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economics

A Computable General Equilibrium Analysis of the United States-Canada 2006 Softwood Lumber Agreement

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We use a global dynamic multiregional computable general equilibrium model to analyze the comparative economic impacts of the 2006 softwood lumber agreement between Canada and the United States over the 2007–2013 period and the extent to which Canadian Provinces made a favorable choice of export tax border measure options. Results show that the agreement was effective in curtailing Canada's softwood lumber entry into the United States market. It benefited the United States producers through increased stumpage rates, whereas the United States consumers lost marginally in welfare due to increased price index while gaining in household income. Canadian producers compensated for their loss of market share in the United States by redirecting their exports to rest of the world market. All Canadian Provinces except Saskatchewan and Ontario made a favorable choice of the export tax border measure options from a consumer welfare perspective. However, alternative export border control measure choices could have had more favorable impacts on other economic variables in these and other Provinces.

Keywords: computable general equilibrium, softwood lumber dispute, export tax, export quota, economic impacts

United States-Canada bilateral trade in softwood lumber is the subject of long-standing and persistent disputes, negotiations, and limited term agreements that have been going on for more than two centuries, dating back to 1789 (Devadoss et al. 2005).[1] The disputes have typically centered around the United States claims that fees charged for harvesting softwood on public lands (i.e., stumpage) by certain Canadian provincial governments are artificially low and that these constitute countervailable subsidies (Gulati and Malhotra 2006).

In the latest round of negotiations, Canada and the United States signed the 2006 Softwood Lumber Agreement (SLA) (United States Trade Representative [USTR] 2014). The SLA came into force from October 2006 for an initial seven-year term; in 2013, it was extended for two additional years, until October 2015. After the expiry of the agreement, both the United States President Barack Obama and Canadian Prime Minister Justin Trudeau, speaking at a joint press conference in March 2016, said the issue came up at their White House meeting but that negotiations were ongoing. President Obama was quoted in *The Globe and Mail* to say "This issue of softwood lumber will get resolved in some fashion…. It's been a longstanding, bipartisan irritant," although neither side is likely to get everything they are seeking in the final deal. Currently negotiations for new agreement is ongoing between the two countries.

Under the 2006 agreement, Canada imposes a varying export tax on Canadian lumber exported to the United States when the price of lumber is at or below US$355 per thousand board feet (MBF) (US$ 150.50/m^3). This export charge is expressed as a percentage of the price of the product being exported. The lumber price in this case is a weighted average of 15 structural lumber prices as provided for in SLA Annex 7A (USTR 2014), commonly known as Framing Lumber Composite (FLC) prices produced by Random Lengths (2012). Export charge revenues collected by the Government of Canada are distributed to the Provinces, minus costs associated with SLA implementation and administration.

To implement the export charge, there are two border control measure options available for Provinces to choose from. Option A is an export charge, with the charge varying with the FLC prices. If a region under this option exceeds its export volume threshold by more than 1% in any given month, all exports in that month are subject to a retroactive additional export charge, equal to 50% of that month's export charge rate (the "surge mechanism"). Option B is an export charge that is lower than that in Option A and

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Table 1. 2006 Softwood lumber agreement export border control measures.

Prevailing monthly price per thousand board feet	Option A: Export charge (%)	Option B: Export charge plus volume restraint
More than US $355	0	0
US $336–355	5	2.5%+ regional share of 34% of US consumption
US $316–335	10	3%+ regional share of 32% of US consumption
US $315 or less	15	5%+ regional share of 30% of US consumption

is combined with a volume restraint (i.e., a quota), where both the rate and the volume restraint vary with the prevailing monthly FLC price.[2] Table 1 provides details of the two border control measures.

The *ad valorem* export tax under this trade agreement excludes the Atlantic Provinces of New Brunswick, Nova Scotia, Prince Edward Island, and Newfoundland; also excluded is softwood lumber originating from the territories (Yukon, Northwest Territories, and Nunavut). Atlantic Provinces are excluded on the grounds that their stumpage pricing systems, the systems through which the provincial governments sell rights to cut standing timber on provincial Crown lands, are "market-determined" and not controlled by the provincial governments. The territories are also excluded as there is no evidence that their stumpage benefits from any government subsidies.

The six Provinces subject to the export tax border measures were invited to choose the option that best meet their needs. British Columbia and Alberta initially chose Option A, whereas Saskatchewan, Manitoba, Ontario, and Quebec chose Option B. Each region can choose to switch option once every 3 years. Throughout the SLA period, all regions retained their original options.

To date, there has been little economic analysis conducted on the 2006 SLA using a global trade model. Specifically, only one study by van Kooten and Johnston (2014) has shed light on the economics of this agreement. Using an integrated log-lumber partial equilibrium global trade model, they considered welfare effects of the removal of the 2006 SLA export restrictions on Canadian lumber exports to the United States. They found that Canadian integrated timber harvesting and lumber processing firms gain some $948.8 million in welfare based on 2010 data, with lumber and log producers in British Columbia receiving the majority of the gains from increased lumber exports to the United States. The United States was estimated to experience a relatively small net loss of approximately $16 million in welfare as Canadian lumber sales shift to the United States market. This resulted largely from consumers receiving a gain of more than $100 million in welfare from lower lumber prices, and producers receiving a loss of more than $150 million in welfare from increased competition by Canadian producers. To some extent, these gains and losses can be simply reversed to get a sense of the economic effects associated with the implementation of the 2006 SLA.

Whereas the van Kooten and Johnston (2014) study shed some light on economic impacts of the SLA, it failed to link impacts of the SLA with those of other sectors of the economy through economywide impact analysis. Through direct and indirect linkages, changes in one sector of the economy not only affects a particular sector (in this case logging and lumber manufacturing sectors) but also many others. Therefore, softwood lumber demand and supply resulting from the SLA have direct, indirect, and induced effects on many (if not all) other sectors of the economy as well (such as wood products manufacturing, pulp and paper, housing construction, and labor demand). As a result, an analytical tool that will capture such intersectoral linkages is required. The computable general equilibrium (CGE) modeling approach is a suitable analytical tool for economic impact analysis of the SLA because of its economywide and market-based approach (Iglesias et al. 2012). A multiregional CGE model in particular is even more appropriate for the analysis as it considers an interactive global economy with interregional trade specified by regions of origin and destination. This allows for the capture of interregional "feedback effects" from global market activities on the region(s) of interest. Both the interregional interactions and feedback effects play a critical role in determining direction and magnitude of economic impacts in each region from exogenous shocks in their own and (or) other regions (Rickman and Schwer 1993, Lofgren and Robinson 2002, Haddad 2009).

As the SLA closed its first seven years by end of 2013, three critical questions that many industry players and policy analysts would ask are the following. First, did the SLA achieve its objective by reducing Canada's share of the United States softwood lumber market, benefiting United States lumber producers, and benefiting Canadian government (households in our analysis) through export tax revenues? If so, to what extent and how did this vary among the regions? Second, did the Canadian regions affected by the SLA make the right decisions by their choice of export tax border measures between Option A and Option B? Third, did the Canadian regions excluded from the SLA gain by the agreement or were they harmed? If so, to what extent and how did this vary among the regions? These research questions lead us to objectives of this study.

The main objective of this study is to assess the regional and global economic impacts of the 2006 SLA over the 2007–2013 period. Here we conduct an *ex post* analysis by retroactively using real export values and export charge rates of Canadian softwood lumber exports to the United States to estimate the comparative economic impacts of the SLA across the regions. Furthermore we determine whether the Canadian regions affected by the SLA had made "favorable" export border control measure choices between Option A and Option B (i.e., what if the regions that chose Option A had opted for Option B instead and vice versa?). We conducted our analysis over the 2007–2013 period using a recursively dynamic, multiregional CGE model. The model included 13 regions: 10 Canadian provinces, the Canadian territories (as one aggregated region), the United States, and the rest of world (RW) region.

To achieve the study objective, two scenarios are defined:

Scenario 1. Implementing export tax charge and quota volumes as per the SLA following each regions' initial (current) options: British Columbia and Alberta initially chose Option A, whereas Saskatchewan, Manitoba, Ontario, and Quebec chose Option B. This scenario is based on *ex post* analysis, which retroactively uses actual data of softwood lumber export values with their corresponding export charge rates (see Tables 4 and 5). As part of this scenario, softwood lumber exports from nonparticipating regions (Atlantic Provinces and the Territories) to the United States are exogenously fixed according to their historical actual export data and they have a zero rated export charge.

Scenario 2. This is a "What-If" analysis in which a reversal of Scenario 1 above is implemented with simplifying assumptions. First, it is assumed that the regions had chosen the opposite export border control measure than what was actually chosen,

such that those that had initially chosen Option A (British Columbia and Alberta) opted for Option B instead, whereas those which had initially chosen Option B (Saskatchewan, Manitoba, Ontario, and Quebec) opted for Option A instead. This scenario further assumes that the original SLA stands throughout the period of study, without amendments.

Methods

The Model

CGE models have been widely used in policy analysis at various levels and scales.[3] We specified a dynamic, multiregional CGE model with three input factors (labor, capital, and stumpage) similar to the recent one by Ochuodho and Lantz (2014) with a few modifications. The regional economies were aggregated into 23 sectors at small (S-level) aggregation following the Northern American Industry Classification System (NAICS) 2002 version.[4] In a recursive dynamic CGE model as in this case, economic agents (producers and consumers) are assumed to be myopic about the future and hence assume that current economic conditions will prevail at all periods in the future (Burfisher 2011). Recursive dynamic CGE models are applied by many government and international institutions in public policy analysis (such as Dixon and Rimmer 2002, Koopman et al. 2002, van der Mennsbrugghe 2005, Gottschalk et al. 2009). Devarajan and Go (1998) show calibration details of a simple dynamic CGE model of open economy and illustrate its application to examine various policy issues, including terms-of-trade shocks and tariff reform.

Our model is deterministic in nature with assumptions of small open economies (price takers) and constant returns to scale technology for each region. The model is formulated as a set of simultaneous linear and nonlinear equations, which defined (1) the behavior of economic agents, (2) market conditions, (3) macroeconomic balances, (4) intertemporal components, and (5) steady-state economic growth path. Ochuodho and Lantz (2014) provide detailed a model description, a graphical sketch of commodities flow, and general representation of the CGE model equations. Other studies that have used similar CGE models for policy analysis include Das et al. (2005), Zhai et al. (2009), and Iglesias et al. (2012).

In this study of a bilateral trade agreement, specification of foreign trade plays a central role in the modeling framework. Therefore, product imports/exports are differentiated according to their region of origin/destination. On the demand (import) side, domestic consumers discriminate between goods at two levels: first discriminating between domestically produced and imported goods and then discriminating between imported goods from different regions. This is known as Armington aggregation through constant elasticity of substitution (CES). Next, we outline key trade and output equations that play significant role in determining the economic impacts of the SLA. Throughout this article, we use subscripts o and d to designate regions (of origin and destination of imports and exports, respectively, in trade equations) and subscript i to designate sector of the economy. A complete listing of model variables and parameters and a general representation of equations can be found in Appendix A (Table A2) of Ochuodho and Lantz (2014).

The domestic demand of domestic output, XDD_{oi} is given by

$$XDD_{oi} = \left(\frac{1}{\phi A_{oi}}\right)^{(1-\sigma A_{oi})} \left(\gamma A_{oi} \frac{PX_{oi}}{PDD_{oi}}\right)^{\sigma A_{oi}} X_{oi} \qquad (1)$$

where X_{oi} is domestic sales of composite commodities, PX_{oi} is the composite export price, PDD_{oi} is the price of domestic sale of domestic output, ϕA_{oi} is the shift parameter in the first level of the Armington function, γA_{oi} is the CES share parameter in the first level of the Armington aggregation function, and σA_{oi} is the Armington substitution between aggregate imports and domestic output.

The aggregate import demand, IMP_{oi} is defined by

$$IMP_{oi} = \left(\frac{1}{\phi A_{oi}}\right)^{(1-\sigma A_{oi})} \left((1 - \gamma A_{oi}) \frac{PX_{oi}}{PM_{oi}}\right)^{\sigma A_{oi}} X_{oi} \qquad (2)$$

where PX_{oi} is the composite commodities demand price and PM_{oi} is the domestic price composite imports.

The consumer Armington CES cost minimization constraint that govern the two equations above is given by

$$PX_{oi}X_{oi} = PDD_{oi}XDD_{oi} + PM_{oi}IMP_{oi} \qquad (3)$$

such that the consumer will buy more from the source (domestic or import market) with lower cost.

The CES aggregation function of imports by origins and destinations, MO_{iod}, is given by

$$MO_{iod} = \left(\frac{1}{\phi M_{di}}\right)^{(1-\sigma M_{di})} \times \left(\gamma M_{iod} \frac{PM_{di}}{(1 + tmo_{iod})\, EXR_d PWMO_{iod}}\right)^{\sigma M_{di}} IMP_{di} \qquad (4)$$

where

$$\sum_{o=1}^{n} \gamma M_{iod} = 1$$

where γM_{iod} is the share parameter in the second level of the Armington aggregation function, ϕM_{oi} is the shift parameter in the second level of the Armington aggregation function, σM_{oi} is the substitution parameter of imports from different origins, tmo_{iod} is the import tariff rate, EXR_d is the exchange rate, $PWMO_{iod}$ is the world cost, insurance, and freight (c.i.f.) import price by origin and destination, and PM_{di} is the import price.

The cost-minimization constraint of consumer for aggregated imports from various origins is given by

$$PM_{di}IMP_{di} = \sum_{o=1}^{n} \left((1 + tmo_{iod})\, EXR_d PWMO_{iod} MO_{iod}\right) \qquad (5)$$

On the supply (export) side of the transactions, the export decision of producers is governed by a constant elasticity of transformation (CET) function, which distinguishes between exported and domestic goods such that domestic supply of domestic output, XDD_{oi}, is defined by

$$XDD_{oi} = \left(\frac{1}{\phi T_{oi}}\right)^{(1-\sigma T_{oi})} \left(\gamma T_{oi} \frac{PP_{oi}}{PDD_{oi}}\right)^{\sigma T_{oi}} XD_{oi} \qquad (6)$$

where XD_{oi} is domestic production (output), PP_{oi} is the producer output price, PPD_{oi} is the price of domestic sale of domestic output, ϕT_{oi} is the shift parameter in transformation function, γT_{oi} is the CET share parameter in the transformation function, and σT_{oi} is the CET substitution elasticity between domestic and export markets.

The export demand of domestic output, EXP_{oi} is defined by

$$EXP_{oi} = \left(\frac{1}{\phi T_{oi}}\right)^{(1-\sigma T_{oi})}\left((1 - \gamma T_{oi})\frac{PP_{oi}}{PE_{oi}}\right)^{\sigma T_{oi}} XD_{oi} \quad (7)$$

where PE_{oi} is domestic composite export price.

The producer profit maximization constraint that governs the two equations above is given by

$$PP_{oi}XD_{oi} = PE_{oi}EXP_{oi} + PDD_{oi}XDD_{oi} \quad (8)$$

such that the producers will sell more to the destination (domestic or export market) with higher returns. To ensure zero global foreign savings, regional composite export, EXP_{oi}, is given by the sum of all imports purchased from the region by the importing regions such that

$$EXP_{oi} = \frac{1}{PE_{oi}}\sum_{d=1}^{n}\left(\left(\frac{EXR_o}{1 + teo_{iod}}\right)PWEO_{iod}MO_{iod}\right) \quad (9)$$

where teo_{iod} is export tax and $PWEO_{iod}$ is the world free on board (f.o.b.) export price.

The regions of commodity origin (o) and destination (d) are significant in the pricing system. The export price reflects the price received by the domestic producers for selling their output on the foreign market, whereas the world export price is the f.o.b. price that already includes export tax such that

$$PWEO_{ido} = (1 + teo_{iod})\left(\frac{1}{EXR_o}\right)PE_{oi} \quad (10)$$

Bilateral trade flows between the 13 regions specified in the model are captured through import by source and export by destination equation specifications.

Production block is governed simultaneously by Equations 11–14 below. First, factor demand by firm is given by

$$FAD_{oif} = \left(\frac{1}{\phi V_{oi}}\right)^{(1-\sigma V_{oi})}\left(\gamma V_{oif}\frac{PVA_{oi}}{PF_{of}}\right)^{\sigma V_{oi}} VAD_{oi} \quad (11)$$

where $\Sigma_{f=1}^{3}\gamma V_{oif} = 1$, f denotes labor and capital for all sectors and stumpage for forest sector only, FAD_{oif} is factor demand, VAD_{oi} is composite value-added, PF_{of} is factor price, PVA_{oi} is composite value-added price, ϕV_{oi} is shift parameter in the composite value-added input function, σV_{oi} is elasticity of substitution in the composite value-added function, and γV_{oif} is the share parameter in composite value-added input function.

The composite value-added demand function is given by the equation

$$VAD_{oi} = \left(\frac{1}{\phi P_{oi}}\right)^{(1-\sigma P_{oi})}\left((1 - \gamma P_{oi})\frac{PD_{oi}}{PVA_{oi}}\right)^{\sigma P_{oi}} XD_{oi} \quad (12)$$

in which ϕP_{oi} is shift parameter in total cost (production) function, σP_{oi} is elasticity of substitution between the composite value-added input and the composite intermediate input, γP_{oi} is share parameter in total cost (production) function, and XD_{oi} is domestic production (output).

Composite intermediate input demand, IDE_{oi}, is given by equation

$$IDE_{oi} = \left(\frac{1}{\phi P_{oi}}\right)^{(1-\sigma P_{oi})}\left(\gamma P_{oi}\frac{PVA_{oi}}{PID_{oi}}\right)^{\sigma P_{oi}} XD_{oi} \quad (13)$$

where PID_{oi} is intermediate input price.

Zero profit condition for the firm is defined by equation 14:

$$PP_{oi}XD_{oi} = PVA_{oi}VAD_{oi} + PID_{oi}IDE_{oi} \quad (14)$$

such that producers will substitute between value-added and intermediate inputs to reduce costs.

Gross domestic product (GDP) can be estimated either from the input (value-added) side at factor prices or from the output (final demand) side. At equilibrium, both sides balance. In this study, we estimate GDP from the final demand side by summing final demand consumption (C_{oi}) factored by its price (PC_{oi}), investments (I_{oi}), and exports less imports factored by exchange rate (EXR_o) as in Equation 15:

$$\mathrm{GDP}_o = \sum_{i=1}^{23}((PC_{oi}C_{oi}) + I_{oi}) + \sum_{i=1}^{23}((PE_{oi}E_{oi}) - (PM_{oi}M_{oi}))\,EXR_o \quad (15)$$

Observed GDP impacts on tariff shocks are therefore attributed to changes in both levels and prices of these GDP components from both final demand and value-added sides.

Data, Model Calibration, and Scenarios

We calibrate the model following procedures and data sources in Ochuodho and Lantz (2014), with a few modifications. Specifically, the model is calibrated to 13 regions composed 11 Canadian regions (10 Provinces and the Territories),[5] the United States, and the rest of the world using 2006 baseline industry accounts input-output (IO) data, before the softwood lumber agreement came into effect in 2007. In terms of parameter specifications, elasticities of substitution in the composite value-added function and income elasticities of demand for commodities are obtained from Dimaranan et al. (2006). Armington CES and CET parameters, along with import tariffs, are derived from the GTAP (Global Trade Analysis Project) database after sectoral aggregation. For simplicity and because of the lack of region- and sector-specific (in some cases) empirical data, we assume same elasticities for all regions.[6]

To focus our analysis on the lumber market, we needed to isolate the softwood lumber sector in our IO tables. Unfortunately, the NAICS (2002 version) does not have softwood lumber as a distinct industry sector under its small (S-level) aggregation for Canadian Provinces. However, this sector is contained within the wood products manufacturing sector (NAICS 2002, code 321). Therefore, to disaggregate softwood lumber as a sector from its mother sector of wood products manufacturing in each Canadian Province, two steps are followed. First, we establish the 2006 regional ratio of softwood lumber shipments to total wood products shipments using Natural Resources Canada statistical data on trade (Natural Resource Canada 2014) and used this ratio to disaggregate total softwood lumber shipments from the total wood products manufacturing sector in our IO table. Second, because there was no other information available, we establish the remainder of the IO table transactions using the assumption of the same technology mix for both intermediate and value-added requirements under both sectors. Final demand is similarly estimated, assuming the same consumer taste and preference between the two sectors.

For the United States softwood lumber sector, we use the ratio of softwood lumber production (output) value data for 2006 (Food and Agriculture Organization of the United Nations [FAO] 2015) to wood products manufacturing to disaggregate the softwood lumber sector from wood products manufacturing in the United States

IO table in a way similar to that described for the Canadian Provinces above. Softwood lumber import data in the United States from Canada were derived from the Canadian (export) side.

For the RW softwood lumber sector, we use the FAO (2015) data in two steps. First, we estimated the RW softwood lumber sector output by subtracting the sum of Canada and US production value data for 2006. We then subtract this value from the wood products manufacturing sector to disaggregate the two and follow the same procedure as above to fill out the RW IO table. RW softwood lumber imports from Canada were derived from the Canadian side (international exports excluding the United States). RW softwood lumber imports from the United States were derived from the United States side (international exports excluding Canada) (UN Com Trade 2014).

For practical purposes of this study, we consider Canadian softwood lumber exports subject to the SLA as defined under Annex 1A and further restrict this to only products defined under Annex 7D (10)[7] (Canada Treaty Information 2014). Table 2 provides reference FLC prices on which Canadian softwood lumber export charge rates are pegged as per the SLA. Table 3 shows annual Canadian softwood lumber exports to the United States. Table 4 shows the annual value of Canadian softwood lumber exports to the United States.

Regional annual export charges are estimated by averaging reported monthly rates (Canadian Revenue Agency 2014). This is straightforward when there are uniform monthly rates as is the case for all regions under both Options for 2007 and 2008 periods. However, amendments to the SLA affected rates for some regions in certain months. In addition, the "surge mechanism" resulting from the trigger volume limit affected the rates in Option A for some regions in certain months. In such cases, regional annual average export charge rates were estimated from the reported monthly rates weighted by their respective monthly export volumes. The export volume is significant here because it is the basis of determining monthly export charge rate in terms of triggering the volume limit in Option A and the export volume quota restriction in Option B. A second reason for the choice of export volume (rather than FLC price) as the weight of annual average export charges is that British Columbia and Alberta, which chose Option A, show greater monthly export charge rate variability as a result of trigger volume limit provision.

Labor supply growth projections for Canadian regions are taken from average annual growth rates (percent) between 2010 and 2014 (Ochuodho and Lantz 2014, Statistics Canada 2015). The year 2010 was the earliest start period from the source. For the United States, we use projected labor supply and productivity average annual rate of change (2006–2016) of the civilian labor force from the United States Bureau of Labor (2014). For the RW, we use annual world (excluding the United States and Canada) average growth rates from 2004 to 2012 from the World Bank (2014).

Stumpage is exogenously fixed through the time path. Technological progress (total factor productivity) is assumed to be labor-augmented, so the model reaches a steady state in the long run (Zhai et al. 2009).

To achieve the study objective, three scenarios are defined. First, we defined a *baseline* scenario (without softwood lumber tariffs), for which we zero-rated softwood lumber export charges from Canada to the United States and ran the model over the 2007–2013 period to produce estimates of economic variables without the 2006 SLA between the two countries. These estimates are used as reference points to which the other scenarios were compared.

To assess impacts of the 2006 SLA, we simulated *Scenario 1* using the softwood lumber export values (Table 4) and charges (Table 5)

Table 2. Reference monthly FLC prices of softwood lumber.

	Reference FLC prices (US $/MBF)[a]						
Month	2007	2008	2009	2010	2011	2012	2013
January	278	268	224	251	276	264	357
February	293	262	207	250	291	269	385
March	291	243	195	281	303	283	395
April	289	244	199	311	296	289	416
May	279	238	200	325	288	299	443
June	286	266	207	361	267	321	407
July	292	281	198	316	260	343	356
August	309	263	239	251	264	323	326
September	292	272	235	251	271	328	353
October	288	284	239	247	259	341	353
November	273	255	233	250	265	326	380
December	257	225	238	260	257	334	387
Annual average	286	258	218	280	275	310	380

[a] Authors' compilation from Canadian Revenue Agency (2014).

Table 3. Annual volume of Canadian softwood lumber exports to the United States.

	Annual Canadian softwood lumber exports to United States (m^3)[b]						
Region of origin[a]	2007	2008	2009	2010	2011	2012	2013
British Columbia	23,165,673	15,993,383	11,975,872	12,393,421	11,318,978	12,593,177	13,750,915
Alberta	3,277,058	2,902,743	2,424,573	2,444,408	2,145,896	2,248,381	2,618,897
Saskatchewan	169,255	110,125	88,704	102,072	99,124	231,466	205,725
Manitoba	337,813	179,412	31,028	6,440	8,531	24,081	40,584
Ontario	3,550,911	1,944,552	708,089	835,506	1,324,770	1,537,610	1,850,549
Quebec	5,974,998	4,376,440	2,738,547	3,168,637	3,544,423	3,473,503	4,598,458
New Brunswick	1,963,373	1,377,583	1,308,170	1,837,858	1,980,031	1,982,520	2,167,634
Nova Scotia	859,124	513,523	302,902	504,906	430,184	350,403	490,722
Prince Edward Island	29,400	96	0	0	0	0	0
Newfoundland	47,652	24,700	17,316	23,712	28,674	29,872	37,701
Territories	534,000	283,000	212,000	92,000	246,000	71,000	0
Canada	39,375,791	27,422,840	19,595,413	21,317,052	20,880,857	22,471,084	25,761,185

Data from Statistics Canada, International Trade Statistics.

[a] Newfoundland refers to Newfoundland and Labrador as a province; territories combines Yukon, Northwest Territories. and Nunavut. Produced by: BC Stats - Ministry of Technology, Innovation and Citizens' Services.

[b] Softwood lumber products as defined by Annex 1A (1) but restricted to exports products defined by Annex 7D (1a) of 2006 SLA for purposes of volume calculations of United States consumption shares. All volume units converted to cubic meters where necessary by conversion factors in Annex 7D (10).

Table 4. Annual value of Canadian softwood lumber exports to the United States.

Region of origin[a]	Annual Canadian softwood lumber exports to United States ($CDN million)[b]							Total (%)
	2007	2008	2009	2010	2011	2012	2013	
British Columbia	3,469.312	2,286.106	1,600.501	1,846.092	1,653.327	2,062.459	2,627.431	60.28
Alberta	402.761	314.730	244.054	297.203	250.233	298.733	420.043	8.64
Saskatchewan	23.322	11.026	6.562	6.505	8.562	24.604	29.667	0.43
Manitoba	38.837	18.874	3.192	0.730	1.088	3.157	5.239	0.28
Ontario	446.302	223.258	78.221	103.162	157.961	220.974	306.875	5.96
Quebec	851.883	583.236	353.137	417.905	453.922	521.911	793.932	15.42
New Brunswick	280.984	188.710	176.149	258.185	263.108	290.529	359.670	7.05
Nova Scotia	116.418	66.647	40.907	65.193	54.895	52.494	76.645	1.83
Prince Edward Island	3.740	0.010	0.000	0.000	0.000	0.000	0.000	0.01
Newfoundland	6.011	2.531	1.897	3.151	3.343	3.726	5.717	0.10
Territories	0.096	0.087	0.052	0.020	0.083	0.012	0.000	0.00
Canada	5,640	3,695	2,505	2,998	2,847	3,479	4,625	100.00

Data from Statistics Canada, International Trade Statistics.
[a] Newfoundland includes Newfoundland and Labrador as a province; Territories combines Yukon, Northwest Territories, and Nunavut. Compiled from BC Stats, Ministry of Technology, Innovation and Citizens' Services.
[b] Softwood lumber products as defined by Annex 1A (1) but restricted to exports products defined by Annex 7D (1a) of 2006 SLA for purposes of volume calculations of US consumption shares.

Table 5. Weighted annual average export charges of softwood lumber exports to the United States.

Year	Results for region of origin					
	British Columbia	Alberta	Saskatchewan	Manitoba	Ontario	Quebec
	(%)					
2007	15.0	15.0	5.0	5.0	5.0	5.0
2008	15.0	15.0	5.0	5.0	5.0	5.0
2009	15.0	19.6	5.0	5.0	5.0	5.0
2010	12.4	12.6	6.6	7.9	8.2	7.9
2011	15.0	18.2	7.2	7.8	9.5	12.2
2012	10.9	11.5	3.7	3.9	3.8	6.3
2013	1.5	1.6	0.7	0.7	0.6	2.9

Authors' weighted average estimates from monthly rates from the Canadian Revenue Agency (2014). British Columbia and Alberta are operating under Option A, whereas rest of the regions are under Option B. Only regions affected by SLA are presented. Other regions in the CGE model are assumed to have zero rated export charge to all destinations.

over the 2007–2013 period. Differences in economic outcomes between the baseline and Scenario 1 represent the economic impacts of the 2006 SLA.

To assess whether the Provinces selected favorable export border control measure choice between Option A and Option B, we simulate *Scenario 2*. We do this by simulating the model using the "would be" export values and charges had the Provinces selected alternative export border control measure as defined under Scenario 2 and run the model over the 2007–2013 period. Differences in economic outcomes between baseline and Scenario 2 represent the economic impacts under Scenario 2.

The CGE model is solved using the general algebraic modeling system (GAMS) software with a nonlinear programming (NLP) algorithm along with the CONOPT3 solver (Rosenthal 2012, GAMS Development Corp. 2015).

Results and Discussion

GDP and Welfare

GDP impacts of the SLA were mixed across Canadian Provinces under Scenario 1 in which almost half of the regions realized marginal GDP gains and the other half GDP reductions (Table 6). These ranged from a GDP loss of 1.88% in New Brunswick to a GDP gain of 1.94% in Saskatchewan, with a weighted average gain for Canada of 0.12%. Both the United States and the rest of the world realized GDP gains under Scenario 1. However, under Scenario 2, the Canadian regions' gains/losses were generally intensified relative to those in Scenario 1, except for British Columbia and New Brunswick which reverse their GDP losses under Scenario 1 into GDP gains under Scenario 2. The largest difference in GDP impacts between scenarios emerged in Alberta where it increased from 0.47% under Scenario 1 to 12.27% under Scenario 2. Alberta contributes the third largest share (17%) of Canada's national GDP ($1.3 trillion, 2006 Canadian dollars, reference year), following Quebec (19%) in second place after Ontario (40%), the largest provincial economy. The Canadian overall impacts are weighted averages of the regional impacts. The GDP impacts in major provincial economies above played a major role in increasing Canada's overall GDP gain from only 0.12% under Scenario 1 to 2.45% under Scenario 2. Under Scenario 1, the United States gains GDP of 1.32%. This increase follows an increase in stumpage price (9.9%), rental rate of capital (0.8%), increase in investments (4%), and increase in exports (1.5%). Conversely, the United States realizes a loss of 1.17% under Scenario 2. This is contributed by declines in investments (6%), export declines (0.4%), marginal declines in both labor and capital expenditures, and decreases in final demand prices (5.3%) and export prices (1.8%) coupled with a surge in import prices (0.4%). These together lower the United States' terms of trade index. The rest of the world realizes GDP gain of 2.21% under Scenario 1. This GDP gain results mainly from increased investments (5.6%) and an increase in stumpage prices (10%) coupled with an increase in exports (1.4%). Under Scenario 2, the rest of the world realizes GDP gains at a lower rate (1.9%). This impact can be traced to two major sources, a 21% increase in investments and a 19% increase in stumpage. These huge increases compensate for reductions in the rental rate of capital (3.3%) and increase in import prices (7.2%) in the region. Overall, GDP impacts the result from factor substitution due to input factor price changes in the composite value-added production function as constrained by final demand impacts in investments, household consumption, and net exports.

Welfare impacts were measured using compensating variation, which is the effect of a price change on a consumer's overall welfare. It reflects new prices and the old consumer utility level. It is the amount of additional money an agent would need to reach its initial

Table 6. Regional economic impacts of United States-Canada 2007–2013 softwood lumber agreement.

Region	GDP		Welfare (CV)[a]		Household income		CPI[b]	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
	(%)							
BC	−0.82	0.76	0.69	−0.07	0.25	0.36	0.23	−1.34
AB	0.47	12.27	0.59	0.21	−0.11	0.20	1.04	2.75
SK	1.94	2.59	−0.56	0.24	−0.49	0.49	−0.20	−1.27
MB	−0.19	−1.12	−0.64	−0.88	0.36	−1.04	−1.45	−3.88
ON	0.43	1.61	−0.39	2.75	0.17	1.84	1.97	−1.15
QC	−0.31	−1.94	0.22	−0.62	0.11	−0.49	0.25	−0.05
NB	−1.88	1.00	−6.27	−0.33	−3.56	−0.36	−3.37	−0.68
NS	−1.40	−4.92	−1.26	−7.35	−0.88	−3.44	−0.10	1.49
PE	0.15	0.48	−0.97	−4.08	−0.69	−2.16	0.52	1.68
NL	1.90	1.19	2.30	−0.48	2.79	−0.63	−0.86	0.82
TR	0.36	2.05	1.34	−1.56	1.05	0.44	0.40	3.52
Canada[c]	0.12	2.45	−0.06	0.77	0.06	0.59	0.85	−0.41
US	1.32	−1.17	0.00	−0.20	0.30	0.15	1.19	−1.10
RW	2.21	1.90	0.92	−6.62	1.51	−2.60	−0.60	−4.71

BC, British Columbia; AB, Alberta; SK, Saskatchewan; MB, Manitoba; ON, Ontario; QC, Quebec; NB, New Brunswick; NS, Nova Scotia; PE, Prince Edward Island; NL, Newfoundland and Labrador; TR, Yukon, Northwest, Nunavut, and Enclaves, combined; US, United States; RW, rest of the world. Scenario 1: first choice of softwood lumber agreement export border control measure. Scenario 2: alternative choice of softwood lumber agreement export border control measure.

[a] Compensating variation as a percentage of GDP.

[b] Consumer price index estimated from a nested Stone-Geary (linear expenditure system [LES]) household utility function.

[c] Weighted average of Provincial impacts.

utility after a change in prices (Ochuodho and Lantz, 2014).[8] Approximately half of the Canadian Provinces realized welfare losses under Scenario 1. Furthermore, all regions except Saskatchewan and Ontario fair better under Scenario 1 than under Scenario 2 in terms of welfare. These results follow same pattern as impacts on the consumer price index (CPI) (Table 6). The quota volume restriction under Option B restrains British Columbia's exports to the United States under Scenario 2. Therefore, the region redirects its "excess" supply to the domestic market, thereby dampening the domestic softwood lumber consumer prices. However, in both the United States and the rest of the world, consumers experience higher prices, resulting in welfare losses. This outcome is consistent with theoretical expectations for which export quota restrictions are expected to increase supply and lower the price in the domestic market (Canada). On the other hand, these restrictions reduce the supply and increase the price in export markets (the United States and the rest of the world). The welfare impact in the United States is negligible in Scenario 1 and a loss of 0.2% in Scenario 2. The rest of the world realizes a marginal welfare gain of 0.92% in Scenario 1. However, the region has a 6.62% welfare loss in Scenario 2. The regional welfare impacts can be attributed to relative proportional changes in both household income and CPI as compensating variation is a welfare measure that uses prices and utility. A classic example is between British Columbia and Ontario welfare impacts under Scenario 2. Although the two regions experienced reduced consumer price indices at 1.34 and 1.15%, respectively, Ontario realized a welfare gain of 2.75%. whereas British Columbia recorded a welfare loss of 0.07% because Ontario's household income increased by 1.84% against British Columbia's only 0.36% (Table 6).

Bilateral Trade Flows and Terms of Trade

The SLA succeeded in curtailing Canada's softwood lumber exports to the United States (Table 7). All Canadian regions experienced export declines under Scenario 1, ranging from 1.16% in Nova Scotia to 12.13% for New Brunswick except for Ontario and Quebec. The territories' decline of 12.40% is not economically significant as it only constituted negligible (0.0014%) softwood lumber exports to the United States The increases in exports from Ontario and Quebec are significant. Even though both regions were operating under Option B in Scenario 1, they only constituted a relatively small share of total softwood lumber exports. Therefore, despite quota restrictions, the regions could still afford to increase their export volumes, within the quota ceilings at relatively lower export tariff rates. New Brunswick's exports to the United States decline of 2.13% under Scenario 1 is unique, given that it is the fourth largest softwood lumber exporter after British Columbia, Quebec, and Ontario and is a nonparticipant in the SLA. It seems that shifts in regional trade patterns and reduced domestic prices enabled New Brunswick to redirect its softwood lumber to domestic markets.

Comparing British Columbia's softwood lumber exports to the United States under Scenario 1 versus Scenario 2 explains the whole essence of British Columbia's choice of Option A instead of B. With volume quota restrictions under Option B, British Columbia's exports to the United States would have declined significantly by 25% (as shown in Scenario 2) from only 3.67% (as shown in Scenario 1). This means that even though the region's softwood lumber prices to the United States increased after export tariff charge, it could still afford to export unrestricted volumes of softwood lumber to the United States under Option A (Scenario 1).

The 10.06% increase in Alberta's exports to the United States under Scenario 2 could be due to its relatively low export volumes to the United States at 8% of total (less than Quebec's 15%). This means Alberta could still afford to export its maximum potential softwood lumber volume to the United States at a lower export charge without hitting the quota ceiling. This result raises questions on Alberta's initial choice of Option A for which it paid a higher export charge with unlimited export volume instead of exporting "equivalent" volumes under Option B but at much lower export charge rates.

Of interest also are the increases under Scenario 2 of exports to the United States of four regions of Saskatchewan, Manitoba, Ontario, and Quebec if they chose Option A instead of their original choice of Option B. This implies that these regions benefited from

Table 7. Regional trade impacts of United States-Canada 2007–2013 softwood lumber agreement.

Region	SWL[a] exports to US		Domestic SWL sold in domestic market		SWL export share in US consumption		SWL exports to rest of the world		Terms of trade index[b]	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
	(%)									
BC	−3.67	−25.00	−0.20	4.06	−10.83	−40.49	−0.89	31.04	0.42	0.73
AB	−1.84	10.06	−0.79	35.28	−1.23	2.49	0.18	91.82	0.57	2.25
SK	−5.47	5.74	9.04	10.05	−0.50	0.22	1.72	15.89	0.62	1.37
MB	−4.39	1.17	−2.30	3.38	−1.10	−0.12	2.78	11.00	0.21	1.28
ON	2.38	0.43	−0.42	0.32	−1.12	−2.53	11.23	10.04	0.77	1.81
QC	1.79	2.78	0.63	−0.67	−4.39	2.98	−3.68	13.14	0.27	−0.96
NB	−12.13	−43.92	0.51	1.50	−3.34	−9.63	−1.48	23.42	0.90	1.18
NS	−1.16	−1.14	−0.05	3.64	−0.62	−0.29	11.12	122.06	−0.64	−1.66
PE	−8.58	−41.35	0.05	−2.58	−0.09	−0.33	2.57	29.29	0.26	1.10
NL	−7.50	−22.90	−0.33	1.76	−0.05	−0.10	3.24	67.54	1.17	−0.12
TR	−12.40	−40.54	−4.14	−4.20	0.00	−0.01	−1.78	31.32	0.46	3.33
Canada[c]	−2.87	−16.87	−0.12	5.60	−7.63	−24.57	−0.84	32.80	0.55	1.07
US	–	–	2.25	1.35	–	–	−1.02	2.05	1.36	−1.54
RW	4.15	−11.28	5.62	3.51	3.24	−32.35	–	–	−1.68	4.40

BC, British Columbia; AB, Alberta; SK, Saskatchewan; MB, Manitoba; ON, Ontario; QC, Quebec; NB, New Brunswick; NS, Nova Scotia; PE, Prince Edward Island; NL, Newfoundland and Labrador; TR, Yukon, Northwest, Nunavut, and Enclaves, combined; US, United States; RW, rest of the world. Scenario 1: first choice of softwood lumber agreement export border control measure. Scenario 2: alternative choice of softwood lumber agreement export border control measure.
[a] Softwood lumber.
[b] Laspeyres terms of trade index.
[c] Weighted average of Provincial impacts.

the prevailing lumber prices (Table 2) on which the export charge rate was pegged.

The relatively large percent impacts of softwood lumber exports to the United States from other Atlantic regions (except New Brunswick), and the territories were relatively insignificant as they constituted only 1.9% of total exports to the United States.

Overall, Canada's softwood lumber exports to the United States would have been impacted to a lesser degree under Scenario 1 (at a 2.87% reduction) compared with that under Scenario 2 (at a 16.87% loss). Canada compensated for its decline in United States exports under Scenario 2 by redirecting this excess demand to both domestic and the rest of the world markets such that overall, Canada's 16.87% decline in US exports (decrease of 24.57% share in United States consumption) results into an increase of 32.80% of its exports to the rest of the world. However, Scenario 1 has negative impacts on Canada both domestically and abroad in the United States and the rest of the world.

The terms of trade index measures the health of the economy. It is estimated by measuring the cash flow into the economy from the export receipts relative to the import expenditures over a particular time period. An economy would be doing well (capital accumulation) if export receipts are in excess of import expenditures and vice versa. It is a factor of changes in both export/import quantities and their respective prices. All of the Canadian regions except Nova Scotia experienced positive terms of trade under Scenario 1. This means that overall, Canada is a net exporter (positive foreign savings). Similarly the United States realized positive capital accumulation under Scenario 1. Under Scenario 2, Canada experienced an overall improved increase of its terms of trade index of 1.07% up from 0.55% under Scenario 1. This is due to its huge increase in softwood lumber exports to the rest of world at 32.80%, which compensated for a decline of 16.87% of its exports to the United States. The terms of trade index impacts for Canada and the United States follow those of their GDP.

Table 8. Regional capital, stumpage and employment impacts of United States-Canada 2007–2013 softwood lumber agreement.

Region	Capital rental rate		Stumpage rate		Unemployment rate	
	Scenario 1	Scenario 2	Scenario 1	Scenario 2	Scenario 1	Scenario 2
	(%)					
BC	0.19	0.52	19.35	26.27	−0.55	1.06
AB	−0.16	0.26	0.01	−0.01	0.97	0.04
SK	−1.00	1.05	0.00	0.00	0.19	−0.06
MB	0.95	−2.94	0.00	0.00	−0.08	−0.22
ON	1.93	2.02	0.00	0.00	8.96	−18.46
QC	0.04	−1.20	0.00	0.00	−0.47	2.71
NB	−4.71	−0.51	−0.03	0.01	28.82	2.93
NS	−0.92	−3.25	−25.43	0.00	8.76	35.93
PE	−1.23	−1.06	−0.03	0.00	4.31	21.48
NL	3.56	−0.63	−0.02	0.00	−9.96	3.84
TR	1.98	2.53	0.04	−0.04	−5.33	25.88
Canada[a]	0.73	0.50	15.08	20.57	4.26	−5.77
US	0.75	0.40	9.93	7.44	−0.02	0.00
RW	3.71	−3.30	46.68	19.98	0.13	32.74

All prices are 7-year (2006–2013) average in domestic currency. BC, British Columbia; AB, Alberta; SK, Saskatchewan; MB, Manitoba; ON, Ontario; QC, Quebec; NB, New Brunswick; NS, Nova Scotia; PE, Prince Edward Island; NL, Newfoundland and Labrador; TR, Yukon, Northwest, Nunavut, and Enclaves, combined; US, United States; RW, rest of the world. Scenario 1: first choice of softwood lumber agreement export border control measure. Scenario 2: alternative choice of softwood lumber agreement export border control measure.
[a] Weighted average of Provincial impacts.

Household Income and CPI

Weighted average household income for Canada increased from 0.06 to 0.59% from Scenario 1 to Scenario 2 with a mix of impacts at the regional level. This change can be attributed to the largest change of stumpage in British Columbia (Table 8), which accounted for 72% of total softwood lumber exports. The United States experienced a modest household income decline from 0.30 to 0.15% in Scenario 1 and Scenario 2, respectively. This is explained by similar pattern of changes in stumpage. However, for the rest of the world, the case is different. Although there is a change in income

from a 1.51% gain under Scenario 1 to a decline of 2.60% in Scenario 2 despite the reverse effects on stumpage, differences in the changes in labor expenditures between the two scenarios as indirectly implied by unemployment rate impacts explain the differences (refer to the next subsection).

The CPI in the United States under Scenario 1 marginally increased by 1.19% (Table 6). In response, United States producers increased their domestic softwood lumber sales and reduced their exports to the rest of the world. However, under Scenario 2, CPI deflated in Canada as the reductions in softwood lumber exports to the United States were redirected to the domestic market, thereby ballooning domestic supply and deflating prices. Similar arguments can explain the decline in CPI in rest of the world as Canada "flooded" the rest of the world market with excess supply that would have been exported to the United States.

Capital Price, Stumpage, and Employment

The regions realized mixed impacts on rental rates of capital, ranging from a gain of 0.04% in Quebec to a loss of 4.71% in New Brunswick. Overall, rental rates of capital for Canada increased by 0.73% and 0.50% in Scenario 1 and Scenario 2, respectively. These impacts were largely contributed to by impacts realized in Ontario, which accounted for 35% of Canada's capital investments. British Columbia, which accounted for 78% of stumpage expenditures and 72% of total softwood lumber exports realized a 26.27% increase in stumpage rate under Scenario 2. This can be explained from the increased demand for softwood lumber from British Columbia by the rest of the world. British Columbia shifts its exports from the United States to rest of the world. All the other Canadian regions had negligible impacts except for Nova Scotia with a decrease of 25.43%. However, the region only accounted for 0.3% of stumpage payments and therefore had negligible national impact. The impacts had similar general trends under Scenario 2.

Regarding the unemployment rate under Scenario 1, it increased by 4.26% for Canada overall. Despite the unemployment rate decline in British Columbia and other Canadian regions, the overall Canada impact is mainly influenced by the 8.96% increase in Ontario, which accounted for 41% of Canada's total labor expenditures. Despite British Columbia's major role in the softwood lumber market, it only had 12% of total labor expenditures. This trailed Quebec's 19% and Alberta's 14%. The largest unemployment rate increase of 28.82% in New Brunswick weighed less on the national average as it only accounted for 1.9% of total labor expenditures. Under Scenario 1, the United States marginally benefited with a decline of 0.02% in unemployment rate. However, under Scenario 2, Canada benefited with a reduction of 5.77% of its unemployment rate. This can be tracked to Ontario's huge reduction in the unemployment rate of 18.46% as it benefits from the quota-free export regime under Option A. Other huge increases in the unemployment rate in the Atlantic Provinces do not affect Canada's overall impact much as they accounted for only 5.9% of Canada's labor expenditures.

Summary and Conclusions

This study has produced a number of important findings. First, it confirmed the intuition that the 2007–2013 SLA was effective in curtailing Canada's softwood lumber entry into the United States market. The agreement benefited United States softwood lumber producers through increased stumpage rates, whereas United States consumers lost marginally in welfare due to increased price index while gaining in household income. The Canadian government gained through additional export tax revenue. Canadian producers compensated for their loss of market share in the United States by redirecting their exports to the rest of the world market. These findings are consistent with those of Devadoss et al. (2005) and Baek and Yin (2006) on past SLAs and with those of van Kooten and Johnston (2014) for the 2006 SLA.

Second, from a welfare perspective, the study has shown that most Provinces (except Saskatchewan and Ontario) made the right choice of export tax border control measure options. However, Canada as a whole would have benefited more in terms of welfare if the Provinces had selected the alternative border control measure options (Scenario 2). In addition, many Provinces would have had preferable GDP and household income impacts if the alternative border control measure options had been selected. Overall Canada would have been better off under Scenario 2 in terms of GDP, household income, welfare, employment, and terms of trade.

It seems that some regions (Manitoba, Ontario, and Quebec) participating in Option B avoided the quota volume restraint by shifting their exports toward wood manufacturing products that were exempted from quota volume restraint calculations as per Annex 7D of the SLA. This allowed them to export unlimited quantities of these products, which were only subjected to 5% export charge.[9]

Finally, the study has shown the "unintended consequences" of bilateral agreement in other markets. Even though the Atlantic Provinces were excluded from the export control measures, they have nevertheless been affected (mostly negatively) by the trade shifts resulting from the SLA. Despite their stumpage being considered "competitive," the Atlantic Provinces are not immune to the softwood lumber market influences of the western Provinces' big players.

There are a number of points worth noting while interpreting results from this study. First, it was assumed that all softwood lumber originating from both Ontario and Quebec Provinces were subject to the SLA export duty charge. However, Annex 10 of the SLA lists some 32 companies from the two Provinces (3 Ontario companies and 29 Quebec companies) that were exempted from the export charge.[10] The SLA provided for a "third-country adjustment mechanism" so as to preserve Canada's share of the United States market and to address increases in third-country share of the United States market. The study did not take into account this provision and, therefore, could have overestimated the export charges in such cases.[11] In addition, our study did not take into account the costs associated with the SLA implementation (that are to be subtracted from the Federal Government's transfer of funds to the Provinces), which may also lead to an overestimation of the impacts. Furthermore, due to data limitations, we made a simplifying assumption that the input-output structure of the softwood lumber sector mirrored that of the wood products sector as a whole. Future refinements of this and other issues identified above is needed to have more realistic estimates.

As a final note of caution in the interpretation of the findings in this study, it should be emphasized that the estimated impacts from CGE models are very sensitive to elasticities, functional forms, model parameters, assumptions, closure rules, and other factors that embody the models (Decaluwe and Martens 1988, Partridge and Rickman 1998, Arndt et al. 2012). These model aspects vary across models given little consensus on any "standards" that apply across

the board. The use of the same elasticities across the regions (of significantly varying economic sizes) could explain some relatively high impacts in this study. Despite the caveats, this study has provided a framework that future studies on this historical bilateral trade dispute can rely on.

Endnotes

1. Reed (2001) provides chronology of the dispute before 1981, Rhaman and Devadoss (2002) provide a detailed discussion of the disputes covering the period 1981–2000, Yin and Baek (2004) outline the history of the dispute and critique past studies of various United States-Canada softwood lumber trade agreements, Random Lengths (2014) provides a succinct summary of monthly events of the dispute in a historical timeline from 1982 to 2012, and Zhang (2007) gives a more detailed account of the real players in this dispute and many of its economic and policy consequences from its inception from Lumber I through Lumber IV until the signing of the 2006 Softwood Lumber Agreement.
2. Article VII of the SLA details the export charge and export charge plus volume restraint for the two options. Calculations of quota volume and of United States consumption and market share are in Annexes 7B and 7D of the SLA, respectively, whereas Annex 8 details calculations of regional trigger volume under Option A. Annexes 1A and 1B detail softwood lumber products covered by the SLA (USTR 2014).
3. For extensive reviews of CGE modeling technique and its applications, see Decaluwe and Martens (1988), Shoven and Whalley (1992), Partridge and Rickman (1998), Haddad (2009), and Hosoe et al. (2010)
4. The NAICS 2002 version has 25 sectors. However, we disaggregated manufacturing (31–33) into three sectors: softwood lumber (from 321), pulp and paper manufacturing (322), and "other manufacturing" (31–33 except 321 and 322). We also aggregated five other service sectors into one sector: Other services (except public administration) (81); Operating, office, cafeteria, and laboratory supplies (not NAICS defined); Travel and entertainment, advertising and promotion (not NAICS defined); Transportation margins (not NAICS defined); and Non-profit institutions serving households (8131) (numbers in parentheses represent NAICS 2002 codes). For further details on the sectors, see Statistics Canada Table 381-0013 (Statistics Canada 2014).
5. These provinces from east to west are Newfoundland and Labrador (NL), Prince Edward Island (PE), Nova Scotia (NS), New Brunswick (NB), Quebec (QC), Ontario (ON), Manitoba (MB), Saskatchewan (SK), Alberta (AB), British Columbia (BC), and the Territories, which includes Yukon, Northwest, Nunavut, and Enclaves (TR).
6. CGE model results are sensitive to key parameters such as elasticities. However, there is little consensus among CGE modelers on the magnitude of these elasticities that would be considered "suitable" under various modeling conditions (Arndt et al. 2012, Partridge and Rickman 1998). Deriving elasticities from primary data is no menial task due to large data requirements over a long period of time. Modelers have tended to rely on elasticities from the literature and at times assign their own values using authors' judgment (e.g., Alavalapati et al. 1998).
7. This left out only three categories of actual softwood lumber exported to the United States (Canadian Custom Tariff: 44189099, 44219060, and 44219090), which include joinery and carpentry wood, fence rails and sawn pickets, and wood articles (value data are available without quantity units). It is significant to note that these products do not play roles in the SLA and are only prominent in regions participating in Option B (particularly Manitoba, Ontario, and Quebec), where they have been excluded from quota volume calculations as per Annex 7D of the SLA. Therefore, excluding these products was a matter of necessity rather than choice for practicality of calculation of regional quota volumes for Option B and regional trigger volumes for Option A as per Annexes 7B and 8 of the SLA, respectively.
8. Compensating for variation is estimated with the expenditure function using new prices and the old utility level. Equivalent variation (EV) is a closely related measure of welfare that uses old prices and the new utility level. It estimates amount of money an agent would pay to avoid a price change, before it happens. In this study, compensating variation (CV) was a more appropriate measure of welfare than EV because of *ex post* (retroactive) analysis rather than anticipatory (what would be). CV represents a more accurate estimate of welfare than consumer surplus because the former accounts for income effects, whereas the latter does not. When the good is neither a normal good nor an inferior good, or when there are no income effects for the good, then EV = CV = CS (change in consumer surplus) (for more details, see Hicks 1939, Varian 1999).
9. In this regard, Manitoba, Ontario, and Quebec increased their export values of the exempted products, which include builder's joinery and carpentry of wood, fences and fence sections of wood, prefabricated, including fence rails and sawn pickets, and wood articles. It is significant to note that Ontario and Quebec (operating under Option B) peaked the share of the exempted products with the economic downturn witnessed in 2009, which recorded lowest FLC prices (Table 2). Total values of their exempted products accounted for 34 and 39% of total softwood lumber exports to the United States for Ontario and Quebec, respectively.
10. These companies were previously found by United States authorities not to benefit from alleged subsidies. In this regard, our analysis has somehow overestimated the export charges from these two regions as a result, the extent of which depends on the unknown actual softwood lumber export volumes to the United States from the exempted companies over the seven-year study period. The analysis subjected the total provincial softwood lumber exports to the United States to the export tax and quota restrictions.
11. The SLA allows the Government of Canada to retroactively refund export charges (up to the equivalent of a 5% charge) if all of the following circumstances occur in two consecutive quarters when compared with the same two consecutive quarters in the preceding year: third-country share of United States market increases by 20%; Canadian market share decreases; and United States domestic producers' market share increases. This was the case in some months for some regions (Alberta for October and November 2008).

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