Crown ownership of forestlands and the structure of the forest product industry. In the absence of competitive timber markets, stumpage prices have been historically established through administrative procedures. However, prices of various final products determined in competitive markets are used through the residual value (RV) approach to calculate the stumpage price. In contrast, forestlands in the United States are primarily (about 75%) owned by the private sector, with the remainder belonging to federal, state and local governments (Sedjo 2006). Timber harvested from private and public forestlands in the U.S. is generally transacted through auction process. The difference in the ownership of forestlands and the resulting stumpage pricing systems of Canada and the U.S. have given rise to the U.S. charge that the Canadian stumpage price is below that which would be obtained in a competitive market, and thus the administered system provides a subsidy to forest product companies. This has been the central issue behind the two-decade softwood lumber trade dispute between the two countries.

During the course of negotiation between the two countries to solve the softwood lumber trade dispute, the U.S. government emphasized the need for the Canadian provinces to change their administrative stumpage pricing systems to market-based systems (USDOC 2003). On September 12, 2006, the two governments signed the Softwood Lumber Agreement (2006 SLA) to temporarily solve the long-standing and bitter trade dispute. However, this central issue remains unresolved. The Canadian softwood lumber exports to the U.S. markets are still
subject to export tax and quota restrictions enforced by the new agreement\textsuperscript{16}. To provide theoretically sound, based on economic theory, inputs to find a long-term solution to this trade dispute and possible future similar trade disputes, it is necessary to develop an understanding of the relationship between an administratively determined timber price and a price that represents a competitive market value of timber. In addition, generally, one of the goals of the stumpage pricing system is to ensure that the landowners capture as much available economic rent as possible (Whiteman 2005). Hence, an understanding of the ability of the administrative stumpage pricing systems to capture the potential economic rents of timber is critical from the perspective of provincial governments\textsuperscript{17}.

The 2006 agreement, however, has a provision that if and when a Region uses a market-determined timber pricing system, its exports of softwood lumber products to the U.S. qualify for exemption from the export measures. In response to the proposal of the US Department of Commerce (USDOC) and to create competitive timber markets and increase the return to the Province (BCTS 2002), the BC Ministry of Forests (MOF) has been using a “market pricing system (MPS)” since 1999 to establish reservation prices on a small portion of annual harvest (MOF 1999). Hence, the question faced by the other provinces is whether they should follow BC MOF and adopt the MPS to respond to the complaint from the U.S. and to improve the ability of the stumpage prices to reflect the true market values?

\textsuperscript{16} According to the 2006 SLA, the U.S. will refund about 80% of approximate SUS$5.4 billion in duties it collected on lumber imports since May 2002 and stop collecting the countervailing duty and anti-dumping duty on Canadian softwood lumber imports. But the 2006 SLA includes an export measure which specifies two options for the exporting provinces: Option A and Option B. If a region chooses Option A, the exporters of softwood lumber from this region will pay an export tax between 5 - 15% if the price drops below SUS$355 per thousand board feet (mbf) depending on the price level; under option B, exporters would have to pay an export tax between 2.5 - 5% plus a volume restraint if the price drops below SUS$355/mbf.

\textsuperscript{17} Rent capturing affects not only the distribution of economic rents from the use of forest resources, but also financial feasibility and sustainability of forest management. It is often argued that insufficient stumpage rates have contributed to degradation of tropical forests conditions through non-sustainable logging practices such as high grading (FAO 1993; Grut, Gray, and Egli 1991; Hyde, Amacher, and Magrath 1996; Barbier and Burgess 1995; Repetto and Gillis 1988; Bushbacher 1990). Even though high grading may not be a problem in Canada as logging practices are regulated by the law to ensure sustainability, it is still crucial for the provincial governments to set appropriate stumpage prices to cover the administrative costs for forest management, to provide sufficient funds for forest regeneration, improvement and protection, and to respond to the concerns from the public and the complaints from the United States.
This study is focused on Ontario – one of the four main provinces of Canada involved in the softwood lumber trade dispute – and addresses the four issues mentioned above. First, I examine the discrepancy between the administratively determined stumpage price and the market value of stumpage, measured by residual timber value (RTV). Second, I examine the economic rent captured by the administrative stumpage system. Third, based on the results of the economic rent captured by the system, I investigate the subsidy issue on timber prices in Canada. Fourth, I compare the market performances of the administrative pricing system in Ontario and the market-based systems in BC and discuss the difference between the RV approach based stumpage prices and the market prices of timber in the U.S. to provide insight into the issue whether Ontario should change its current stumpage system.

The Parity Bounds Model (PBM), developed by Baulch (1997), is used to address these issues. To serve the purpose of this study better, I enhance the standard PBM in two ways: first, I introduce a new term in the model that represents the average discrepancy between the administrative stumpage fee (converted from stumpage price per m³) and the market value during the period in study; second, I relax the assumption of the truncated normal distribution of the two error terms in the standard model and assume them to be normally distributed as it is more economically and statistically reasonable in this specification. I name it an Enhanced Parity Bounds Model (EPBM).

The EPBM is employed to estimate the discrepancy between the administratively determined stumpage fee (and thus price) and the market value of stumpage in Ontario using monthly data on the market prices of spruce-pine-fir (SPF) lumber, the stumpage prices determined under Ontario’s current stumpage pricing system, and the costs associated with the manufacturing of SPF lumber covering the period from June 1995 to January 2007.

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18 The term stumpage fee used in this paper refers to the charge by the Ontario Ministry of Natural Resources (OMNR) for the amount of timber used to produce one thousand board feet (mbf) of lumber. The term stumpage price is the charge by the OMNR for one cubic meter of timber. The stumpage fee = stumpage price ($Cdn/m³) × timber utilization factor (m³/mbf). In the PBM in this paper, the stumpage fee, not the stumpage price, is used. This conversion is to ensure unit consistency with the mill net price of lumber, the total processing cost, and the RTV calculated based on equation [4.1], which are all in $Cdn/mbf.
I proceed in the next section by reviewing the previous studies which attempted to investigate the existence of a subsidy in Canada, followed by a brief overview of the economic rationale and structure of Ontario’s stumpage system. I then illustrate the EPBM and describe the data. Next, I discuss the empirical estimation of the EPBM, report and discuss the estimation results, and compare the market performance of RV-based pricing systems with that of the auction-based systems in BC and the U.S. Last, I present the policy implications of the findings.

4.2 Literature Review
A large body of economic literature has been accumulated during the past two decades regarding the softwood lumber trade dispute. While many aspects of the trade dispute have been addressed, the focus has been on the analysis of the market and welfare impacts of various trade restrictions. Yin and Baek (2004) have provided an extensive review of the literature up to 2004, and the recent studies include Stennes and Wilson (2005), Baek and Yin (2006), Li and Zhang (2006), Mogus, Stennes, and van Kooten (2006), and Zhang (2006). However, only a few studies have attempted to use economic logic to examine the competitive level of the stumpage prices in Canada.

In the absence of data on competitive prices in Canada, Uhler (1991) examined the relationship between the annual allowable and actual timber harvests, and concluded that over the period 1969 - 1984, the administrative prices of timber on the BC Coast might well have been above competitive levels and in the BC Interior, the administrative prices of timber were near or below competitive levels. Grafton, Lynch, and Nelson (1998) measured the total economic rents collected between 1970 and 1994, and found that about 70% of available rents were collected with stumpage fees. However, economists estimated that the rest of the economic rents had gone to labour, which had used the power of unions to earn higher wages than their opportunity costs would indicate (e.g., Copithorne 1979; Percy 1986; Grafton, Lynch, and Nelson 1998). On the basis of this kind of evidence, van Kooten (2002) concluded that tenure holders in British Columbia have not benefited from uncollected resources rents. Therefore, most of the findings of these studies have been in favor of the Canadian argument on the absence of a subsidy on timber prices in Canada. There are two notable features in
these studies: first, these authors as the resource economists used theoretically appropriate economic methods to address this issue; second, the authors have drawn their conclusions based on relatively long-term (at least 10 years) analysis of the ability of the stumpage systems to capture the economic rents available.

In contrast to the economic methods and long-term approach employed by resource economists, cross-border comparison of prices (either stumpage prices or log prices) by annual administrative reviews was used by the USDOC and the U.S. Coalition for Fair Lumber Imports (hereafter referred to as “the Coalition”) to measure the existence of a subsidy. For example, in the countervailing duty (CVD) investigation of Canadian softwood lumber in 2003, the USDOC measured the existence of a benefit from the Crown stumpage pricing systems by comparing the provincial government stumpage prices in Canada with market prices charged in the United States\(^\text{19}\). Similarly, the Coalition has attempted to quantify the amount of subsidy from each province of Canada using the market prices of timber established in the states close to the Canadian provinces (British Columbia vs. Washington, Alberta vs. Montana, Ontario, Saskatchewan, Manitoba vs. Minnesota, and Quebec vs. Maine). Their most recent subsidy finding was based on the report entitled “Assessing the Market Value of Public Softwood Sawtimber in Canada (Updated)” prepared by their consultants D.R. Cox, C. Ehlen and J. Lutz. This report makes cross-border stumpage price comparisons by simply averaging stumpage prices in one area and comparing them to stumpage prices in another and uses it as an appropriate economic method for determining the adequacy of the stumpage price for timber harvested from public forestlands in Canada (Natural Resources Canada 2004).

Direct cross-border comparison of timber prices does not provide theoretically sound evidence on the existence of a subsidy on timber prices in Canada. The obvious reasons, as reviewed by

\(^{19}\text{Canada challenged and a NAFTA panel disagreed with the use of cross-border benchmarks because timber is not a traded good across border. In response to the NAFTA panel's original remand, the USDOC used domestic Canadian log prices including internal log prices and import log prices as benchmarks and determined a subsidy rate of 13.23%. The use of these Canadian log prices as benchmarks was accepted by the NAFTA panel, but the Panel remanded the determination to the USDOC four more times for considering certain benchmark and calculation issues. As an outcome of the Panel's decisions, the subsidy rate was revised downward by the USDOC with each successive remand determination from 7.82% to 1.88% to 1.21% until the de minimis result in the Fifth Remand Determination on November 22, 2005 (USDOC 2006).}
Natural Resources Canada (2004), are: they ignore the wide differences in timber characteristics, locational characteristics, operating costs, sales conditions, and size of the forestland being auctioned that vary significantly between and even within jurisdictions throughout the U.S. and Canada which affect the local stumpage prices (Haynes 1998); there is substantial economic literature on the variables influencing stumpage prices and some most recent examples include Brannman (1996), Munn and Palmquist (1997), Baldwin, Marshall, and Richard (1997), Stone and Rideout (1997), Carter and Newman (1998), and Athey and Levin (2001). In addition, these cross-border comparisons do not take into account the fact that the stumpage markets considered are not integrated. Nagubadi, Munn, and Tahai (2001), Prestemon and Holmes (2000), Washburn and Binkley (1993) and Yin, Newman, and Siry (2002) studied stumpage markets in the U.S. and found that market integration for timber did not hold for the regions in consideration, and therefore price in one market cannot be used as a benchmark price for another region.

In summary, generally the findings of the resource economists were favoring the Canadian position on the subsidy argument; the results by the USDOC and the Coalition were in support of the U.S. stand. The major reasons for diverse conclusions are probably the differences in the methodologies used and the time-span in the investigation. Therefore, it is important to use an approach that is economically and statistically appropriate to determine the existence of a subsidy and the amount of a subsidy if it is found. Moreover, the evidence of a subsidy should be investigated based on long-term data, because in the short run the stumpage prices may diverge from their market values due to economic or policy changes or influenced by business cycles of the final products, but in the long run, it may be close to the true market values on average.

4.3 The Economic Rationale and Structure of Ontario’s Stumpage System
What is the market value of stumpage? In principle, stumpage or any good is worth whatever someone is willing to pay for it. We witness this obvious truth when there is an effectively functioning market for stumpage. However, this principle should be valid even in the absence of competitive stumpage markets. It suggests that if one take the competitive market value of the products produced from timber, such as lumber and pulp, subtract the competitive market
costs associated with the production of the product, and allow the producer to make an acceptable profit, the residual value is the maximum amount that the producer of the product would be willing to pay for the stumpage. The value of timber calculated this way, as if there were a market for it, is a residual timber value (RTV). This residual value (RV) calculation is based on the principle of derived demand and makes use of the fact that the demand for stumpage is derived from the demand for final products such as lumber and pulp which are sold in relatively competitive markets. Therefore, the RTV is sensitive to market conditions of the final products: when the cost of production other than timber remains the same, the timber value increases or decreases with the market prices of the final products. The RTV thus represents the hypothetical open-market value of stumpage. The key assumptions underline this approach include: 1) the final products are traded in effectively competitive markets; 2) the values of the other factors of production such as labour, energy, other material, and capital are determined by the market, so the entire residual timber value is attributable to the timber owner (OMNR 1993).

In Northern Ontario and throughout much of Canada, conditions for competitive standing timber markets do not exist. The main reason is that there is essentially only one seller of stumpage (the Crown) and the buyers of stumpage, which are large mills producing softwood lumber, pulp and paper, or composite boards, are scattered over a vast landscape. As the distances between the mills are so large, only one or maybe two mills would be the realistic purchasers of many stands of timber. The lack of competition on both sides of the stumpage market violates one of the key conditions – a large number of sellers and buyers who actively and effectively competes with each other during the sales and purchases - needed for a competitive timber market. As a result, the use of an administrative price-setting mechanism for timber in Ontario seems unavoidable. A stumpage system developed based on the RV approach, which economists considered the second-best solution in the absence of competitive markets, was identified as the suitable timber valuation system (Nautiyal, Kant, and Williams 1995). The RTV approach has been a standard methodology used for estimating the value of stumpage in the provinces of Canada and in many countries around the world (Whiteman 2005). The standard identity for RTV, also known as the conversion return, is (Nautiyal, Kant, and Williams 1995):
\[ RTV = \text{finished product price} - \text{processing costs} \]  

[4.1]

The finished product price is the mill net price that the producer receives at the gate of the mill. The processing costs contain an allowance for producer’s profit and risk and the cost of harvesting and transporting timber to the mill and processing it. Letting \( MN \) represent the mill price of the end product, the processing cost in equation [4.1] can be decomposed as given in equation [4.2]:

\[ RTV = MN - (1 + PR) \times (HC + TRC + MC) \]  

[4.2]

where \( PR \) is the profit and risk allowance (the return to the entrepreneur), \( HC \) is the harvesting cost for the amount of timber used to produce one unit of the product, \( TRC \) is the transportation cost of timber from the forest to the mill, and \( MC \) is the manufacturing cost at the processing mill. The values of \( HC \), \( TRC \) and \( MC \) depend entirely on the characteristics of the forest stand and the processing mill.

The Ontario Ministry of Natural Resources (OMNR) introduced the RV approach-based stumpage system and named it the market-based stumpage system in October 1994. However, to accomplish a selective set of objectives through the stumpage price of timber, several deviations were added to the standard calculation of the RTV. Under this system, the total stumpage prices per cubic meter charged to the forest companies have three components: the minimum rate, the renewal charge, and the residual value. The intent of the minimum rate is to provide some desired level of stability to government revenues from the stumpage and it is determined annually. The renewal charge is used as a correction factor for externalities associated with timber harvesting and it is set annually for each management unit to ensure sufficient funds for forest regeneration and protection. The renewal charge is fixed by species irrespective of the end product, such as lumber or pulp. The residual value component is the main component of the stumpage system and it is intended to capture the additional value of timber when the market is favorable. It is calculated monthly for each species-product combination using market prices of the final products collected in the previous month and the total costs associated with the production of the product collected through surveys. In the case of SPF timber used for producing lumber, the RV is calculated using the formula: \( RV \) \( ($Cdn/m^3) = \frac{[MN - BCA] \times 29\%}{CF}, \) when the \( MN \) is above the \( BCA \) and below a certain level named the point of inflection, where \( MN \) is the FOB mill net price per thousand board.
feet (mbf) of lumber that a mill receives at the gate and \( MN = RP - FR - PM \), where \( RP \) is the reference price, which is the lagged market price of lumber; \( FR \) is the freight rate of transporting Ontario lumber from mills to the major markets; \( PM \) is the product modifier\(^{20}\). 

\( BCA \) is the base cost allowance, also called the threshold price, which is the total costs associated with the production of one mbf of lumber and the components of the \( BCA \) include: (1) delivered wood cost, net of stumpage charges and residual revenues, and net of the revenue from the chips; (2) direct manufacturing costs; (3) indirect costs; (4) an allowance for profit and risk. Return on Capital Employed (ROCE) has been used as the allowance for profit and risk for the purposes of the system because it is considered to be the most appropriate measure of industry’s financial performance. ROCE has been set at the level of 20\% for determining the threshold price; and (5) the minimum charge and weighted average renewal charge of timber. \( CF \) is the utilization factor, which is the amount of timber used to produce one mbf of lumber. During the period from June 1995 to March 1999, \( CF \) was 5.1\( m^3/mbf \) and during the following period, it was 5.09\( m^3/mbf \). When the mill price is below the \( BCA \), the \( RV \) is set zero. So the producers only pay the minimum rate and the renewal charge for stumpage. When the mill price reaches a higher level, namely the point of inflection, \( RV = \frac{[\text{point of inflection} - \text{BCA}] \times 29\% + (\text{MN} - \text{point of inflection}) \times 10\%}{\text{CF}} \). 

While the stumpage system generally embodies economic principles, the inclusion of a minimum charge and the renewal charge departs from pure theory. Moreover, the Crown receives only 29\% of the incremental value when the mill net exceeds the threshold price may seem unjustifiable. These divergences from economic principles may be seen as the requirements of government financial system, which prefers a stable and predictable stream of revenue. Moreover, government could not put itself in a position where it would have to pay licensee for the timber they harvest when the RTV (the market value) fell below zero.

\(^{20}\) The stumpage system recognizes that not all conifer lumber produced achieves the price level attached to Std. & Btr. Grade. To account for this, the product modifier was used to further reduce the delivered prices to reflect the actual mix of products sold. The product modifier was calculated based on the reference price and the mill net price data collected through previously conducted surveys. It is computed in such a way so that the mill net prices calculated are consistent with the mill net prices yielded by surveys. It is currently set at 11\% of the reference price.

\(^{21}\) The MN price reaches the point of inflection when \([\text{MN} - \text{BCA}] \times 29\% ÷ \text{CF} = \$\text{Cdn}20/m^3\). The point of inflection was introduced to prevent excessive stumpage rates. However, since the MN price has never reached the point of inflection, this formula has never been used so far.
However, the impacts of these divergences from pure theory may offset each other to some extent and so the fact that the system departs from theory does not necessarily mean that the outcome is unfair.

As discussed earlier, the RTV calculated based on equation [4.1] represents the market value of standing timber and thus the potential economic rent for the amount of timber used to produce one unit of the final product. Therefore, the difference between the stumpage fee (converted from the stumpage price determined by the OMNR based on the revised version of RV approach) and the RTV calculated according to equation [4.1] will reveal the ability of the current stumpage system to collect the full economic rents. The next section discusses an econometric model that is used to estimate this discrepancy between the two values.

4.4 The Theoretical Model
4.4.1 Specification of the Theoretical Model
The PBM was introduced by Baulch (1997), building on the switching regression models of Spiller and Wood (1988) and Sexton, Kling, and Carman (1991). The PBM overcomes several problems of the conventional methods for testing market integration, and it has been further applied and extended by several researchers (e.g., Barrett, Li, and Bailey 2000; Barrett and Li 2002; Park, Jin, Rozelle, and Huang 2002; Penzhorn and Arndt 2002). The main advantage of the PBM over the conventional methods is that it uses not only the time series data on the market prices but also the data on the transaction costs between the markets and measures the probability of the markets examined being in different spatial market efficiency regimes. In contrast to the conventional approaches, which generally study the long-run market equilibrium relationship between the market prices, the PBM provides additional information on the short-run market efficiency of the prices. In addition, the PBM takes explicit account of the possibility of discontinuous trade between markets and the statistical problems posed by nonstationary and co-integrated time series (Baulch 1997). The statistical reliability of the PBM results for prices series non-stationary in levels but stationary in first differences [i.e., I(1)] has been demonstrated by Baulch (1997) using Monte Carlo experiments.
In a study of the market performance of Ontario’s market-based stumpage system, Yang, Kant, and Shahi (2006) found a long-run equilibrium relationship revealed by the co-integration between the market price of SPF lumber and the stumpage price of SPF timber used to produce lumber during the period from June 1995 to February 2005, and the stumpage price of SPF timber responded to the changes in the market price of SPF lumber. However, co-integration does not provide any information on the adequacy of the stumpage prices. Due to the constant fluctuation in the market price of lumber caused by multiple factors including the changing housing markets, harvest restriction in the U.S., the softwood lumber trade dispute, and frequent modifications of the stumpage system of Ontario, it is expected that prices can depart from the long-run equilibrium relationship occasionally and the stumpage prices administratively-determined may diverge from the true market values of stumpage. The PBM provides a highly useful method, specifically for I(1) price series, for determining the short-run divergence of the administrative prices from the market values.

In the previous studies, economists have used the PBM to examine spatial integration between two markets of the same products or spatial arbitrage. In this study, I use the PBM to estimate the extra profit or loss from the use of timber by the lumber industry resulted from the under or overcharged stumpage price. Hence, the two price series in this study are mill net price ($Cdn/mbf, derived from the market price) of lumber and the stumpage fee of timber ($Cdn/mbf) and transaction cost is the total processing cost (TPC) of softwood lumber ($Cdn/mbf). Ideally, price margin between the mill net price and the stumpage fee should be equal to the TPC; if this is the case, then the stumpage fee would equal the RTV and thus the true market value (as represented by the rearrangement of equation [4.1]). However, in reality, the price margins could be above or below the TPC, creating extra profit or loss for the lumber producers.

As accurate data on the TPC in each period (month) are not available, 95% confidence interval of the mean TPC, which were collected and updated based on some cost indices by the OMNR, is estimated to account for the variation in the TPC among the months. The upper and lower bounds of the TPC are determined in the PBM. When the price margins fall between the upper and lower bounds of the TPC, they are at the parity bounds, which implies
that the stumpage fees (and so the stumpage prices) are equal to the market values of timber; when the price margins fall below the lower bounds of the TPC, they are inside the parity bounds, which suggests that the stumpage fees (and prices) are above the market values; and when the price margins fall above the upper bounds of the parity bounds model, they are outside the parity bounds, which implies that the stumpage fee (and prices) are below the market values. Hence, the PBM examine the adequacy of the stumpage prices by distinguishing among three possible regimes: (1) at the parity bounds (Regime 1); (2) inside the parity bounds (Regime 2); and (3) outside the parity bounds (Regime 3).

However, the standard PBM introduced by Baulch (1997) does not allow me to estimate the average discrepancy between the actual stumpage fee and the market value. Therefore, I introduce a new term in the specification of Regime 2 and 3 each to measure the average difference between the price margin and the total costs and it also represents the average difference between the actual stumpage fee and the market value. In addition, the assumption of half-normal distribution of the errors in Regimes 2 and 3 is questionable (Baulch 1997). Fackler (1996) argued that the appropriateness of the interpretation of regime probabilities depends on the validity of distributional assumptions and the truncated normal distribution of the error terms has no linkage with any economic theory. Hence, I relax the assumption of the truncated normal distributions of the error terms in Regimes 2 and 3. Instead, I assume them to be normally distributed as it makes better statistical sense in the application of the PBM for the purpose of this study. The new specification is named the Enhanced PBM (EPBM).

Mathematically, the three regimes of the EPBM are as follows:

Regime 1: \( MN_{t-1} - SF_t = TPC_t + e \), \[4.3\]

where \( MN_{t-1} \) is the mill net price ($Cdn/mbf) for a given month t-1 used by the OMNR to determine the RV component for the month t, \( SF_t \) is the stumpage fee for the amount of timber used to produce one mbf of lumber in month \( t \), \( TPC_t \) is the total processing cost of lumber ($Cdn/mbf) in month \( t \) as in equation [4.1] and is the BCA net of the minimum charge and renewal charge for stumpage, \( e \) is the error term allowing the total cost to vary among the months during the period in consideration and it is assumed to be independently and
identically distributed with zero mean and variance $\sigma^2_e$. It is assumed that Regime 1 occurred with probability $\lambda_1$ during the period.

Regime 2: $MN_{t-1} - SF_t = TPC_t - U + e + \varepsilon_u$  \[4.4\]
where $e$ is the same with Regime 1; $U$ is the average amount of the difference between the price margin and the TPC ($MN_{t-1} - SF_t - TPC_t$) when the price margin is below the TPC, it is therefore a positive number; $\varepsilon_u$ is the error term associated with $U$ allowing $U$ to vary among the months and is assumed to be independently and identically distributed with zero mean and variance $\sigma^2_{\varepsilon_u}$. It is also assumed to be independent from $e$. The probability of Regime 2 occurrence is assumed to be $\lambda_2$.

Regime 3: $MN_{t-1} - SF_t = TPC_t + V + e + \varepsilon_v$  \[4.5\]
where $e$ is the same with Regime 1; $V$ is the average difference between the price margin and the TPC ($MN_{t-1} - SF_t - TPC_t$) when the price margin is above the TPC and it is also a positive number; $\varepsilon_v$ is the error term associated with $V$ allowing $V$ to fluctuate among the months during the period and is assumed to be independently and identically distributed with zero mean and variance $\sigma^2_{\varepsilon_v}$. It is also assumed to be independent from $e$. The probability of Regime 3 occurrence is assumed to be $\lambda_3$.

As the three regimes cover all the possible relationships between the price margin and the TPC, the summation of the three probabilities is equal to one ($\lambda_1 + \lambda_2 + \lambda_3 = 1$).

Based on the assumptions of the error terms in the three regimes, the likelihood function for the EPBM is formulated as follows:

$$L = \prod_{t=1}^{n} \left( \lambda_1 f^1_t + \lambda_2 f^2_t + \lambda_3 f^3_t \right)$$  \[4.6\]

where $f^1_t$, $f^2_t$ and $f^3_t$ are the density functions as given in [4.7], [4.8], and [4.9]

$$f^1_t = \frac{1}{\sigma_e} \phi \left( \frac{y_t - TPC_t}{\sigma_e} \right)$$  \[4.7\]

$$f^2_t = \frac{1}{\sqrt{\sigma_e^2 + \sigma_{\varepsilon_u}^2}} \phi \left( \frac{y_t - TPC_t + U}{\sqrt{\sigma_e^2 + \sigma_{\varepsilon_u}^2}} \right)$$  \[4.8\]
\[ f_i = \frac{1}{\sqrt{(\sigma_x^2 + \sigma_y^2)}} \phi \left( \frac{y_i - TPC - V}{\sqrt{(\sigma_x^2 + \sigma_y^2)}} \right) \]  

where \( n \) is the number of observations, \( y_i \) is the price margin between the mill net price in month \( t-1 \) and the stumpage fee in month \( t \) (\( y_i = MN_{t-1} - SF_t \)).

### 4.4.2 The Data

SPF is the most significant softwood species group in Ontario and constitutes about 94\% of the softwood timber consumption for lumber during the period since 1995 to 2007\(^{22}\). The data used for this study comprise the reference prices of lumber ($Cdn/m^3$), the BCA associated with the production of lumber ($Cdn/m^3$), and the stumpage prices ($Cdn/m^3$) of SPF timber used to produce lumber. These data are obtained from the OMNR and cover the period from June 1995 to January 2007. Since the introduction of the new stumpage system, the OMNR has been using the lagged monthly market price of the final product as the reference price to calculate the RV component of the total stumpage price by each industry. In the case of lumber, the reference prices are the market prices taken from various markets in the U.S. and Canada. To better capture the market value of lumber produced in Ontario, the source of the reference prices has changed over the period: for the period from June 1995 to March 1997, the reference prices were the market prices of one SPF softwood product SPF 2×4 standard and better (Std&Btr) in Chicago; for the period from April 1997 to March 1999, the reference prices were the market prices of SPF 2×4 Std&Btr in the Great Lakes; and since April 1999, the reference prices have been the SPF lumber composites prices, which are the weighted average of the delivered prices in Toronto and Great Lakes of SPF lumbers of different grades (#2&Btr, Economy) and dimensions (2×4, 2×6, 2×8). Currently, the Great Lakes and Toronto markets together account for about 80.5\% of the volume sold in all the markets. The BCA associated with the production of one mbf of lumber including the allowance for profit and risk was computed by the OMNR based on information obtained through surveys conducted by PriceWaterhouseCoopers in 1993 and by KPMG LLP in 1999 and through discussions.

\(^{22}\) White pine and red pine timber accounts for 4.8\% of the total softwood timber used to produce lumber, with the remaining about 0.1\% of softwood timber consumption comes from the Hemlock/Cedar species group.
with the industry. The BCA reflects all of the pre-tax costs associated with the manufacturing of the products. During the subsequent years after the surveys, the total costs were updated annually using the GDP implicit price index prepared by Statistics Canada to reflect inflation.

To estimate the EPBM, I first calculate the MN ($Cdn/mbf) from the reference prices of lumber using the formula $MN = RP – FR – PM$, then compute the TPC($Cdn/mbf) from the BCA ($TPC = BCA – (the \ minimum \ rate \ + \ the \ renewal \ charge) \times CF$), and convert the stumpage price ($Cdn/m^3$) to stumpage fee ($Cdn/mbf$) for the amount of timber used to produce one mbf of lumber ($SF = stumpage \ price \ (Cdn/m^3) \times \ timber \ utilization \ factor \ (m^3/mbf)$).

Table 4.1 provides the statistical summary of the MN price ($Cdn/mbf), the TPC, the actual SF, and the RTV calculated as the difference between the mill net price and the TPC (equation [4.1]). Table 4.1 shows that on average the actual SF charged by the OMNR was less than the RTV, which implies that OMNR has not collected the full economic rents of timber during this period.

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23 The cost data for the SPF lumber industry used at the beginning of the new stumpage system were derived from a study conducted by the PriceWaterhouseCoopers during 1993 covering the period 1987-1992. The PriceWaterhouseCoopers compiled the overall results based on the data gathered from ten forest product companies operating 18 lumber mills, and data collected from Statistics Canada, the OMNR, the Ontario Forest Industry Association and the Ontario’s Lumber Manufacturers’ Association. The data were collected through comprehensive questionnaire and the PriceWaterhouseCoopers then independently reviewed the responses, which represented from 69% to 85% of the SPF lumber production of the province, for reasonableness and consistency, and compared them to audited financial statements. Therefore, the information is considered representative of the SPF lumber industry in Ontario for this period. In 1999, the OMNR contracted the KPMG LLP to undertake another survey to collect cost data from 23 softwood lumber mills in Ontario covering the period 1996 – 1998. The survey results were reviewed for reasonableness by the respondents’ external accountants who prepared appropriate reports. The KPMG also conducted additional reviews of the survey to ensure the completeness, reasonability and consistency of the survey responses.
Table 4.1 Summary statistics of MN, TPC, SF, and RTV.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>MN ($Cdn/mbf)</td>
<td>385.28</td>
<td>77.41</td>
<td>236.02</td>
<td>564.03</td>
</tr>
<tr>
<td>TPC ($Cdn/mbf)</td>
<td>321.48</td>
<td>16.02</td>
<td>302.46</td>
<td>349.98</td>
</tr>
<tr>
<td>SF ($Cdn/mbf)</td>
<td>55.85</td>
<td>18.73</td>
<td>36.98</td>
<td>111.38</td>
</tr>
<tr>
<td>RTV ($Cdn/mbf)</td>
<td>63.81</td>
<td>85.42</td>
<td>-113.96</td>
<td>256.32</td>
</tr>
</tbody>
</table>

Note: MN is the mill net price of SPF lumber; TPC is the total processing cost associated with the production of one mbf of lumber; SF is the stumpage fee for the amount of timber used to produce one mbf of lumber; and RTV (= MN – TPC) is the residual timber value calculated as the difference between the mill net price and the total processing cost.

Figure 4.1 compares the actual SF and the RTV in each month. One notable observation from Figure 4.1 is that the SF fluctuated with the RTV when it was less than the RTV; however, when it was more than the RTV, it remained flat. For instance, during the period between January 1996 and June 2000, the SF was lower than the RTV, which indicates that the OMNR did not capture sufficient amount of economic rents through stumpage prices, the SF increased or decreased with the RTV. However, from June 2000 to January 2007, when the RTV fluctuated dramatically due to the instability of the market prices and in most months the SF was more than the RTV, the SF remained flat. Particularly, during the periods between September 2000 to April 2001, between October 2002 and February 2004, and between August 2005 and January 2007, the RTV was below zero in all months except three months and the actual SF was above zero and much higher than the RTV in most months, which indicates that the OMNR charged more economic rents than it should have from the softwood lumber producers. During the whole period, it seems that only in a few months, the SF was equal to the RTV. However, as the TPC was only the estimate of the mean of the real cost and it should vary among different months, seasons and years, the analysis solely based on the mean cost data and the figure would not be able to draw reliable inference. The results from estimating the EPBM would provide further scientific evidence to support this observation.
Figure 4.1 The comparison of the RTV (\(\$\text{Cdn}/\text{mbf}\)) and the actual SF (stumpage fee) charged for the amount of SPF timber used to produce one mbf of lumber (\(\$\text{Cdn}/\text{mbf}\)).

4.4.3 The Estimation Algorithm

The previous studies applying the PBM to investigate market integration use the Davidson-Fletcher-Powell (DFP) algorithm to maximize the log likelihood functions and estimate the model parameters. However, it is well acknowledged that this algorithm along with other commonly used optimization algorithms does not guarantee the global maximum even after hundreds of runs with different initial values. Instead of a global maximum, it is likely that a local maximum is found as this algorithm can only moves uphill (in the case of maximization) or downhill (for minimization). Therefore, the estimates obtained from the conventional algorithms are suspect especially when the function in interest is complicated and multidimensional, which is the case in this problem.

To improve the reliability of the estimates, I used the simulated annealing (SA) algorithm to estimate the EPBM. SA, first suggested by Kirkpatrick (1983), possesses several advantages as compared to the conventional optimization techniques, and are discussed by Goffe, Ferrier,
and Rogers (1994) and Wu and Wang (1998): (1) it can differentiate between the global and local optima as it explores the function’s entire surface and tries to optimize the function by moving both uphill and downhill; (2) it does not heavily rely on the starting points as the conventional algorithms do; (3) it is especially advantageous in multidimensional problems as it is almost insensitive to dimensions; (4) it can more easily solve functions that have ridges and plateaus due to the relaxed assumptions about the function. Owing to its advantages, SA has been commonly used to solve econometric problems (Goffe, Ferrier, and Rogers 1992, 1994; Ingber 1996).

4.5 Estimation Results and Discussion

The EPBM is estimated using the statistical software GAUSSX8.0. The results\(^\text{24}\) of the maximum likelihood estimation of the EPBM are reported in Table 4.2. The t-statistics show that except the estimate for \(\lambda_1\), all the parameter estimates are statistically significant at the 1% level. The estimate of \(\lambda_2\) indicates that the price margins between the mill net prices per mbf and the stumpage fee fell into Regime 2 (inside the parity bounds) in about 39.0% (about 55 months\(^\text{25}\)) of the total observations and the estimate of \(\lambda_3\) implies that price margins fell into Regime 3 (outside the parity bounds) in about 56.5% (about 79 months) of the total observations. The estimate for \(\lambda_1\) shows that only 4.4% of the observations fell into Regime 1 (at the parity bounds). The standard error for the total processing cost is only $Cdn4.00/mbf, which indicates that the total processing cost did not vary significantly among the months, seasons and years during the period and the estimates of the mean total cost updated using the GDP implicit price index seem to be accurate. The large standard errors for the error terms in Regime 2 and Regime 3 show that when the price margins were different from the total processing costs, they varied significantly during the period. The results also show that when

\(^{24}\) I test the stationarity property of the mill net price and stumpage fee using the augmented Dickey-Fuller test and found that both are nonstationary in level and stationary in first-difference (i.e., I(1) processes). Hence, the stationarity properties of the price series are the same as of the food prices in Baulch (1997). As mentioned earlier in section 4.4.1, Baulch has already demonstrated the statistical reliability of the PBM results for I(1) price series, therefore the results of this study are also statistically reliable.

\(^{25}\) One disadvantage of the switching regression model with unknown switching point based on which the PBM is developed is that it does not allow individual observations to be identified with particular regimes (Quandt 1972) when the economic problem is complicated. However, because of the simplicity of the problem in this study, I could estimate which observations to be more likely fall into which regimes on the basis of the estimation results and the data.
the price margins fell into Regime 2, the average magnitude of the differences between the price margins and the total processing costs was $\text{Cdn}60/\text{mbf}$. This means that the stumpage price paid by the softwood lumber producers was on average about $\text{Cdn}11.76/\text{m}^3$ ($\text{Cdn}60/\text{mbf} \div 5.1\text{m}^3/\text{mbf}$) higher than the market value per $\text{m}^3$ during those months. This amount is even higher than the actual average stumpage price during those months. This is because that the average RTV per $\text{m}^3$ is negative. When the price margins fell into Regime 3, which indicates that the stumpage prices paid by the softwood lumber industry were below the market value, the average magnitude of the difference between the actual stumpage prices and the market value was $\text{Cdn}10.59/\text{m}^3$.

Table 4.2 Estimation results of the Enhanced PBM.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>SE</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda_1$ (Regime 1)</td>
<td>0.044</td>
<td>0.033</td>
<td>1.34</td>
</tr>
<tr>
<td>$\lambda_2$ (Regime 2)</td>
<td>0.390</td>
<td>0.089</td>
<td>4.36**</td>
</tr>
<tr>
<td>$\lambda_3$ (Regime 3)</td>
<td>0.565</td>
<td>0.098</td>
<td>5.75**</td>
</tr>
<tr>
<td>U</td>
<td>60.00</td>
<td>10.28</td>
<td>5.84**</td>
</tr>
<tr>
<td>V</td>
<td>54.00</td>
<td>10.59</td>
<td>5.10**</td>
</tr>
<tr>
<td>$\sigma_e$</td>
<td>4.00</td>
<td>1.64</td>
<td>2.43**</td>
</tr>
<tr>
<td>$\sigma_{eu}$</td>
<td>37.00</td>
<td>6.10</td>
<td>6.07**</td>
</tr>
<tr>
<td>$\sigma_{ev}$</td>
<td>45.00</td>
<td>6.52</td>
<td>6.90**</td>
</tr>
<tr>
<td>n</td>
<td>140</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-789.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: SE: Standard error; ** indicates significant at the 1% level.

Figure 4.2 illustrates the upper and lower parity bounds defined by the 95% confidence interval of the total processing costs and the three regimes of the EPBM divided by the upper and lower parity bounds. It shows that most of the observations that fell into Regime 3 occurred at the beginning of the period after this new stumpage system was introduced from April 1996 to May 2000. During this period, the softwood lumber trade was controlled by the 1996 Softwood Lumber Agreement (1996 SLA). Due to the higher marker prices of lumber mainly driven by the strong housing markets in the United States and the 1996 SLA (van
Kooten 2002; Zhang and Sun 2001; Zhang 2006), the stumpage price was not increased sufficiently by the OMNR to capture the additional value of the timber. As a result, a significant amount of quota rent was created by the 1996 SLA to Canadian lumber producers during the period covered by this Agreement and this result is similar to the results of van Kooten (2002)\textsuperscript{26}. While the Ontario government benefited from the trade restrictions by the increased stumpage prices resulted from the increase in the market price of lumber, it failed to collect the extra economic rent created\textsuperscript{27}.

\textsuperscript{26} van Kooten (2002) found that the 1996 SLA generated a large windfall rent not only to Canadian lumber producers but also to U.S. producers at the expense of US consumers. Zhang (2006) showed that U.S. lumber producers gained increased producer surplus of about $US2.6 billion (in 1997 dollars) and Canadian producers received producer surplus of about $US305 million. Li and Zhang (2006) decomposed the welfare effects of the 1996 SLA among southern softwood landowners, loggers and lumber producers and found that the 1996 SLA created approximately $US85 million for the southern softwood lumber producers, $US102 million for the southern softwood timber landowners and $US28.5 million for loggers per year.

\textsuperscript{27} In addition to the increased stumpage price that benefited the provincial government, corporate income taxes on incremental producer profit is another source of gains to the provincial and federal governments. However, due to lack of data on the corporate income tax collected from the SPF softwood lumber producers in Ontario, this benefit to the government is not included in the analysis.
Figure 4.2 The Three Regimes of the Enhanced Parity Bounds Model: Regime 1 indicates the stumpage prices were equal to the market values; Regime 2 indicates the stumpage prices were more than the market values; and Regime 3 indicates the stumpage prices were less than the market values.

However, the Ontario government did not overlook the additional profit earned by the industry. In April 1999, the government did a series of modifications to the system and increased the sensitivity of the stumpage system to the market price of lumber when the market conditions are favorable. Figure 4.3 plots the SF against the MN price used to determine the RV component of the stumpage price. It shows that at the MN price below $Cdn390/mbf, the SF remains almost the same; however, when the MN price is above $Cdn390/mbf, the SF starts to increase with the MN price. Nevertheless, due to the multiple factors that influenced the market prices of lumber, the market prices of lumber have remained at low level since June 2000 although a high level was reached occasionally, and the stumpage

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28 There are two notable higher values of stumpage prices on Figure 4.3. They exist because the OMNR took about 69% and 62% of the extra profit from the industry in April 1997 and May 1997, respectively. The share of the OMNR for the extra profit was not fixed to 29% until April 1999. The share was set zero initially when the stumpage system was introduced in October 1994 and was set mostly at around 31%. However, it was as low as 13% in April 1996 when the 1996 SLA went to effect and was as high as 69% in April 1997.
price could not decrease with sufficient amount to account for the loss of the industry when the market prices are lower than $Cdn390/mbf. It is due to the fixed minimum rate and the renewal charge components of the total stumpage price. Figure 4.2 also shows that most of the observations occurred during the period from Jun 2000 to January 2007 fell into Regime 2, which indicates that the industry paid stumpage prices higher than the market value in most months during this period. As a result, the industry might have overpaid for stumpage. Therefore, Figure 4.2 indicates that the industry underpaid to the government for stumpage during the period covering the 1996 SLA and overpaid during the post SLA. The difference between the underpayment when the market was favorable and overpayment when the market was depressed would indicate the overall underpayment or overpayment by the industry for stumpage during the period in study.

Figure 4.3 Stumpage fee charged for the amount of SPF timber used to produce one mbf of lumber vs. mill net price of SPF lumber per mbf.
The quantity of SPF timber used to produce SPF for each month during the period from June 1995 to January 2007\textsuperscript{29} obtained from the OMNR is plotted in Figure 4.4. During June 1995 to December 1998, when the market prices of lumber were high, the quantity of timber harvested were significantly more than the quantity harvested during the subsequent period when the market prices of lumber were relatively low. Based on the results of the estimates of the EPBM and the prices and cost data, I calculate the additional amount of the economic rents that could have been collected by the OMNR when the market conditions were favorable. This amount is about $Cdn1124.98 million. For the 55 months in which the stumpage prices charged by the OMNR were above the market values, the total amount that the OMNR had overcharged the industry is around $Cdn692.96 million. The difference between these two amounts is $Cdn432.01 million, which is the amount of economic rents that the OMNR undercharged from the softwood lumber industry and accounts for about 16.4% of the total economic rents available during the period\textsuperscript{30}.

However, as discussed earlier, the underpayment mainly occurred during the earlier period after the stumpage system was introduced and in April 1999, the OMNR did a series of modifications to the system to improve the market sensitivity of the stumpage prices. Prior to April 1999, as indicated by Figure 4.2, the stumpage prices in almost all the months were below the market values, except a few months that were either above or equal to the market values and the overall underpayment (underpayment subtracting the overpayment) during this period was at least $Cdn756.1 million. This amount is substantially higher than the overall underpayment ($Cdn432.01 million) during the whole period, which implies that after April 1999, the industry overpaid the government at least $Cdn324.1 million.

\textsuperscript{29} As it takes time for the softwood lumber producers to report the total timber harvested during each month, the data on the total SPF sawtimber consumption in January 2007 is incomplete. The data from January 2005 was used as the approximation for this month.

\textsuperscript{30} The total economic rents (TER) available during the period are calculated based on the RTV and the total timber consumption without discounting (\(TER = \sum_{t=1}^{140} RTV \times CF \times SPF \text{timber consumption}, \) \(t\) represents each month, the unit for RTV is $Cdn/mbf, for CF is m\(^3\)/mbf, and for SPF timber consumption is m\(^3\)).
Figure 4.4 Consumption of SPF timber used to produce lumber in Ontario during the period from June 1995 to January 2007.

Nevertheless, the uncollected economic rents did not contributed to the profits of the softwood lumber producers during the whole period. Rather, they have been deposited to the import duties collected by the U.S. government. It has to be kept in mind that during the period from May 2002 to August 2006, the industry also paid the import countervailing and anti-dumping duties imposed by the U.S. government, which was a substantive cost to the industry, but it was not considered in the determination of stumpage prices. Ontario accounts for 9.32% of the total softwood lumber exports in value ($Cdn) to the United States that were subject to the import duties and approximately paid $US503.47 million import tariff to the U.S. government (the U.S. government collected about $US5.4 billion import tariff in total since May 2002). This amount is substantially higher than the amount that was not charged by the Ontario government. Therefore, the uncollected economic rents by the OMNR in earlier years during the period went to the U.S. government in later years through the CVD and anti-dumping duty (ADD). This finding agrees with the earlier studies on welfare impacts of the various trade
restrictions, e.g., Stennes and Wilson (2005) and Mogus, Stennes, and van Kooten (2006), who found that U.S. government gained from the import duty in the form of government revenues.

During the period from May 2002 to August 2006 when Canadian softwood lumber exports were controlled by import tariff, most of the observations fell into regime 2, which means that the industry not only paid a higher stumpage price to the government, but also bore the cost of a significant import tariff. This finding is consistent with the previous analysis on the market performance of the stumpage system in Ontario (Yang, Kant, and Shahi 2006). In contrary to the loss caused to the Canadian producers, Stennes and Wilson (2005) found that a 27% tariff benefited U.S. producers.

Moreover, the softwood lumber markets in the U.S. are expected to be worse during the next two years according to the RISI forecasts based on the deteriorating housing markets. The weak housing markets in the United States will further push the U.S. domestic consumption of lumber down. As a result, the lumber imports from Canada will decline. RISI (2006) predicts that the market prices of lumber will remain lower than $US350/mbf during 2007 and 2008. At this price level, the Ontario softwood lumber exporters will pay a 2.5% - 5% export tax and will be restricted by export quota through this period under export measure Option B of the 2006 SLA. At this price level, the stumpage prices will remain higher than the market value at the future market price levels for at least the next two years (24 months) as indicated by the results. This implies that the underpayment by the industry to the government during the five years, from June 1995 to June 2000 when the market condition of lumber was favorable which was partially induced by the 1996 SLA, will be evened out or even surpassed by the overpayment from July 2000 to December 2008 when the market condition of lumber was poor. In the meantime time, they will pay extra export tax which will be again a substantive cost to the industry.

Therefore, the results of this study, in support of the NAFTA’s affirmation on no subsidy on March 17, 2006, show that the CVD and the export tax, which were determined by the USDOC based on the cross-border comparisons of stumpage rates or domestic Canadian log
prices and import log prices, were unwarranted and the refund of the import tariffs under the 2006 SLA is warranted. The declining prices of lumber coupled with the import duties during the last few years have forced some sawmills to shut down in Ontario and in other provinces.

4.6 Comparison of the Market Performances of RV-based and Auction-based Stumpage Systems

To resolve the softwood lumber trade dispute, the USDOC had proposed that administered stumpage prices in Canada be determined using information obtained from competitive timber auctions. The BC MOF has been therefore using a MPS to establish reservation prices on a small portion of annual harvest (MOF 1999). The question faced by the OMNR is whether Ontario should follow BC MOF and adopt the MPS in Northern Ontario to attempt to obtain exemption from the trade restrictions under the 2006 SLA and to improve the ability of the stumpage prices to reflect the true market values? A careful examination on the relative market performance of the RV-based stumpage system in Ontario and the MPS adopted by BC following the U.S. proposal and systems will offer some insight into this issue. Moreover, lessons from the U.S. can also be used as examples for the decision making in Ontario.

The central concept of the MPS is that auctions of stumpage establish the market values which can then be used to set the stumpage price for timber harvested under long-term tenures (MOF 2004). The potential acceptance of this system by Ontario will depend on the capability of auctions to simulate a truly competitive market (Niquidet and van Kooten 2006). It is noted that lack of competition is perhaps the biggest obstacle to auction-based pricing in BC (Fox 1991). As discussed earlier, lack of competition on both sides of the market is the major problem for establishing a competitive stumpage market. Niquidet and van Kooten (2006) examined the impact of competition on the effectiveness of using MPS to determine the stumpage fees on public forestlands in the BC interior where the forest industry structure and the nature of the timber resource have similar conditions throughout the rest of Canada. They found that lack of competition in several northern zones of BC has caused the bids to be lower than their true values by $Cdn1.47 – 2.64/m³ and particularly in one zone dominated by only one significant manufacture (monopsony) which has substantial market power in this district, the bids are less than their true values by $Cdn12.56/m³, which is about equal to the
transportation cost to the nearest sawmill in an adjacent zone. In addition, they found that the MPS based on ordinary least squares method (OLS) (proposed and used by the U.S. for timber valuation) biases the true value of forestlands – it tends to overestimate the value of lower-valued stands and underestimate the value of higher-valued stands. Moreover, their results imply that the imposition of the latest CVD resulted in a decline in bids by $Cdn 5.21/m³, which is probably neither the intension of the BC government nor the U.S. government. Furthermore, they concluded that in BC increased dependence on timber auctions to issue harvest rights and determine stumpage prices will face challenges, one of which is dealing with the different levels of competition throughout the province and failure to address it would significantly hinder the success of an auction-based stumpage pricing system. Roise (2005) examined the performance of the MPS on the BC coast and found that tenure holders may pay more or less than the market price in the short term and pay more than the market rates at least 50 percent time and pay less than 50 percent time in the long term.

The comparison between the estimation results and these findings indicates that: 1) both the auction-based and RV-based system may underestimate the market value of timber in some stands or in the short run; 2) when there is lack of competition, particularly in a market dominated by monopsony, which is common in Northern Ontario, the MPS may generate a stumpage price less than the price determined under RV-based pricing system ($Cdn 12.56/m³ vs. $Cdn 10.59/m³ less than the market value); 3) when the softwood lumber trade is controlled by trade restrictions, specifically by the import tariff regime, the RV-based stumpage systems generates a higher stumpage price as a result of a higher mill net price induced by the trade restriction; however, the MPS generates a lower stumpage price as tariff is a significant cost to the producer and it reduces the producer’s ability to pay a higher stumpage price; 4) the MPS is more difficult to implement and evaluate with respect to the market performance as compared to the RV-based system given the different competition levels in the different regions of BC and Ontario.

In the United States, Spelter (2005) compared the timber prices reported by various public and private U.S. agencies and the estimates of timber value based on the RV approach. He found that the residual value estimates deviated from the report prices; however, over 5 years, the
deviations even-out each other. In addition, the Forest Service Prices (determined by auctions) were substantially lower than the RV calculations. These results indicate that the administratively determined stumpage prices based on the RV approach are not necessarily below the prices determined by auctions or the competitive price level in the long run. Moreover, the prices determined by competitive auctions can deviate from the true market values of timber and thus may not result in true market values of timber in the U.S. markets, as believed and argued by the U.S. governments, in the short run. Therefore, the RV-based stumpage price system may not be worse, instead may even better than the market performance of the auction-based pricing system in area where there is a lack of competition. Similar conclusion was reached by Leefers and Potter-Witter (2006), who compared four public agency stumpage pricing systems in the Lake States, bordering to Ontario, where forests have similar species composition, but are managed under different institutions. They concluded the RV approach is more appropriate to areas with little competition and in Northern Ontario where competition is limited, this traditional approach including product market may provide the best method for determining stumpage prices. Spelter’s (2005) findings also support the argument that the market performance of a system should be evaluated based on long-term (at least a few years), in stead of short-term (one year) analysis.

The inference that a proper evaluation of the market performance of a stumpage system should be based on the analysis for a long-term is also supported by Luppold, Prestemon, and Baumgras (1998). In their study of the long-term and short-term relationships between hardwood lumber and stumpage prices in Ohio, they found that while there is a long-run equilibrium relationship between the lumber and stumpage prices, stumpage prices do not always follow the lumber prices in the short run as owners do not have adequate market information. They also found that only when there were large changes in lumber prices, the stumpage prices move simultaneously with the lumber prices, which is similar to the softwood lumber case in this study.

4.7 Policy Implications
In this study, I develop and use the EPBM to examine the discrepancy between the administratively determined stumpage price and the true market value of stumpage in Ontario.
in the case of SPF lumber during the period from June 1995 to January 2007. I compare the
market performances of Ontario’s RV approach-based stumpage system with the MPS used in
BC and discuss the difference between the RV approach based stumpage prices and the
market prices of timber in the U.S. The estimation results of the EPBM show that in the short
run, the stumpage prices determined under the RV-based system were either below or above
the market values of stumpage that would have been obtained based on the economic theory in
the absence of competitive markets for stumpage. However, in the long run, the underpayment
and overpayment will even out each other. The comparison of Ontario’s government-
controlled but market-based stumpage system with the auction-based stumpage system in BC
and the evidence from the U.S. indicate that the Ontario’s stumpage system is as good as the
MPS in terms of reflecting the market value of standing timber in the long run. These results
have following policy implications.

First, Ontario’s modified RV-based stumpage pricing system is superior to the conceptual
RTV system. The residual value component complies with the economic theory in the absence
of competitive markets and links the value of standing timber closely to the prices of final
products and their manufacturing costs that are determined in competitive markets. The
monthly adjustment to the residual value component improves the market sensitivity of the
system. The inclusion of the minimum rate ensures that the Ontario government receives a
stable and predictable stream of revenue and tempers the severe swings that can be caused by
volatile lumber prices. If the OMNR had adopted the standard RTV approach, it would not be
able to collect economic rents from softwood lumber producers for stumpage during some
periods when the softwood lumber markets experience downturns in the business cycles,
which would likely be used by the Coalition as an evidence of a subsidy31. The renewal charge
component guarantees a sufficient funding for regeneration and protection of forests.

31 The Coalition for Fair Lumber Imports would likely argue that the OMNR should let mills shut down. It
could also argue that (1) low stumpage induces high capacity in Ontario in the first place, (2) high capacity
in Canada contribute to the fall in lumber price in bad macroeconomic conditions, and (3) as the lumber
price falls, the stumpage payment become very low. The responses to these arguments from an economic
point of view would be: (1) high capacity in Ontario and in Canada was mainly driven by the high market
prices resulted from the high demand in the U.S. in good macroeconomic conditions. This was also the case
for the U.S. softwood lumber industry. As explained by Zhang (2006), the high lumber prices in the US
markets during the period covered by the 1996 SLA contributed to the high capacity in both the US and
Canada; (2) The high capacity in both U.S. and Canada contribute to the fall in lumber price in bad
Second, the advantage of the modified system over the standard RTV approach also lies in the fact that it represents not only the timber processor’s perspective, as the standard RTV approach, but also the timber owner’s valuation, which is not represented by the standard RTV approach. Yet, the stumpage prices determined under the revised system has the potential to collect the full economic rents of standing timber in the long term; therefore, it is fair to both the seller and the buyer of stumpage. Thus, although there are deviations from the true market value of timber in the short term, the stumpage prices determined under the modified system include both buyer’ and seller’s preferences in the long term.

Third, the comparison of the market performances of Ontario’s current stumpage system and the MPS in BC implies that the former is as good as the latter, especially in Northern Ontario where the competition between timber processors is limited, in terms of the ability of reflecting the true market value. Therefore, OMNR should not decide to introduce the MPS system without careful examination of local industry structure as it may not result in improved market performance of the pricing system. Moreover, the administration costs involved in each pricing system and the resulting financial returns to the government should also be compared. While the RV-based methods require the collection of considerable input data, which is expensive, the MPS system needs substantial analytical expertise, which makes it expensive to implement in a different way (Schuster and Niccolucci 1990). The OMNR ought to assess the overall pros and cons of alternative stumpage pricing systems by determining the objectives of the appraisal, identifying test criteria, conducting comparison tests, and analyzing which performs best (Schuster and Niccolucci 1990). No doubt, it will be an extremely difficult task for the OMNR and requires special expertise to accomplish the task. It would be probably a much easier job just to adjust the parameters, for example, decrease the minimum rate and increase the proportion of the excess profit at the same time to enhance the market sensitivity of the current system.

Fourth, as deviation of the actual stumpage price from its true value may happen under any stumpage system (auction-based or RV-based), short-run deviation should not be used to

macroeconomic condition: and (3) it makes perfect economic sense that the raw material becomes cheaper when the market price of the end products decrease.
judge the sufficiency of any stumpage or as the evidence of a financial subsidy. In stead, sufficiency should be determined based on the long-run behavior of the stumpage prices.

Fifth, although this analysis is based on Ontario, it may be relevant to the other provinces in Canada, for instance, Alberta and Quebec, which have similar forest ownership and industry structure and from which lumber export was controlled by trade restrictions. If similar results were obtained, they can be used as scientific evidence to support their argument on the subsidy issue. However, if the specific system is not efficient according to the analysis, the government may consider improving their system by revising the parameters or even the structure of the system used. In addition, given the fact that the vast majority of the forests in the world (about 77%) are owned and administered by governments and timber from these forests is generally allocated to firms holding harvest rights at charges set by government agencies (White and Martin 2002), the EPBM can be used (provided the detailed cost data are available) to evaluate the ability of the existing stumpage pricing system in each region or country. If the current system used does not result in sufficient stumpage prices, Ontario’s modified RV approach might provide a more economically appropriate and financial feasible approach to determining the stumpage prices.

It has to be pointed out that although Ontario’s RV-based stumpage pricing system has some notable merits, its major deficiency is that its market performance heavily depends on the accuracy of the requisite detailed input data. As many forest products companies consider their financial information confidential, they are not willing to share the detailed cost data that are required to determine the RV component. When data are not available, the OMNR has to estimate the total manufacturing costs, which reduces the market performance of the system. The OMNR may need to impose a legislative obligation to force the firms to provide adequate and accurate cost data to enhance the efficiency of the system.
CHAPTER V

AN ECONOMIC PERSPECTIVE ON THE DETERMINATION OF DUMPING IN THE US-CANADA SOFTWOOD LUMBER TRADE

5.1 Introduction
The United States is one of the leading softwood lumber producers in the world, yet it meets only two thirds of its domestic need for softwood lumber with the rest relying on imports. Canada is the world’s largest exporter of softwood lumber with about 60% of softwood lumber production exported to the United States. The softwood lumber import from Canada accounts for over 90% of the total softwood lumber imports in the US. In 2006 alone, 43.1 million m$^3$, worth $Cdn7.3$ billion, of lumber was shipped from Canada to the United States (NRC 2007). This trade continues to be an important component of the trade between the two countries. However, it has been accompanied by a persistent dispute which is so controversial that it is described as a “softwood lumber war” (Zhang and Sun 2001). Since 1982 when the modern form of the dispute started, it has experienced four stages of accusation, threats, investigation, negotiation and temporary settlement (Zhang 2001). Various studies, for example, Yin and Baek (2004), and Zhang (2007), have summarized the history of this dispute.

In 1996 during the third phase of the dispute, the two governments signed the softwood lumber agreement (SLA), which was a tariff-regulated quota system to restrict softwood lumber imports from Canada. The SLA covered the period from April 1, 1996 to March 31, 2001. Under the 1996 SLA, 14.7 bbf per year could be exported from British Columbia, Quebec, Ontario, and Alberta to the United States without export tax. An additional 650 million board feet (mmbf) could be exported subject to an export tax of $US50 per thousand board feet (mbf), and volumes above this were charged an export tax of $US100/mbf by the Canadian government.
Following the expiration of the SLA, the U.S. Department of Commerce (hereafter, the Department) received a petition from U.S. lumber producers to investigate the countervailing duty (CVD) and anti-dumping duty (ADD) of softwood lumber imports from Canada. The US producers claimed in the petition that the production of Canadian softwood lumber was subsidized through lower stumpage fees and that Canada was dumping softwood lumber in the U.S. market by selling lumber at prices below the cost of production. The Department initiated the investigation in April 2001, and immediately thereafter, the two countries started bilateral negotiations to find a long-term solution to the dispute. However, a durable solution was not reached and the Department established a combined duty of 27.22% (18.79% for CVD and 8.43% ADD) on Canadian softwood lumber in April 2002. These duties took effect on May 22, 2002.

In July 2003, the Department initiated the first annual administrative review of the CVD and ADD orders covering the periods May 2002 to March 2003 and May 2002 to April 2003, respectively. As a result, the combined duty rate was lowered to 21.21% (17.18% for CVD and 4.03% for ADD, and these results were later amended to 16.37% for CVD and 3.78% for ADD). A second administrative review was undertaken for the period 2003-2004 and results were released on December 6, 2005 showing a much lowered combined duty rate of nearly 11% (8.18% for CVD and 2.44% for ADD).

In response to these US actions, Canada filed petitions with the North American Free Trade Agreement (NAFTA) and the World Trade Organization (WTO). The petitions challenged the legitimacy of the imposition of the CVD and ADD and the US claim that the US softwood lumber industry was threatened with material injury by the alleged subsidization and dumping of Canadian softwood lumber imports. Although most of the rulings of these challenges by the NAFTA and WTO panels were mixed, they mainly uphold Canada’s positions on all of these three issues. In the case of CVD, the NAFTA Subsidy Panel ruled that the United States has no basis in using the US stumpage prices as the benchmark in calculating the amount of benefit accruing to the Canadian stumpage programs (NAFTA 2003a) and accepted the Department’s fifth remand determination of de minimis subsidy in March 2006. The WTO Subsidy Compliance Appellate Panel ruled that the U.S. procedures used to establish CVD on
the Canadian softwood lumber imports are inconsistent with WTO rules (WTO 2005). With respect to the ADD issue, the NAFTA Dumping Panel ruled that the zeroing method used by the Department in calculating dumping margins is illegal (NAFTA 2005) and the WTO Dumping Panel ruled that the Department erred in its method for computing the ADD by using a zeroing method (WTO 2004a). The zeroing method is a practice of assigning a margin of zero to goods in transactions for which the export price exceeds the normal value. While the difference between the normal value and the export price of the product is generally referred to as the margin of dumping, the negative difference between the two values is referred to as negative dumping margin. The practice of the zeroing method prevents a firm’s positive dumping margins from being offset by negative dumping margins. The NAFTA Injury Panel ruled that imports from Canada did not impose threat to cause material injuries to the U.S. lumber industry (NAFTA 2004) and the WTO Injury Panel found that the US International Trade Commission (USITC) threat of injury determination violated WTO rules (WTO 2004b). The WTO ruling essentially removes the basis for the imposition of US CVD and ADD on softwood lumber imports from Canada and could have potential ramifications on future legal proceedings.

Despite the large body of literature on the softwood lumber trade dispute, to my knowledge, no study has attempted to examine whether dumping has in fact taken place. This study examines whether softwood lumber producers in Ontario have dumped softwood lumber in their major market in the US. Information gleaned from this study may provide insights for seeking a long-term and durable solution to the dispute and could support policy and decision making in the affected provinces, as well as in the federal government.

If results indicate that Ontario producers had intentionally dumped softwood lumber into the US markets it should be a concern to the Ontario Ministry of Natural Resources (OMNR). Yang, Kant, and Shahi (2006) found that stumpage prices of spruce-pine-fir (SPF), the dominant softwood species in Ontario, responded to changes in the market price of SPF lumber. This implies that deliberately depressed market price due to dumping has translated to lower stumpage prices as a consequence of the residual value approach based stumpage

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32 The relevant literature is reviewed in Chapter IV.
pricing system. If this is indeed the case, the OMNR may need to examine ways on how to improve the current stumpage pricing system. However, if the results do not imply deliberate dumping, the Ontario government should enact policies to motivate producers to reduce production costs. Lower production costs will increase the stumpage prices and reduce the risk of the OMNR being accused of providing subsidy. They will also reduce the likelihood of producers being imposed further CVD and ADD in the future after the expiration of the 2006 SLA.

Economists have long associated dumping with international price discrimination (Boltuck 1987). Dumping is considered to occur when the export price of a product, corrected for transportation costs and related items, is lower than the home market price of the same or similar product. Reverse dumping occurs when the corrected export price exceeds the home market price. Both practices are forms of spatial price discrimination (Yarrow 1987). Hence, the usual test to determine dumping, from an economic point of view, is by comparing the price in the foreign market and the domestic or home market price. The Department, however, disregards the concurrent home market sales when they are not profitable and compares the export price with the remaining home market prices in determining, and calculating the margin of dumping. The margin of dumping is the difference between the normal value and the export price of the product. This accounting approach has been criticized by several researchers, for example Cass and Nankin (1991) and Boltuck, Francois, and Kaplan (1991), for biasing the margin of dumping upwards. In addition, the Department applied the zeroing method, which further inflated the margin of dumping. This is the reason that WTO ruled that this method violated WTO antidumping rules.

This study investigates the possibility of dumping by Ontario softwood lumber producers in the U.S. market from an economic perspective. Specifically, it compares the import market price in the US and the home market price of softwood lumber produced in Ontario under two trade regimes, namely, the 1996 SLA and the subsequent tariff regime. The enhanced parity bounds model (EPBM) developed by Yang and Kant (2007), is employed.
I proceed in the next section by presenting the legal background for antidumping cases, followed by a brief introduction to the US determination of dumping in the case of softwood lumber. I then discuss an economic perspective on the determination of dumping. Next, I illustrate the theoretical model, describe the data, and report and discuss the estimation results. I draw the conclusions and policy implications in the final section.

5.2 Legal Background for Antidumping Cases
The WTO Antidumping Agreement defines dumping as the situation when a product is introduced into the commerce of another country at less than its normal value. Accordingly, dumping occurs when the export price of the same product is:

(a) less than the comparative price, in the ordinary course of trade, for the like product when destined for consumption in the exporting country, or
(b) in the absence of such domestic price, is less than either
   (i) the highest comparable price for the like product for export to any third country in the ordinary course of trade or
   (ii) the constructed value of the product, which is the aggregation of the cost of production of the product in the country of origin plus a reasonable amount for selling, administrative and other costs, and for profit (GATT 1994).

While this provision broadly defines what normal value is, it is not clear when the domestic price should be treated as in or outside the ordinary course of trade. This is a crucial issue to address as it affects the calculation of dumping margin and thus the conclusion of the presence of dumping. Article 2.2.1 of the Agreement provides details when domestic or third country sales may be treated as not being in the ordinary course of trade, and therefore be ignored in the determination of normal value:

Sales of like product in the domestic market of the exporting country or sales to a third country at prices below per unit (fixed and variable) costs of production plus administrative, selling and general costs may be treated as not being in the ordinary course of trade by reason of price and may be disregarded in determining normal value only if the authorities determine that such sales are made within an extended period of time in substantial quantities and are at prices which do not provide for the recovery of all costs within a reasonable period of time. If prices, which are below per unit costs at the time of sale, are above weighted average per unit costs for the period of
investigation, such prices shall be considered to provide for recovery of costs within a reasonable period of time (GATT 1994: Article 2.2.1, emphasis added).

Therefore, the following three criteria have to be met simultaneously before below-cost domestic sales can be disregarded for determining the normal value: 1) sales in substantial quantities; 2) sales within an extended period of time; and 3) sales at prices that do not permit the recovery of all costs within a reasonable period of time. This provision contemplates considerable long-term below-cost sales as being outside the ordinary course of trade (Annand 2005). The Agreement stipulates, however, that the extended period of time should normally be one year and shall in no case be less than six months, which might be too short to reflect a long-term view for the softwood lumber industry.

In cases where dumping is proven to occur and has caused or threatened material injury to a domestic industry, or materially retards the establishment of a domestic industry, Article VI of GATT 1994 permits that an ADD at a level not greater than the margin of dumping may be levied on imports from the particular source. The Agreement provides some guidance on what constitutes material injury and emphasizes the importance of the surge of imports, price depression, and causal connection between dumping and injury (GATT 1994).

The above are some of the legal grounds for countries to investigate dumping, but each country has the option to establish its own law and operating procedures. In the United States, dumping is defined as import sales at “less than fair value”, where the primary meaning of fair value is the price in the home market of the exporter. However, sales below the cost of production may also be considered dumping. If a U.S. industry has reasons to believe that it is being injured by unfair competition conducted by a foreign firm through dumping, it may request the imposition of antidumping duty by filing a petition with the Department. The Department determines the presence of dumping and the US International Trade Commission (USITC) investigates whether the dumping has caused, or threatens to cause, material injury.

5.3 The US Determination of Dumping
During the antidumping duty investigation for softwood lumber products from Canada, the Department sent questionnaires to six largest Canadian softwood lumber producers: Abitibi-
 Consolidated Inc., Canfor Corporation, Slocan Forest Products Ltd., Tembec Inc., West Fraser Timber Co. Ltd., and Weyerhaeuser Canada to collect detailed information on the production of different softwood lumber products, sales in domestic markets, export markets in the US, cost of production, and other relevant information. The Department then calculated the export price or constructed export price and compared one of them with the normal value or cost of production to determine a dumping margin for each company (USDOC 2001). A weighted average of dumping margins of these six companies was calculated for all other producers.

Export price is defined as the price at which the subject merchandise was first sold before the date of importation by the exporter or producer outside the US to an unaffiliated purchaser in the US or to an unaffiliated purchaser for exportation to the US. Constructed export price is the price at which the subject merchandise was first sold in the United States before or after the date of importation, by or for the account of the producer or exporter of the merchandise, or by a seller affiliated with the producer or exporter to an unaffiliated purchaser. For both export price and constructed export price, the Department adds packing charges (if not already included in the price), rebated import duties, and certain CVD, and deducts transportation cost and export taxes or duties. Also, for constructed export price, the Department deducts selling commissions and other expenses for selling the products in the US, the cost of any further manufacture or assembly conducted in the US and profit.

Normal value is generally the home market price of the identical or similar product if that the product was sold in sufficient quantities or value and that there were no particular market situations that prevented a proper comparison with the two export prices (USDOC 2001). However, when the home market price is below the cost of production, the Department disregarded this sale and used the remaining sales to determine the normal value (USDOC 2001). For example, if firm has two products in both the home and export markets, 2 × 4, and 2 × 6, kiln dried, #2&better, and if the Department finds that the firm’s sale price of 2 × 4 in home market is below cost, it would disregard the sale of 2 × 4 and only use the sale of 2 × 6 as normal value and calculate the margin of dumping (Zhang 2007). If there were no useable home market sales in the ordinary course of trade or all sales of a comparable product failed the cost of production test, the Department based normal value on the constructed value and
compared the export prices or Constructed export prices with the constructed value. The constructed value is the aggregate of the cost of materials and fabrication for the imported product, plus amounts for selling, general, and administrative expenses, profit and U.S. packing (USDOC 2001).

In determining the cost of production during the period of investigation, the Department rejected the average joint costs used by the accounting records of the companies and developed a value-based methodology for allocating joint wood and sawmill costs between different grades of lumber; however, it continued to use a volume-based average cost methodology to allocate joint costs between different sizes of lumber within a particular grade (NAFTA 2003b). In calculating the ADD, the Department first used a weighted-average-to-weighted-average approach to compare the export price and the normal value, i.e., the Department compared average export price (or constructed export prices) to average normal values. The averages were based on sales made over the course of the period of investigation. In calculating the margin of dumping, the Department used the zeroing method. As mentioned earlier, this method prevents a firm’s positive dumping margins from being offset by negative dumping margins, resulting in a higher overall antidumping margin. To determine the antidumping duty rate, the Department aggregated the amount of positive dumping margins and divided it by the aggregate value of all U.S. sales which included non-dumped and dumped sales.

After WTO ruled that the zeroing practice under the weighted-average-to-weighted-average approach was inconsistent with its antidumping rules, the Department used a transaction-to-transaction approach, i.e., it compared the export price (or constructed export price) of an individual U.S. sale to an identical sale in Canada33. However, the Department continued to use the zeroing method to calculate the margin of dumping. The Department used this new

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33 The transaction-to-transaction approach is a complicated process. The Department started with transactions with certain characteristics in the United States and then attempted to find an identical match in the home market at the same level of trade on the same day or within seven days before or after a U.S. sale. To identify the most appropriate match, the Department used six criteria including: (1) variable cost, (2) quantity, (3) customer category, (4) channel of distribution, (5) movement expenses, and (6) number of days between payment and shipment. If the Department found more than one equally comparable match, it used the computer to select the first observation on the list of equally appropriate matches (Zhang 2007).
approach to establish a dumping rate of 11.54%, an increase from the dumping rate of 8.43% calculated based on the weighted-average-to-weighted-average approach.

5.4 Economic Perspective on the Determination of Dumping

While there are many issues that affect the determination of dumping and calculation of dumping margin, some issues are particularly important and have therefore drawn more attention by economists. Such issues include the treatment of below average cost in the determination of normal value and the practice of the zeroing methodology.

On the first issue, in contrary to the treatment of below average cost sale as outside the ordinary course of trade by the Department, economists recognize that price below cost is a normal business behavior for any firm in a depressed competitive market. Any perfectly competitive firm will continue to produce and sell when the price drops below its average cost, so long as it remains above its marginal cost and it can recover portion of its fixed costs. Thus pricing below average cost should not be considered as outside the ordinary course of trade both in the domestic and international markets. It makes perfect economic sense for competitive firms to remain in business even if they suffered from both domestic and international markets in the short run so long as they expect to obtain profits in the near future when the market turns around. Even if the firms have to shut down due to lack of competitiveness, it can reduce the total loss by continuing to produce to recover portion of the fixed cost (Deardorff 1989).

Therefore, below average total cost, but above marginal cost, sales should be included in the determination of normal value from an economic point of view. However, economists also recognize that dumping may happen under the condition when the market price is below the marginal cost because it may suggest some sort of predatory pricing behavior. Predatory pricing is a form of strategic behavior whereby a firm with market power deliberately cuts its price with the intent to driving competitors out of business. It then raises its prices in the long run, in the absence of competition, and thus recoups any losses while realizing great profits (OECD 1989). \(^{34}\)

\(^{34}\) Predatory pricing has been a major focus of antitrust policy and alleged predatory pricing has led to many legal cases. As a result, many scholars have studied and proposed the rules that can be used to distinguish legitimate competition from predatory pricing. Although no consensus has been made which rule is most appropriate, the so-called “Areeda-Turner rule” has received most attention. In their widely cited article,
If predatory behavior of any softwood lumber firm is a concern in the softwood lumber trade, it is necessary to evaluate the possibility and credibility of predatory pricing by any softwood lumber producers. However, a careful examination on the structure of the softwood lumber industry in North America would suggest that predatory pricing is neither possible nor rational for any firm in the industry. First, for any firm to be successful in the predation, it must possess market power. However, there are many softwood lumber producers in each province of Canada and in each region of the United States. Spelter, McKeever, and Alderman (2007) reported that there were over 1,000 larger lumber producers before 2006 and market share of the biggest firm which operates both in Canada and in the US was only 7.5% in the US in June 2007. Thus, it is more reasonable to assume that lumber markets are highly competitive and no firm has significant market power. Moreover, there is no barrier to entering to the industry in the US and it does not require huge amount of capital to set up mills. Therefore, even if some firms could drive all the other firms out of business by sacrificing short term profit, new firms would be set up by the competitors which would make the recoupment of foregone short-run profits in the long run impossible. In addition, offshore import would fill in the demand and again lower the market price. Furthermore, there are other substitutes, for example steel, for lumber. If the market price of lumber is too high, the consumers could substitute lumber with steel, which will reduce the demand for lumber. As a result, the market price of lumber will decrease. Hence, it can be reasonably concluded that predatory pricing has not taken place in the case of softwood lumber trade. Hence, there is no sound economic reason that below cost sale should be disregarded in the determination of normal value and it is reasonable to determine the normal value based on the domestic sales that are both below and above average costs in this softwood lumber case.

Areeda and Turner (1975) argued that a firm’s pricing should be considered predatory only if price was below its short-run marginal costs. Their argument is that the marginal-cost pricing is the economically sound division between acceptable, competitive behavior and “below-cost” predation. However, since conventional business accounts do not readily infer the incremental cost of making and selling the last unit, the more readily available average variable cost can be used as a proxy. While some scholars considered this rule too permissive, others consider it too restrictive (Anderson and Johnson 1999).
The zeroing methodology has been found to violate the WTO Antidumping Agreement, and has been termed as “one of the most notorious methodology” by Lindsey and Ikenson (2002a) because it significantly distorts the calculation of dumping margin. Therefore, an appropriate approach to determining the dumping margin should include all the export prices that are either below or above the normal values from both the economic and legal perspectives.

There is another issue that is also critical, at least for some of antidumping cases, but has not drawn enough attention. It is the time span during which dumping should be considered. From an economic perspective, when the market is characterized by business cycles, the margin of dumping should be determined on the basis of the long-term behavior of markets and not the short-term behavior. It is because during the short term, when the markets are experiencing the downturn influenced by some macroeconomic factors, the firms may suffer losses; however, they should expect to get profits when the markets improve. As some studies have already demonstrated, for example, Takacs (1981), and Niels and Francois (200) that there are more requests for antidumping measures during macroeconomic downturns and exchange-rate appreciations. This is because positive injury findings may be easier to make in a downturn, increasing the chance of success, even though the foreign firms are engaging in normal business activities. This is a significant issue particularly in this softwood lumber case because lumber markets have been highly volatile during the past two decades due to various factors, one of which is this trade dispute. As shown later in this study, the choice of the timing and time span for the investigation of dumping by the Department contributes the affirmative finding of dumping.

In view of the above economic grounds, this study considers the following in the study: the weighted average delivered price in Toronto is used as the normal value; the export price is represented by the weighted average delivered price in the US, and a longer time span of four to five years is used as the period for the determination of dumping.

SPF is the major softwood species group in Ontario and account for about 94% of the softwood timber consumption for lumber during the period, 1995 through 2007. SPF lumber products of different grades and dimensions are produced jointly by individual producers in
Ontario. There are many companies that run small to large scale mills that produce SPF lumber in Ontario. Softwood lumber products are shipped from mills to wholesalers, dealers or customers in Toronto and in the Great Lakes in the US by trucks or rail. These products are mainly sold in Toronto and the Great Lakes, which together account for over 80% of SPF lumber produced in Ontario each month. Softwood lumber mills generally arranged the shipment of lumber to the wholesalers and dealers in the two markets; therefore, they charge the delivered prices to their customers. As the mills are located in different regions in Northern Ontario, they pay different transportation costs for shipping the products to the markets.

In the case of the availability of accurate time series data for delivered prices in the Great Lakes and in Toronto markets, and transaction costs from mills to both markets, I can simply compare the price differential between the delivered prices in these two markets with the difference between the transaction costs from mills to the Great Lake and Toronto markets. I term the difference between the transaction costs from mills to the two markets as extra transaction cost (ETC). If the price differentials are equal to ETC, it would suggest that the Ontario softwood lumber industry did not discriminate the US market. However, if the price differential is less than the ETC (that is, the market price in the Great Lakes is less than the market price in Toronto, after allowing for the ETC), and if this situation persisted in the long run, during which a substantial volume of softwood lumber was exported from Ontario to the Great Lakes, it may indicate that the Ontario softwood lumber industry has been dumping softwood lumber products in the Great Lakes market. On the other hand, if the price differential exceeds the ETC (that is, the market price in the Great Lakes is higher than the market price in Toronto), and the producers made more profits by selling the products in the Great Lakes than selling them in Toronto, then it may mean that the Ontario softwood lumber industry did not dump the products in the US markets.

While the delivered prices of major SPF lumber products in both markets were generally collected frequently by Random Lengths, and thus available for this study, the transaction costs associated with shipping the products to the markets were not regularly collected and updated. Accurate data on the transaction costs were collected through survey, and series were
generally updated using consumer price indices. Thus, accurate time series data on the ETC were not available, but the estimated mean of the ETC in each month was. Hence, the Enhanced Parity Bounds Model (EPBM) developed by Yang and Kant (2007) is used in this study. EPBM, as its name implies, is an enhanced version of the Parity Bound Model, originally suggested by Baulch (1997). EPBM estimates the 95% confidence interval of the mean of ETC. The model allows the estimation of the average difference between the delivered prices in the two markets, after considering the ETC, and thus estimates the average positive or negative margin of dumping during the period covered by the analysis.

5.5 The Theoretical Model

5.5.1 Specification of the Theoretical Model

The price series in this study are the delivered price in the Great Lakes (adjusted by deducting CVD and ADD) and the delivered price in Toronto and the transaction cost is the ETC. 95% confidence interval of the mean ETC is estimated to account for the variation in the ETC among the months and the upper and lower bounds of the ETC are thus determined in the EPBM. When the price differentials fall between the upper and lower bounds of the ETC, they are at the parity bounds, which implies that Ontario softwood lumber producers did not dump SPF lumber in the U.S.; when the price differentials fall below the lower bounds of the ETC, they are inside the parity bounds, which suggests that the market price in the Great Lakes is less than the market price in Toronto; and when the price margins fall above the upper bounds of the parity bounds model, they are outside the parity bounds, which implies that Ontario softwood lumber producers charged a higher price in the Great Lakes than in Toronto. Hence, the EPBM examines the performance and behavior of softwood lumber producers in the two markets by distinguishing among three possible regimes: (1) at the parity bounds (Regime 1); (2) inside the parity bounds (Regime 2); and (3) outside the parity bounds (Regime 3). In addition, the EPBM estimates the average differences between the price differentials and the ETCs and thus the average positive dumping margin or negative dumping margin during the period in study when the trade fell under the second and third regimes.

Let $P_{GL_t}$ denote the adjusted delivered price in the Great Lakes, $P_{TOR_t}$ denote the delivered price in Toronto, and $ETC_t$ denote the extra transaction cost from Toronto to the Great Lakes.
Under these regimes, there are three price relationships: 1) the price differentials equal to the ETC, i.e., \( P_{GLt} - P_{TORt} = ETC_t + e \), the error term \( e \) is incorporated to account for fluctuation in the ETC and it is assumed to be independent and identically distributed with zero mean and variance \( \sigma_e^2 \) (Regime 1); 2) price differentials are less than ETC, \( P_{GLt} - P_{TORt} = ETC_t - U + e + \epsilon_u \), where \( U \) is a positive number representing the average difference between the price differentials and the ETC, thus the average positive dumping margin, and \( \epsilon_u \) is a stochastic error term (\( \epsilon_u \sim N(0, \sigma_{\epsilon_u}^2) \)) associated with \( U \) allowing \( U \) to vary among the months (Regime 2); 3) price differentials exceed ETC, \( P_{GLt} - P_{TORt} = ETC_t + V + e + \epsilon_v \), where \( V \) is positive number representing the average difference between the price differentials and the ETC, thus the average negative dumping margin, and \( \epsilon_v \) is the stochastic error term (\( \epsilon_v \sim N(0, \sigma_{\epsilon_v}^2) \)) associated with \( V \) allowing \( V \) to fluctuate among the months during the period (Regime 3).

It is also assumed that Regime 1, 2, and 3 occur with probabilities \( \lambda_1, \lambda_2, \) and \( \lambda_3 \), respectively. As the three regimes cover all the possible relationships between the price differentials and the ETC, the summation of the three probabilities is equal to one \( (\lambda_1 + \lambda_2 + \lambda_3 = 1) \).

Based on the assumptions of the error terms in the three regimes, the likelihood function for the EPBM is formulated as follows:

\[
L = \prod_{t=1}^{n} \left( \frac{\lambda_1 f_1^1(t) + \lambda_2 f_2^2(t) + \lambda_3 f_3^3(t)}{\lambda_1 + \lambda_2 + \lambda_3} \right) \tag{5.1}
\]

where \( f_1^1(t), f_2^2(t) \) and \( f_3^3(t) \) are the density functions as given in [5.2], [5.3], and [5.4]

\[
f_1^1(t) = \frac{1}{\sigma_e} \phi \left( \frac{y_t - ETC_t}{\sigma_e} \right) \tag{5.2}
\]

\[
f_2^2(t) = \frac{1}{\sqrt{\sigma_e^2 + \sigma_{\epsilon_u}^2}} \phi \left( \frac{y_t - ETC_t + U}{\sqrt{\sigma_e^2 + \sigma_{\epsilon_u}^2}} \right) \tag{5.3}
\]

\[
f_3^3(t) = \frac{1}{\sqrt{\sigma_e^2 + \sigma_{\epsilon_v}^2}} \phi \left( \frac{y_t - ETC_t - V}{\sqrt{\sigma_e^2 + \sigma_{\epsilon_v}^2}} \right) \tag{5.4}
\]
where $n$ is the number of observations (months), $y_t$ is the price differential between the delivered prices in the Great Lakes and Toronto in month $t$ ($y_t = \text{P}_{GLt} - \text{P}_{TORt}$).

### 5.5.2 The Data

The data contain the monthly delivered prices of SPF lumber produced in Ontario$^{35}$, in the Great Lakes$^{36}$ and in Toronto, the average production cost of SPF lumber per mbf and the transaction costs per mbf from mills to the two markets from April 1996 to September 2006.

In economic analysis, volume-weighted average of market prices of different products that fall into the same category is typically used to represent the market price in each week, month, quarter or year. Hence, the delivered prices in the Great Lakes and Toronto are the weighted average of the delivered prices of the major SPF lumber and other SPF lumber. The individual delivered price series were obtained from Random Lengths. The delivered prices in the Great Lakes$^{37}$ are in US dollars. For this analysis, they were converted to Canadian dollars using the exchange rate, Wednesday noon average reported by Bank of Canada for that month$^{38}$. The market share of each product in these two markets was provided by the OMNR based on a third party survey covering the years 1996 to 1998. This survey also collected the production costs of SPF lumber products of different mills and reported the weighted average of the

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$^{35}$ The major SPF lumber products produced in Ontario include: Kiln Dried (KD) dimension (random length): $2 \times 4$, $2 \times 6$, $2 \times 8$ of grade #2&Better, $2 \times 4$, $2 \times 6$, $2 \times 8$ of grade #3, $2 \times 4$, $2 \times 6$, $2 \times 8$ of grade Economy; KD studs: $2 \times 3 – 8'$, $2 \times 4 – 8'$, $2 \times 4 – 10'$, $2 \times 6 – 8'$; green random, and green studs. Green random and green studs have only been sold in Toronto, so the delivered prices for these two products are only available for the Toronto market. The delivered prices of other SPF lumbers, KD dimension $2 \times 8$ of grade #3, and $2 \times 8$ of grade Economy, which in total account for 24.8% and 8.9% in the Toronto market and the Great Lakes market, respectively, are not available for both markets. The weighted average of the available SPF lumber product prices was divided by these products’ total market share (75.2% and 91.1% for the Toronto and the Great Lakes markets, respectively) to derive the weighted average delivered price of SPF lumber products in Toronto and the Great Lakes.

$^{36}$ The Great Lakes market includes the states: Minnesota, Wisconsin, Illinois, Michigan, Indiana, Ohio, Pennsylvania, and New York.

$^{37}$ These delivered prices were collected from Columbus, Ohio by Random Lengths. Random Lengths also reports the delivered prices of eastern SPF lumber products in the other markets in the Great Lakes region. However, the delivered prices in the other markets were simply calculated from the delivered prices in the Columbus market by adding or subtracting the transportation cost between the markets. Therefore, including the other markets will not make any difference in the final conclusion.

$^{38}$ This exchange rate is used throughout this paper whenever a comparison between Canadian dollars and US dollars is made.
production costs\textsuperscript{39} for these years. The OMNR have been using the GDP implicit index to extrapolate to obtain the series. The weighted average transaction costs from different mills to the Great Lakes and to Toronto markets in 1997 were also obtained from this survey. In this study, the monthly transaction costs were extrapolated using the Consumer Price Index for transportation in Ontario.

It should be mentioned that the weighted average delivered price in the Great Lakes included the export tax collected by the Canadian government during the period covered by the SLA and the CVD and ADD imposed by the US government during the post-SLA. For this analysis, the CVD and ADD were deducted from the delivered price in the Great Lakes to remove the effect of CVD and ADD on the delivered price. During the SLA, Ontario was allocated about 10.3\% of the 14.7 bbf tax-free export quota (Random Lengths 2007), which was 1.514 bbf, each year\textsuperscript{40}. If Ontario also obtained the same proportion for the low-fee base, then 66.95 mmbf was exported subject to the export tax of $US50/mbf. The actual export was 1.838 bbf\textsuperscript{41} for the first SLA year from April 1996 to March 1997, which exceeded the sum of the quota and the lower-fee base allocated to Ontario; hence, some volumes were also exported within the upper-fee base category, which bore an export tax of $US100/mbf. The same situation occurred during the following four years. Hence, Ontario producers paid some export tax each year. However, the total export tax was not available. Based on the quantity exceeding the quota, the total export tax should range between $US16.22 and $US32.44 million each year and on average, price should have been reduced by between $US8.8 and $US16.7. Nevertheless, export tax was not deducted from the delivered price in the Great Lakes during the SLA\textsuperscript{42}. Whether or not the export tax or CVD and ADD should be reduced

\textsuperscript{39} The production costs include delivered wood cost, direct manufacturing cost and indirect cost. See Yang and Kant (2007) for a more detailed description about the components of the total production costs.

\textsuperscript{40} As the market price of eastern SPF 2 × 4 Std&Btr exceeded the trigger price, Canada received 92 mmbf bonus amount which could be exported free of charge and Ontario probably obtained a proportion of this bonus amount.

\textsuperscript{41} This amount includes all the softwood lumber, including SPF lumber, exported from Ontario.

\textsuperscript{42} The Department deducted SLA export taxes from the importing prices in calculating export prices and constructed export prices during the period of investigation. The companies that were investigated complained that the deduction of SLA tax from shipments of subject merchandise effectively increases the margin of dumping and in effect asked them to pay the tax again in the form of ADD.
from the export price is debatable. The point here is: if it could be shown that after removing
the export tax or CVD and ADD, the market prices in the Great Lakes were equal or higher
than the market price in Toronto, taking into account the ETC, then this would be a strong
evidence that the Ontario softwood lumber industry has not dumped softwood lumber into the
US market.

Figure 5.1 illustrates the FOB mill net price derived from the delivered price in the Great
Lakes (by deducting CVD, ADD, and transaction cost from the mills to the markets) and the
average production cost from April 1996 to September 2006. It shows that during the SLA,
the mill net price was always greater than the average production cost and the price-cost
margin was sizable, ranging from $Cdn39 to $Cdn303 (from $US26 to $US206). Even after
deducting the export tax per mbf paid by the Ontario producers ($US8.8 – $US16.7), the
profit-cost margin was still positive. In addition, it also shows that during the last year of the
1996 SLA, the SPF lumber market price in the Great Lakes dropped dramatically and reached
the lowest level before the SLA expired. Zhang (2006) pointed out the possible reasons for the
market collapse. The first reason could have been the declining demand for softwood lumber:
during the last year of the 1996 SLA housing starts declined 4.57%, which translated to a
lumber price decline of 26.89% given a price elasticity of demand of -0.17. The second reason
could have been the excess supply of US lumber, which may have resulted from high lumber
prices during the first four years of the SLA. On this point, Zhang (2006) elaborates that “in
the short run, the US producers could continue to use the excess capacity and produce lumber
as long as they could cover at least a proportion of their variable cost.” The third reason might
be because of the oversupply of Canadian lumber exports into the US, which could have been
induced by the use-it-or-lose-it rule of quota allocation imposed under the SLA. Under this
rule, firms have an incentive to fully exhaust quota even when US demand is down. The
fourth reason might be a possible delay in the purchase of softwood lumber by US lumber
buyers who might be expecting lower prices after the expiration of the SLA. Based on these
likely possibilities, market forces and strategic behaviour from both US softwood lumber
producers and consumers could have been mainly responsible for the drop in softwood lumber
price.
Figure 5.1 The FOB mill net price derived from the delivered price in the Great Lakes (deducted CVD, ADD, and transaction cost) and the average production cost ($Cdn/mbf) from April 1996 to September 2006.

However, during the post-SLA, the picture was quite different. The adjusted delivered price was lower or higher than the average production cost, which indicates that Ontario softwood lumber industry either gained or lost. Specifically, the price-cost margin was generally positive from April 2001 to August 2001\(^{43}\) when the US government started to impose CVD on the import of Canadian lumber and from February 2004 to August 2005 due to the strong demand for lumber. During the rest of the period, the profit margin was generally negative. One factor that might have contributed to the decline in lumber prices is the continuous strengthening of the Canadian dollar. Compared to the American dollar, the Canadian dollar strengthened on average by 7.4% from 2004 to 2005, and by 6.8% from 2005 to 2006. The sales price of Canadian lumber on the international markets is negotiated in American dollars. Canadian exporters cannot raise their prices to offset the negative effect of an increasing exchange rate. In addition, the market price was also affected by the combined CVD and ADD imposed on Canadian softwood lumber import. It is unlikely that the producer could be able to

\(^{43}\) From April 2001 to August 2001 is a free trade period. The US government started to impose CVD on Canadian softwood lumber imports in August 2001. The duty from August 2001 to April 2002 was actually bonds that were posted by exporters of record. As a result of the May "no injury" ruling by the US International Trade Commission (USTIC), these bonds were ordered "liquidated" which means they were released back to the exporter and thus the exporter only incurred the cost creating the bonds.
raise the delivered price by the same amount of duties. Economic theory and empirical studies demonstrate that the duties are normally shared by the producers and consumers. By subtracting the CVD and ADD from the delivered price, I assume that the producers could transfer all the duties to the consumers and they still could make profits. Furthermore, individual companies that face dumping allegations have to defend themselves. One practical strategy for them to get rid of ADD is to lower their unit production cost. As average fixed cost decreases with production level, firms can increase their production to reduce their unit cost. Thus, an ADD could have consequences that had not been intended by the US: an increase in the Canadian production that decreased the lumber prices in the US (Zhang 2007).

Figure 5.2 depicts the mill net price in Toronto, which was derived by subtracting the transaction cost from the delivered price of lumber, and the average production cost ($Cdn/mbf). It illustrates four clear business cycles, and each cycle lasted for two to three years. Two of the four cycles occurred during the SLA and two appeared during post-SLA. The mill net price reached the peaks in August 1996, July 1999, May 2001, and August 2004 and dropped to the lowest point in December 1996, February 2001, May 2003 and September 2006. It also shows that the mill net price was generally above the average production costs, but it was below the production cost on occasions. When the industry suffered a loss, it normally lasted for less than a year. Particularly, during the SLA period, the industry suffered a loss from August 1998 to March 1999, from July 2000 to February 2001. During post-SLA, it incurred a loss from September 2002 to July 2003 and from May 2006 to September 2006.
An interesting observation is that the Department’s antidumping investigation covered the period from April 2000 to March 2001, the first administrative review covered the period from May 2002 to March 2003, and the second administrative review covered the period from April 2003 to March 2004. Incidentally, all these periods were at the low points during each business cycle. At the downturn of a business cycle, there were more below cost sales than under normal and good market conditions, the Department could disregard those below cost sales in the determination of fair value of softwood lumber and base the fair value on the higher remaining market prices during the downturns of the business cycles. The dumping margin would therefore be higher with the inflated fair value calculated from the remaining high home market prices. Hence, it is not surprising to obtain a positive dumping margin during these periods.

Figure 5.3 compares the delivered price in the Great Lakes (adjusted for CVD, ADD, and the extra transaction cost) and the delivered price in Toronto. It shows that while the delivered price in Toronto follows closely the adjusted delivered price in the Great Lakes, the latter was substantially higher than the former during the SLA with the price differential ranging from $Cdn80 to $Cdn202 (from $US53 to $US136). However, during the post-SLA, the two prices
were closely the same with one price being above the other, on occasions. Particularly, before January 2004, the adjusted delivered price in the Great Lakes was generally higher than the delivered price in Toronto. However, since January 2004, the adjusted delivered price in the Great Lakes was generally slightly less than the delivered price in Toronto. One possible explanation would be the continuous appreciation of Canadian dollar relative to the US dollar. In facing the continuous appreciation of Canadian dollar, Ontario’s lumber producers could not raise their market prices in the US market to fully absorb the appreciation. This figure indicates that the SLA successfully increased the price of lumber in the Great Lakes market and generated significant quota rent for Ontario’s lumber producers in this market; however, the lumber producers in Ontario after paying all the duties might not have been able to make more profit by exporting to the US market than selling in the domestic market during the tariff regime.

![Graph showing delivered prices in Toronto and the Great Lakes](image)

**Figure 5.3 Comparison of delivered prices in Toronto and the adjusted delivered prices in the Great Lakes. (CVD, ADD and the difference, termed as extra transaction cost, between the transaction costs from mills to the Great Lakes market and to Toronto was subtracted from the delivered price).**

While Figure 5.3 illustrates the possible relationships between the delivered prices of the two markets, it could not provide robust evidence that the delivered price in the Great Lakes market was more or less than the delivered price in the Toronto because the extra transaction cost between the two markets that was deducted from the delivered price in the Great Lakes market was only the estimated mean of the true ETC. The estimation results of the EPBM may
suggest how precisely this estimate for the extra transaction cost would be and what the real relationship between the two delivered prices would likely be. Since the adjusted delivered price in the Great Lakes was greater than the delivered price in Toronto and the price differential was substantial, only regime 3 occurred during the SLA, which suggests that the export price in the Great Lakes was higher than the normal value and would imply that Ontario softwood lumber producers did not dump softwood lumber into the US market; therefore, there is also no need to estimate the EPBM for this period. Hence, the EPBM will only be estimated for the post-SLA covered by the tariff regime.

The EPBM model was estimated using the Simulated Annealing algorithm, which has been proven to have the capability to find the global optimum (see Goffe, Ferrier, and Rogers 1994 and Wu and Wang 1998 for more discussion on the advantages over the conventional optimization algorithms)\textsuperscript{44}.

5.6 Results and Discussion
The estimation results of the EPBM during the tariff regime from April 2001 to September 2006 are reported in Table 5.1. The results show that except for the estimate for the standard error of $U$, $\sigma_u$, virtually all estimates are statistically significant at the 1% level, with one, the probability of regime 3, $\lambda_3$, statistically significant at the 5% level. The results also indicate that 54.3% of the observations (about 36 months) fell into regime 1, 24.4% of the observations (about 16 months) fell into regime 2, and 21.3% of the observations (about 14 months) fell into regime 3. When the observations fell into regime 2, the average difference between the price differential and the ETC (that is, the average positive dumping margin) is $\text{Cdn}30/\text{mbf}$. When the observations fell into regime 3, the average difference between the price differential and the ETC (that is, the average negative dumping margin) is $\text{Cdn}65/\text{mbf}$. The estimate for $\sigma_e$ is $\text{Cdn}10/\text{mbf}$ which indicates that there had been a substantial fluctuation in the ETC. In addition, the results show that the estimate for $\sigma_{eu}$ is only $\text{Cdn}2/\text{mbf}$, which suggests that when the price differential was below the ETC, the variation in the difference between the price differential and the ETC was rather small. This estimate nonetheless, is not statistically

\textsuperscript{44} The EPBM is estimated using the statistical software GAUSSX8.0.
significant. On the other hand, the estimate for $\sigma_{ev}$ is $\text{Cdn}40/\text{mbf}$, which indicates that when the price margin was above the ETC, the variation in the difference was substantial.

Table 5.1 Estimation results of the Enhanced PBM during the tariff regime (April 2001 – September 2006).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>EPBM</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>SE</td>
<td>t-statistic</td>
</tr>
<tr>
<td>$\lambda_1$ (Regime 1)</td>
<td>0.543</td>
<td>0.13</td>
<td>4.11 ***</td>
</tr>
<tr>
<td>$\lambda_2$ (Regime 2)</td>
<td>0.244</td>
<td>0.07</td>
<td>3.30 ***</td>
</tr>
<tr>
<td>$\lambda_3$ (Regime 3)</td>
<td>0.213</td>
<td>0.10</td>
<td>2.14 **</td>
</tr>
<tr>
<td>U</td>
<td>30.00</td>
<td>3.47</td>
<td>8.64 ***</td>
</tr>
<tr>
<td>V</td>
<td>65.00</td>
<td>23.01</td>
<td>2.82 ***</td>
</tr>
<tr>
<td>$\sigma_e$</td>
<td>10.00</td>
<td>1.97</td>
<td>5.07 ***</td>
</tr>
<tr>
<td>$\sigma_{eu}$</td>
<td>2.00</td>
<td>6.70</td>
<td>0.30</td>
</tr>
<tr>
<td>$\sigma_{ev}$</td>
<td>40.00</td>
<td>10.03</td>
<td>3.99 ***</td>
</tr>
<tr>
<td>n</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-316.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: SE: Standard error; ***, ** and * indicate significant at the 1%, 5% and 10% levels, respectively.

Figure 5.4 illustrates the three regimes of the EPBM for the tariff regime. It shows that most observations during this period fell into Regime 1 (at the parity bounds). The observations that fell into Regime 2 (inside the parity bounds) occurred during the later period and the observations that fell into Regime 3 (outside the parity bounds) occurred at the beginning of the period. Using the monthly export data and the average negative dumping margin (for Regime 3), I calculated the total of negative dumping margin, which is $\text{Cdn}153.19$ million more from the US market than they would have obtained from Toronto market during this period. When the difference between the price differential and the ETC is negative (for Regime 2), the positive dumping occurs and the total of positive dumping margin is $\text{Cdn}73.08$ million, thus the industry lost $\text{Cdn}73.08$ million more by exporting the products to the Great Lakes than they would have if products were sold in Toronto. Therefore, the Ontario softwood lumber industry had gained more profit by exporting lumber to the Great Lakes market, and the average dumping margin
should have been negative, even after deducting the CVD and ADD from the delivered prices in the Great Lakes during the period covered by the tariff regime.

Figure 5.4 The three regimes of the EPBM: Regime 1 indicating that the price differentials were equal to the extra transaction costs (ETC); Regime 2 indicating that the price differentials were less than the ETC; and Regime 3 showing that the price differentials were more than the ETC.

The finding of this study is contrary to the finding of the Department on dumping and on the calculation of the margin of dumping. It is not unexpected given the different approaches used. For the well-known reasons, the Department’s calculation of dumping margins is more likely to be statistically biased measures of the true value of dumping margin (Boltuck, Francois, and Kaplan 1991).

The first bias comes from the determination of normal value as mentioned earlier. By disregarding the home market sales that were below the cost of production, the margin of dumping was higher than what it should have been if all the home market prices were taken into account. The second bias is resulted from the use of the zeroing method. By excluding the sales in the US that were above the normal value, the margin of dumping was further inflated. Another issue as pointed out earlier is the Department’s unilateral choice of the timing and time span of the investigation and the administrative reviews. The investigation and
administrative reviews only covered one year period, which is consistent with the WTO rules and US antidumping law, but ignores the market situations of softwood lumber. As indicated in Figures 5.1 and 5.2, both markets are subject to wide price swings during the whole period. When the prices reach the low point due to decreased demand, it is not surprising to find that export prices are below the home market price or the cost of production. The period of investigation covered the year from April 2000 to March 2001 when the market was at the low point. If the investigation had included one year earlier, the Department could have possibly found no dumping or extremely low dumping margin even if the zeroing method had been applied. Similarly, the subsequent two administrative reviews covered the periods from April 2002 to March 2003 and from March 2003 to April 2004, during both of which the market experienced downturn. Figure 5.1 and Figure 5.2 also show that each business cycle in the softwood lumber industry lasted as least two years, which is significantly longer than the one year covered by the investigation for dumping and the administrative reviews. Obviously, the time period covered by the investigation or administrative reviews is too short to account for the longer business cycle of the softwood lumber industry, and the timing of the investigation has also put into question the reliability of the dumping margin calculation. Based on these considerations, it is therefore hard to draw an appropriate conclusion on the dumping issue.

5.7 Conclusion and Policy Implications
The results of this study show that for the period covering the 1996 Softwood Lumber Agreement, the market price in the Great Lakes, even after taking into account the effect of export tax, had always been greater than the market price in Toronto. This evidence strongly suggests that Ontario’s softwood lumber producers did not dump the product into the US market, specifically the Great Lakes market. Even after the CVD and ADD were removed from the delivered prices in the Great Lakes market, the industry seems to have gained more profit from the Great Lakes market than from the Toronto market. Thus, it can also be argued that Ontario softwood lumber producers did not dump softwood lumber into the US markets during the post-SLA period. This analysis therefore contradicts the view of the US Department of Commerce that dumping has occurred during the period covering the 1996 SLA, which had been the basis for the US imposition of antidumping duties during the subsequent tariff regime after the expiration of the SLA.
The difference in the conclusions on the occurrence of dumping is the result of different perspectives and methods used to determine the margin of dumping. The conclusion of this study is supported by an economic analysis compared to the one made by the Department replying on flawed methods as ruled by NAFTA and WTO. This softwood lumber antidumping case therefore demonstrates the flaws in the Department’s applications of US antidumping law. During this trade dispute, the Department has manipulated the US antidumping law under the political pressures from the Coalition in order to find positive dumping margins. The US trade laws are subject to manipulation and political pressure due to their imprecise and vague languages. Therefore, this trade dispute demonstrates a need to modify the US trade laws in order to draw correct conclusion. However, due to the strong support from the industries, especially those that enjoy strong political power, to the US antidumping law, it is unlikely that the US government can easily or is willing to change its antidumping law unless the legal foundation of this law - the WTO Antidumping Agreement - has been amended. Therefore, it is necessary to reform the WTO antidumping rules first in order to enforce its members to amend their antidumping law and draw sound conclusion on the occurrence of dumping. In fact, scholars at the Cato Institute have published several studies that discuss the flaws in the current WTO antidumping rules and offering twenty-one recommendations for reform (Lindsey and Ikenson 2002a, 2002b). If at least some of these recommendations are accepted by the WTO members and incorporated in the WTO Antidumping Agreement, the number of requests for an antidumping action will be dramatically reduced. This is because the firms understand that they are more unlikely to succeed under the new rules when the foreign firms do not engage in dumping. This study supports at least two of the recommendations by Lindsey and Ikenson (2002a, 2002b).

First, the article 2.2.1 of the WTO should be rewritten to clarity that under most circumstances, sale below the average cost of production should not be disregarded automatically. Only under specific conditions, for instance, sales of damaged goods, should these exclusions be allowed.
Second, the WTO Antidumping Agreement should be amended to prohibit the zeroing practice at any point in antidumping proceedings. In the determination of dumping margins, when export prices are higher than normal value they should be given their exact value when averaged in with other export prices.

In addition to the above two recommendations, this study also suggests that the “extended period of time” stated in the WTO Antidumping Agreement rule be extended to a longer period of time for the industries which are characterized by business cycles. Specifically, it should cover a sufficient number of years to take into account the business cycles.
CHAPTER VI

CONCLUSIONS, POLICY IMPLICATIONS, LIMITATIONS AND FUTURE WORK

6.1 Conclusions

The long-lasting and contentious softwood lumber trade dispute between Canada and the US has centred on the debate over the existence of a stumpage subsidy in Canada and more recently on the existence of dumping by Canadian softwood lumber producers in the U.S. markets. Thus, to find a long-term solution to this trade dispute, it is necessary to examine whether the stumpage systems used in the Canadian provinces set stumpage prices that were below the market level and therefore constitute subsidies to the softwood lumber industry and whether dumping has indeed taken place using some theoretically sound economic methods. Few empirical studies have been conducted to address these two issues. This research is therefore carried out and economic analyses of Ontario’s stumpage system are conducted to examine these issues. The results of these analyses together indicate the competitive level of the stumpage prices determined under Ontario’s current stumpage system. The first essay examines the sensitivity of the stumpage prices of SPF and white pine and red pine timber administratively determined to the changes in the market prices of lumber, pulp, and wood composites by testing the co-integration and Granger causality relationship between the relevant price series. The second essay estimates the discrepancy between the administratively determined stumpage prices of SPF timber used for producing lumber and its market values, estimates the economic rent captured by Ontario’s stumpage system, investigates the subsidy issue in Ontario, and compares the market performances of the residual value approach based stumpage systems and auction-based systems. The third essay investigates the possibility of dumping by Ontario’s softwood lumber producers in the U.S. market. The major conclusions of these analyses include:

First, the stumpage price of SPF timber for lumber is co-integrated with its reference price, which is a one-month lagged market price of SPF lumber in the U.S. and Canadian markets. In
addition, the reference price Granger causes the stumpage price, but the reverse direction of
the Granger causality does not exist. These results provide evidence that the stumpage price
paid by the lumber industry, for SPF timber, responds to changes in the market price of
lumber and thus has the potential to reflect the market value of timber in the long run. They
also imply that the market price of lumber has not been affected by the stumpage price with
significant degree. Therefore, any attempt by Ontario’s government to increase the stumpage
prices will only increase the production costs of lumber producers, but not lead to higher
market prices of lumber. In addition, the stumpage prices in Ontario did not have a distorting
effect on the lumber market.

Second, the stumpage price of SPF timber for composites is also co-integrated with the market
price of wood composites. Thus, the stumpage price of SPF timber for composites reflects the
market values of the end products to some degree in the long run. However, the Granger-
causality is running from the stumpage price to the market price, which means that the
stumpage price does not respond to the changes in the market price quickly. Therefore,
stumpage price will not be able to capture the additional rent when market price of composites
increases.

Third, the market price of pulp Granger causes the stumpage price. Hence, in the case of pulp
also, the stumpage system is able to capture the additional rent from timber when pulp
markets are favorable.

Fourth, co-integration and Granger-causality relationships do not exist between the stumpage
prices and the market prices of lumber for white pine and red pine timber, which suggest that
the stumpage price does not respond with significant degree to the changes in the market price
of white pine and red pine lumber. Therefore, the stumpage price is likely to be different from
the true market value and can not capture the full economic rents in the long run.

Fifth, the market price of pulp does not Granger cause the stumpage price of white pine and
red pine, which implies that the stumpage price will fail to capture the additional rent from
timber when the market price of pulp rises.
Sixth, I cannot make any sound inference about the relationship between the stumpage price of white pine and red pine timber for composites and the market price of composites on the basis of the different stationarity properties of the two series.

Seventh, the results from the estimation of EPBM show that in a specific month or for a short term, the stumpage price of SPF timber used to produce lumber was either below or above the market value; however, in the long term, the underpayment and even-payment will even out each other. Therefore, it provides further evidence that Ontario’s stumpage system can capture the full economic rents in the long term and it does not confer a subsidy to the softwood lumber industry in Ontario in the long term. In addition, Ontario’s stumpage system is as good as the “Market Pricing System” used in British Columbia in terms of reflecting the market value of SPF timber for producing lumber.

Eight, the analysis for the possibility of dumping by Ontario’s softwood lumber industry in its major U.S. market indicates that during the period in study the industry gained considerably more profit from the U.S. market than from the home market. Based on this economic evidence and the context by which the U.S. antidumping investigation and administrative reviews were conducted, a conclusion can be drawn that the Ontario softwood lumber industry did not dump softwood lumber into the U.S. market during the period in study.

In summary, Ontario stumpage system can capture the full economic rents realized by the use of SPF timber for producing lumber in the long run; therefore, the administrative stumpage price was equal to the true market value on average in the long run and does not confer financial benefits to the softwood lumber industry. It might have also generated competitive market level stumpage prices of SPF timber used to produce pulp. However, the stumpage system might have failed to establish the competitive market-level stumpage prices for SPF timber used to produce composites and for white pine and red pine timber used to produce lumber and pulp. Nevertheless, due to lack of production cost data on the pulp and composites sectors, definite conclusions cannot be drawn. To perform an overall evaluation on the market performance of Ontario’s stumpage system, detailed and accurate data on the cost of product,
at least for some periods, are needed to draw appropriate conclusions. This also reveals the drawback of Ontario’s stumpage system, that is, the effectiveness of the system to set stumpage prices that are close to the market value depends on accurate cost data. But some forest product firms are not willing to reveal their cost data to the government. In that case, the government has to estimate the production cost in order to determine the stumpage prices. If such estimates misrepresent the real cost, then the stumpage prices determined based on these estimates will be different from the true market values. Therefore, the government needs to ensure that forest product companies consistently report to government on an annual basis all cost information necessary to improve the effectiveness of stumpage pricing system in establishing efficient stumpage prices. Nevertheless, the results from the analysis for the lumber industry indicate that Ontario’s system can be efficient in collecting the full economic rents over a period of time and the administrative stumpage prices are market sensitive.

6.2 Policy Implications

Some policy implications are drawn from these analyses:

First, during the period from April 1996 to February 2005 when the softwood lumber trade was restricted by the tariff-regulated quota regime (1996 SLA) and the subsequent tariff regime, the U.S. softwood lumber prices increased due to export tax and import duties imposed by the Canadian or U.S. government, the stumpage price of SPF timber for lumber was increased accordingly in Ontario. This means that the Ontario’s softwood lumber producers paid tariffs as well as higher stumpage prices than without these trade restrictions.

Second, the co-integration between the stumpage price of SPF timber for lumber and its reference prices also indicates that the government-controlled but market-based stumpage system of Ontario is performing well with respect to softwood lumber (for SPF timber), and may continue to perform well as long as there are no government induced market imperfections in the softwood lumber market such as import or export tariffs and quota regime on softwood lumber exports.
Third, Ontario’s modified RV-based stumpage pricing system may be better than the conceptual RTV system on some aspects of sustainability. The residual value component complies with the economic theory in the absence of competitive markets and links the value of standing timber closely to the prices of final products and their manufacturing costs that are determined in competitive markets. The monthly adjustment to the residual value component improves the market sensitivity of the system. The inclusion of the minimum rate ensures that the Ontario government receives a stable and predictable stream of revenue and tempers the severe swings that can be caused by volatile lumber prices. In addition, the renewal charge component ensures funding for regeneration and protection of forests. In fact, the deviation from the conceptual RTV system might also result in the function of the stumpage system of discouraging dumping behavior of softwood lumber producers. Under the current system, softwood lumber producers would lose money from the output market and pay a high stumpage price if they dumped lumber into its major U.S. market. However, if they charged high prices when the market conditions allow, they would make more profits from the output markets and pay low stumpage prices as well. It seems to make more economic senses for the producers to charge high prices if market conditions are favorable when facing the current stumpage system.

Fourth, the comparison of the market performances of Ontario’s current stumpage system and the MPS in BC implies that the former is as good as the latter, especially in Northern Ontario where the competition between timber processors is limited, in terms of the ability of reflecting the true market value. It also indicates that there is no guarantee that stumpage prices will rise if Ontario adopts the MPS, especially in areas where there is only one or a few possible buyers. It is possible that stumpage prices will rise in some areas where there is more competition and decrease in other areas where are characterized by one significant buyer, with the overall results similar to the current system. U.S. softwood lumber producers will certainly not keep silent if the softwood lumber producers pay less for stumpage under the new system. Even though the 2006 SLA provides a provision that if and when a Region uses market-determined timber pricing and forest management systems, its exports of softwood lumber products to the U.S. qualify for exemption from the export measures, substantive criteria need to be developed by a Working Group that should be established within three months after the
effective date of the SLA. It is unclear whether these criteria will be developed in time and implemented smoothly. The history of this trade dispute indicates that the Coalition will unlikely allow this to happen unless the market shares of the lumber producers in the Coalition are guaranteed to maintain after the Canadian provinces are exempted from the trade measures.

Fifth, as deviation of the actual stumpage price from its true value may happen under any stumpage system (auction-based or RV-based) partially due to the constant fluctuations of softwood lumber market prices, short-run deviation should not be used to judge the sufficiency of any stumpage or as the evidence of a financial subsidy. Instead, sufficiency should be determined based on the long-run behavior of the stumpage prices.

Sixth, although this analysis is based on Ontario, it may be relevant to the other provinces in Canada, for instance, Alberta and Quebec, where have similar forest ownership and industry structure and from which lumber export was controlled by trade restrictions. If similar results were obtained from this type of analysis, these results can be used as scientific evidence to support Canada’s argument on the subsidy issue. However, if the specific system is not efficient according to the analysis, the government may consider improving its system by revising the parameters or even the structure of the system used.

Seventh, as the softwood lumber producers in Ontario did not dump lumber in their major U.S. market, the market prices of lumber used to determine the residual value component of the stumpage prices represent competitive market prices. Therefore, the stumpage prices of SPF timber were not artificially depressed by the softwood lumber producers. This further proves that Ontario’s stumpage system needs not to be changed.

Eighth, this trade dispute demonstrates the need to reform the WTO antidumping policies. Specifically, the article 2.2.1 of the WTO should be rewritten to clarity that under most circumstances, sale below the average cost of production should not be disregarded automatically for determining the normal value; the WTO Antidumping Agreement should be amended to prohibit the zeroing practice at any point in antidumping proceedings; and the
“extended period of time” stated in the WTO Antidumping Agreement rule should cover a sufficient number of years to take into account the business cycles occurring in the industry under investigation.

This thesis has focused on the economic performance of Ontario’s stumpage pricing system and addressed the subsidy and dumping issues in the U.S.-Canada softwood lumber trade dispute from Ontario’s perspectives. The main results of the economic analyses have supported Canada’s position in this trade dispute, like those of the previous studies by resource economists. Therefore, they might be used as empirical evidence to support Canada’s argument in the next litigation after the 2006 SLA expires or is terminated. However, it is uncertain how much value these results can have to the Canadian government in the next litigation because it is highly likely that USDOC will ignore these results and use its own method to determine the existence of a subsidy in Canada under the political pressure from the softwood lumber industry in the U.S.

On the surface, this trade dispute is about the differences in the timber pricing in the two countries; however, underneath it is a war between the softwood lumber industries in the two countries for seeking economic rents. As McKinney (2004) insightfully stated, “Fundamentally, this dispute is not about differences in resource pricing. Rather, differences in resource pricing have made a convenient target for the US lumber industry in its efforts to gain protection.” The U.S. softwood lumber industry is well aware that Canada has great potential for expanding its production of this product given the fact that Canada has more softwood growing stock than the U.S. Classic international trade theory suggests that resource endowment is the foundation of comparative advantage, and comparative advantage leads to product and trade specialization. If everything else is equal, Canada could, hypothetically, have about 59.5% of the softwood lumber production in North American and a 49.5% share of US lumber consumption if this trade is not restricted (Zhang 2007).

More importantly, on a per capital basis, Canadians have a much bigger advantage to the Americans, a 13-to-1 ratio in softwood timber resource endowment. Given such an absolute advantage in softwood lumber resources, it is no surprise that Canada would have lower
stumpage price than the US and would have taken an increasing share of the US market in the past few decades (Zhang 2007).

The fear that Canadian producers will increase output under free trade is no doubt a major motivating factor for the U.S. industry pursuing trade remedy measures to limit imports of Canada softwood lumber. Either of the trade measures - import duties, quota, and export taxes, could restrict the imports and limit the market share of Canadian lumber, increase the lumber price in the US, and improve the economic positions of the US producers.

To seek protection from the increasing imports of Canadian softwood lumber, the US softwood lumber producers became organized, formed the Coalition for Fair Lumber Imports and have played interest group politics. The Coalition has succeeded in making some lawmakers to exert pressure on the U.S. administration when necessary. A major group of U.S. senators, mostly from the lumber-producing states in the Pacific Northwest and South, with other senators, who exchange political favors with them, have sometimes constituted a voting majority that could not be ignored by any U.S. president (Zhang 2007). These senators help initiate changes in the U.S. trade laws that provide benefits to the Coalition. Under political pressures and U.S. trade laws, the USDOC and USTIC have used ever-shifting, result-driven methodologies, which are repeatedly ruled illegal by the NAFTA and inconsistent with the WTO rules by the WTO, in their investigations for subsidy, dumping, and material injury (Zhang 2007).

Various studies have shown that the softwood lumber producers in the U.S. benefited tremendously from this trade dispute mainly at the expenses of U.S. lumber consumers, for example, Zhang (2001), Zhang (2006), and van Kooten (2002). It is conceivable that US lumber consumers, who suffered great loss in this trade dispute, should become organized to exercise offsetting political influence of the Coalition. However, the U.S. lumber consumers are scattered across the country and across the industries, they could not provide the U.S. congress something that are significant enough to counterbalance the Coalition in this trade dispute. This has directly resulted in restrictive measures on Canadian lumber imports in the past two decades (Zhang 2007).
The U.S. market is a major market for the Canadian lumber producers; therefore, secure access to the U.S. market is critical to the Canadian producers. During this trade dispute, the Canadian federal and provincial governments defended their stumpage programs and challenged the affirmative determinations of the USDOC and USITC on the subsidy, dumping, and threat of injury issues under the political pressure from the softwood lumber industry. However, the problem for the Canadian lumber industry is that it is fragmented at both the provincial level and the regional levels. Canada had at least five distinguishable industry groups in this dispute – the Maritime Provinces, Quebec, Ontario, coastal British Columbia, and interior British Columbia, which care only their own interests. It is difficult to coordinate these groups to form a united position. In addition, Canada highly depends on U.S. markets and secure access to U.S. markets is important to the Canadian government. This has also influenced Canada’s official position on lumber trade. Canada has received mixed but mostly favorable rulings from both the WTO and NAFTA dispute settlement panels. Nonetheless, a negotiated settlement of soft sort appears inevitable. At times, the Canadian government was willing to make peace with the US and sign a negotiated agreement (Zhang 2007). This has also contributed to the longevity of this trade dispute.

As pointed out by Zhang (2007), this trade dispute involves many issues in complicated political, economic, legal, and institutional settings, and the mix of these issues has made this dispute long and sometimes bitter and acrimonious. Based on lessons learned from the history of this dispute, Zhang (2007) proposes several possible long-term solutions to this dispute. Similar to the conclusion of this research, Zhang (2007) casts doubt on the possibility that a U.S.- style stumpage system in Canada would provide a long-term solution to this trade dispute. He suggests that the most likely long-term and durable solution would involve a series of short-term negotiated deals, coupled with a mutually recognized long-term agreement on an exit ramp leading to free trade and a binding dispute resolution system, and a negotiated long-term settlement, based on moderate and reasonable Canadian trade restrictions that are simple to implement.
6.3 Research Limitations and Future Work

While the economic analyses in this research provide useful results that indicate the competitive level of the stumpage prices determined under Ontario’s current stumpage pricing system, they suffer some limitations mainly due to lack of more detailed required data.

First, in the fourth chapter on the rent capture analysis of Ontario’s stumpage system, I examine the discrepancy between the stumpage prices determined under Ontario’s current stumpage system and the conceptual market level at the provincial level. Thus, these results have meaningful policy implications at the provincial level. However, they do not provide inference about the competitive level of the stumpage prices for individual forest management unit in Ontario. The analysis for each forest management unit could be done if related cost data were available.

Second, in the same chapter, the cost data used to determine the RTV obtained from OMNR were collected almost ten years ago. With the restructuring and consolidation taking place and the increase in the harvesting and energy costs, it may be necessary for OMNR to update the cost data to improve the effectiveness of the current stumpage system in determining market-level stumpage prices. When the updated data are available, the same analysis can be conducted to provide more robust and convincing results.

Third, in the fifth chapter on the determination of dumping by Ontario’s lumber producers, I use the aggregate of the SPF lumber products, instead of individual products, in the Great Lakes and Toronto markets due to the lack of transaction costs data at the individual product level. Future study could perform this analysis at the individual product level and aggregate the results from all individual products to draw the conclusion on the margin of dumping. Such analysis should provide richer information than the analysis at the aggregated level.
Fourth, I address the dumping issue at the provincial level, not at the individual producer/company level because the market prices of the SPF lumber products of each producer are not available.

Fifth, the fourth chapter of this thesis compares the market performance of Ontario’s stumpage system and BC’s MPS to draw inference whether Ontario should change the current system to improve its ability to reflect market value of timber. Although the results from this analysis suggests that Ontario should not change the current system solely for responding to the US complaint, it does not suggest that Ontario should not introduce the MPS in some areas where there is sufficient competition. If Ontario government decides to introduce the MPS in some areas in Northern Ontario to strengthen its future bargaining and legal position with the U.S., it would be interesting to study which system (the RV system vs. the MPS) indeed performs better in terms of reflecting the market value in those areas in the future. In addition, it will be useful to study how to improve the MPS to make it more suitable for different levels of competition in Ontario.
LITERATURE CITED


certain softwood lumber from Canada: comments for the preliminary determination.”
Washington, D.C., USA


### Appendix I: Quarterly average of the SPF stumpage and reference prices

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