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Canada-US Softwood Lumber Trade Revisited: Examining the Role of Substitution Bias in the Context of a Spatial Price Equilibrium Framework

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Canada-US Softwood Lumber Trade Revisited: Examining the Role of Substitution Bias in the Context of a Spatial Price Equilibrium Framework

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ABSTRACT

In the last two decades, softwood lumber trade between Canada and the United States has been characterized by numerous trade restrictions. Many studies have attempted to quantify the effects of such sanctions, and in doing so, softwood lumber was modeled as a single, homogenous commodity. However, recent research has suggested that this may be a misleading assumption, since not all softwood lumber products are equivalent substitutes. We refer to this problem as the substitution bias, and uniquely address this issue in estimating the effects of trade restricting policies. Using a spatial price equilibrium (spe) model, impacts of the post-sla import duties are estimated and compared to estimates of two alternative policy regimes – an export tax and quota. By controlling for substitution bias, our estimates indicate a larger share of the tariff burden is placed on us consumers, with Canadian producers suffering less injury compared to estimates using the traditional homogenous lumber assumption. In addition, by comparing the net impact associated with the alternative policy regimes, a policy equivalence result is found. Our results suggest that the short-run impact of a trade restriction is largely independent of the policy regime incorporated, with the collection of quota rents or tax revenues determining overall winners and losers.

Keywords: Softwood lumber trade, spatial price equilibrium, lumber substitutability

1. INTRODUCTION

A fundamental economic premise states that free trade maximizes the *aggregate* welfare of participating regions, as resources are allocated so that regions specialize in the production of goods and services according to their comparative advantages. However, moving away from free trade does not imply that all regions, or that all sectors within a region, are made worse off. Rather, restrictive trade sanctions alter income distributions, creating both winners and losers, and it is this distributional distinction that often drives trade policy (Boyd & Krutilla, 1987).

The aim of this paper is to provide additional insights into the welfare implications of restrictive trade measures associated with the Canada-US softwood lumber dispute by refining the focus of traditional models used to study the topic. This dispute is not only the largest and longest lasting trade dispute between Canada and the US, it is also the largest forest products trade dispute world-wide (Zhang, 2001; Cashore, 1998). In 2003, Canada exported 19.3 billion board feet of softwood lumber to the US valued at $6.7 billion (2003 $Cdn), accounting for roughly 91% of US softwood lumber imports (Statistics Canada, 2004b). With Canada supplying approximately 34% of the US softwood lumber market, the consequences of distortionary trade policies in terms of welfare are substantial.

Although similar studies have looked at this issue, the current research is unique in its consideration of the substitutability of softwood lumber across end-uses based on species distinctions. By disaggregating softwood lumber into structural and non-structural uses, it enables us to consider these unique products separately, thereby avoiding the 'substitution bias.' The value of this distinction is considerable, as Canada has insisted that the majority of its lumber exports are not perfect substitutes for all US produced softwood lumber, and that they compete directly only with a subset of US products. The implications of this argument for the softwood lumber dispute are substantial, as the issue of competition is a central element in the conflict. In addition, by not controlling for the substitution bias, the welfare inferences of previous studies may be misleading.

2. PREVIOUS RESEARCH

Uncontested Canada-US free trade in softwood lumber has not occurred for any significant period in over two decades. Many theoretical and empirical studies sought to analyze the effects of restricted trade on the economic wellbeing of consumers and producers in the two countries. Much of this work has been summarized in some of the more recent studies, which are briefly discussed below.

Zhang (2001) estimated the welfare impacts associated with the Softwood Lumber Agreement (SLA) using an aggregate price impact model to detect a discernable change in both price and quantity and estimate a price impact. Average price was estimated to increase by some $59/mbf (1997 $US) over the first four years of the SLA.[1] He calculated that US producers gained some $7.7 billion while US consumers lost $12.5 billion, for a net loss of $4.7 billion. While Canada gained some $3.1 billion, non-Canadian exporters to the US also gained $626 million. The overall loss associated with the SLA was estimated to be $1 billion.

Using a two-region partial equilibrium model, van Kooten (2002) estimated the SLA to be comparable to a 6.5% ad valorem tax in terms of its impacts on the US market.

[1] Thousand board feet (mbf) is the common unit of measurement used in North American lumber markets and is equivalent to 2.36 m^3.

During the SLA period, both Canadian producers (capturing quota rents) and American producers (receiving quasi rents) received significant benefits, by and large at the expense of US consumers. An optimal quota that maximized profits to Canadian producers was derived analytically as the sum of export quota rents and domestic producer surplus, and was estimated to be approximately equivalent to a 15% ad valorem tariff. In the absence of significant 'quota busting' from non-covered regions and non-covered products, he recommended that Canadian lumber producers form a cartel to maximize rent capture.

Using a gravity equation, Hanlon (2004) found that the SLA was ineffective in restricting Canadian imports and raising prices, largely as a result of the incentive dynamics associated with the method of quota allocation. In contrast, post-SLA import duties were found to increase US prices by 12%, however, the resulting US net welfare was similar to that under free trade due to tariff revenues accruing to the US government. In contrast, in the absence of an increase in imports from non-covered regions, a price increase of nearly 27% was likely, which would lead to a large redistribution of surplus from US consumers to producers and the government, and a net welfare loss of several billions of dollars to the US.

Stennes and Wilson (2005) used a spatial price equilibrium model to examine the welfare and income distributional effects of a 27% ad valorem tariff, a quota (equivalent to the tariff), and a unit tax on Canadian factors of production (resulting in equivalent US impacts). The tariff and quota resulted in a price wedge of roughly \$80/mbf (1995 \$US), while the unit factor tax caused prices in all regions to increase by \$25-\$28/mbf. Both the tariff and quota caused US producers and Canadian consumers to be better off at the expense of Canadian producers (assuming no rent was collected) and US consumers. The net welfare impact for the US was similar to the unit factor tax, however this policy resulted in higher domestic prices in Canada and other foreign (non-US) markets and accompanying net welfare losses. Net welfare gains and losses at the national level were dictated by which country collected the quota rents or taxes.

Although central to the current study, the literature on substitutability between different softwood lumber products is sparse. Lewandrowski et al. (1994) found that pine lumber produced in the US west was complementary to Douglas fir lumber produced in the US Pacific Northwest and to southern pine produced in the US south. However, evidence also indicated that Douglas fir and southern pine were not substitutes, but that Canadian lumber was a substitute for each of these three US lumber species. The species mix and close proximity of Canadian producers to the US market were cited as significant factors to explain this result.

Likewise, Nagubadi et al. (2003) found that Canadian spruce-pine-fir (SPF) lumber was unrelated to treated southern yellow pine, Douglas fir and other species groups that together accounted for approximately 71% of softwood lumber produced in the US. Rather, Canadian SPF was determined to be a substitute for both untreated southern yellow pine and structural panel products. Interestingly, these authors found that there was greater competition between structural panel products and untreated southern yellow pine than between Canadian SPF lumber and untreated southern yellow pine.

Finally, Yin and Baek (2005) tested the law of one price (LOP) for US lumber markets using co-integration analysis on a comprehensive set of (monthly) lumber data covering most of the 1990s.[2] They found substantial evidence supporting the LOP hypothesis in terms of the main species groups, grades within those species groups and

[2] Law of one price maintains that, once quality differences and transport and trading costs are taken into account, prices in separate market segments should behave uniformly and consistently over time.

across geographic regions of the US.

3. MODELING STRUCTURAL VS NON-STRUCTURAL TRADE IN SOFTWOOD LUMBER

Previous studies of Canada-US softwood lumber trade have generally made use of the spatial price equilibrium (SPE) framework. The advantage of this approach is its regional modeling capability. By using transport costs as the source for regional price differentials (Boyd & Krutilla, 1987), the SPE framework implicitly assumes that a single, integrated North American lumber market exists. This assumption was recently validated by Yin and Baek (2005) for the US market. Because SPE allows multiple but separate supply and demand regions to be examined distinctly, it provides greater realism and precision compared to more aggregated approaches or econometric models. Importantly for the current study, the SPE model also enables us to distinguish lumber produced from different species, as species are often region specific. Since the standard SPE model in the context of forest products trade is well known (e.g., van Kooten and Folmer, 2004, pp.409-418), we consider only the effect that the distinction between structural and non-structural lumber has on the model.

Our model consists of 15 regions allocated into net demand or net supply regions. An (net) excess supply region is defined as producing more lumber than it consumes, while a (net) excess demand region is unable to satisfy domestic consumption from domestic production and must therefore import lumber. Regions are categorized as net supply or net demand based on the production and consumption conditions that prevailed in 2003.[3]

Along with the production and consumption figures, price data and exogenous supply and demand elasticities are used to derive linear excess supply and excess demand for each region.[4] The respective functional forms of the regional (inverse) excess demand and excess supply functions are expressed as follows:

(1) $P_i = \alpha_i - \beta_i q_i, \ \forall \ i \text{ and } \alpha_i, \beta_i > 0$

(2) $P_j = \mu_j + \delta_j q_j, \ \forall \ j \text{ and } \delta_j > 0$

The variables q_i and q_j represent the total quantities demanded (by region *i*) and supplied (by region *j*) in the trade market; parameters α and μ denote the intercept terms for the regional (inverse) excess demand and excess supply functions, respectively, and β and δ represent the corresponding slope coefficients. The objective is to maximize the trade surplus (TS), which equals the sum of the consumer and producer surpluses in the trade market, by allocating lumber from excess supply to excess demand regions, while minimizing total shipment costs.[5] Using linear trade functions (1) and (2), and including transportation costs, the objective function can be written as:

(3) $$\underset{q_{ij}}{Maximize} \ TS = \sum_{i=1}^{M}(\alpha_i q_{ij} + 1/2\beta_i q_{ij}^2) - \sum_{j=1}^{X}(\mu_j q_{ij} + 1/2\delta_i q_{ij}^2) - \sum_{i=1}^{M}\sum_{j=1}^{X} t_{ij} q_{ij}, \ \forall i, j$$

where q_{ij} is the quantity exported by region *j* to region *i*, t_{ij} is the transportation cost from

[3] Two regions represent supply and demand for the rest of the world, based on import and export levels between Canada, the US and the rest of the world.
[4] See Table A1 in Appendix A for a list of the model regions and their associated supply and demand elasticities. A description of production, consumption, prices and transportation data is provided in Appendix B.
[5] As this is a partial equilibrium analysis – softwood lumber is examined in isolation of all other goods – the sum of consumer and producer surpluses is not to be considered a measure of aggregate wellbeing (Samuelson 1952).

region j to region i, and there are X exporting and M importing regions. In addition, the following constraints are imposed:

(4) $\sum_i q_{ij} \leq q_j, \forall j$ – a net supply region cannot export more than it produces (q_j).

(5) $\sum_j q_{ij} \geq q_i, \forall i$ – all demand in a net demand region must be satisfied.

(6) $q_i, q_j, q_{ij} \geq 0$ – non-negativity.

Assuming respective regional domestic supply and demand slopes are positive and negative (as implicitly stated in the excess supply and demand expressions), *TS* is strictly concave in q_i and q_j, concave in q_{ij}, and bounded from above. This assures a solution exists, and that it is unique in terms of q_i and q_j, but not necessarily for q_{ij} (Takayama & Judge, 1971, p.142).

Model Calibration

SPE models are typically calibrated on a free trade market basis, drawing on regional production, consumption, price and elasticity data to define domestic supply and demand schedules, which are in turn used to construct regional trade functions. A free trade market is implicitly characterized by transportation costs representing the natural (and exclusive) source of price differences between regions.[6] With a free trade market defined, trade restrictions are imposed and their impacts assessed relative to free trade.

[6] Transportation costs in used here to refer to all costs associated with exporting lumber, which may include transaction costs.

This approach, however, requires that the market reflect a state of a free trade, a condition that was absent in the North American softwood lumber market during our period of analysis. Specifically, in 2003 a 27.2% ad valorem tariff existed on US softwood lumber imports from Canada.[7] Thus, production and consumption levels observed in 2003 were influenced by the tariff. Hence, it was necessary to calibrate the free-trade model so that, when the 27.2% duty was imposed, the outcome replicated the observed state in 2003. The key to achieving this was to establish price-quantity pairs. Optimizing a SPE model yields an array of regional prices, which are centered on representative prices, but differentiated according to transportation costs. In the absence of free trade, it was necessary to incorporate policy-induced price differences as well.

The following steps were taken to determine regional prices: (1) Using representative supply and demand prices, the objective function specified in the SPE model was maximized with reference to the Canadian excess supply curves adjusted to the tariff level.[8] By explicitly creating the price wedges that were present during 2003, this information was captured in the model-generated prices. (2) The model prices were re-entered into the model, and new prices were generated. After several such iterations, the SPE model was able to mimic the production and consumption levels observed in 2003.[9] (3) With regional supply and demand schedules identified, free trade prices and quantities were determined by removing the embedded price wedges (i.e., using the free trade excess supply curves in the objective function).

(4) One additional step was included to determine prices in non-tariff covered

[7] This import tariff represented an 18.79% countervailing duty (CV) and an 8.43% anti-dumping duty (AD). Only the AD was imposed on the provinces in Atlantic Canada.
[8] Various composite price indexes were used to generate representative prices (Random Lengths, 2005). See Appendix B.
[9] Roughly 99% of the data was replicated after only two price iterations.

regions to which Canadian exports could flow. This was necessary because optimization approaches imperfectly incorporate discriminatory ad valorem tariffs.[10] What this meant was that the tariff-adjusted excess supply functions for the Canadian regions were applied to all demand regions, rather than exclusively to those in the US. To correct for this, the two non-US demand regions (denoted RWD and ECD) were 'rebated' back the tariff equivalent amount from the Canadian excess supply regions (via the cost coefficients for transport). These rebates were adjusted in the price iteration process and subsequently converged after a few iterations.

Distinguishing the Markets

In this study, we differentiate softwood lumber according to structural and non-structural end-uses, with this distinction based on the species from which the lumber originates.[11] Admittedly this is not an exact demarcation, but it should suffice as a reasonable approximation since many species have 'typical' end-use applications. In general, structural and non-structural uses are determined by inherent strength and appearance characteristics, respectively. Although species are commonly classified according to these characteristics, there may also be considerable variation within a species. Incorporating species grades (strength and visual properties that largely dictate within-species end uses) to account for this would have been preferred, but this information is not available.

Numerous sources were used to determine which species to allocate to the non-

[10] Nicholson et. al. (1994) have shown that it is not possible to directly solve a SPE model with discriminatory *ad valorem* tariffs (i.e. tariffs on imports that differ by exporting region) via an optimization model because the value of the tariff depends on the endogenously-determined supply price. However, a solution may be obtained by using an iterative process, whereby the approximated tariff rate is successively updated after each iteration (Nicholson & Bishop, 2004).

[11] An exception is treated Southern Yellow Pine (SYP), which was included on the basis of the additional treatment.

structural category.[12] We defined the following species as non-structural: Cedars (western/inland red, incense, yellow, and Port Orford), redwood, and various pine species (Ponderosa, Sugar, White, Red and *treated* Southern Yellow).

The SPE model was solved sequentially using two distinct markets – an all softwood lumber market (All SWL) that included both structural and non-structural lumber, and a structural softwood lumber market (Structural SWL) that excluded non-structural lumber. The former could alternatively be referred to as the traditional market conventionally used in previous studies. We contend that using the Structural SWL market is preferred as it is a more accurate representation of a homogenous commodity, which is a requisite condition in SPE analysis. Further, by controlling for the substitution bias, we measure the impacts of trade-restricting policies more precisely.

4. MODEL RESULTS

The SPE model was able to simulate precisely the production and consumption patterns observed in 2003 (Table 1). In addition, the volume of trade flowing between Canadian regions and the US (which is the critical element in measuring the impacts of trade restrictions) is accurately reflected in the trade flows generated by the model, as seen in Table 2.[13] This was achieved with very few flow constraints.[14] The difference between the total volume of Canadian exports to the US generated by the model and

[12] Sources included: Random Lengths, 2000; USDA, 1999; Canadian Wood Council, 2005; National Association of Home Builders, 2001; Cintrafor (personal communication), 2005; Western Wood Products Association, 2001, 2005; and Nagubadi et. al., 2003.

[13] Regional information on actual flows of Structural SWL from Canada to the US was not available. However, the model was able to replicate the *total* volume of Canadian Structural SWL exports to the US, exclusive of the estimated 129 mmbf of Structural SWL brought into Canada.

[14] In the All SWL market, two ‘minimum shipment’ flow constraints were imposed. These lower bounds were (mmbf): 468 from the US to RWD and 300 from AC to ECD. For the Structural SWL market, three lower bounds were imposed: 393 from the US to RWD, 165 from AB to ECD, and 300 from AC to ECD.

actual 2003 exports is equivalent to the volume of lumber imported into Canada from the US and the rest of the world.

The base case for our two model formulations is given in Table 3. These production, consumption and price figures reflect a paradigm of unconstrained (free) trade between Canada and the US, and were used as a basis for comparing the restrictive trade policies.

<Insert Tables 1, 2 and 3 about here>

Policy Scenarios and Impacts

Three conventional trade policies (all of which have, at some point, characterized softwood lumber trade between Canada and the US) were examined: a 27.2% ad valorem import tariff (8.4% for Atlantic Canada i.e. the AC region), a quota (restricting Canadian regional exports to the same levels observed with the tariff), and a unit export tax (restricting total Canadian exports to the same level observed with the tariff).[15] The price impacts of these trade policies are presented in Table 4 for both markets. As suspected, all policies yield similar price impacts within the export markets since the total volume of Canadian lumber exported to the US was equated across the three policies. However, the unit export tax resulted in larger Canadian market impacts than the quota or the *ad valorem* tariff. Moreover, all three policies are clearly effective in creating a substantial price wedge between Canadian and US regions, averaging $74/mbf in the 'All SWL'

[15] The unit export tax imposed on the AC region was roughly one third of that applied to the other Canadian supply regions (which is consistent with the tariff case, and allows the polices to be directly compared).

market and $70/mbf in the 'Structural SWL' market.[16] The AC region is an exception, however, as the trade policies cause the price to increase. In this case, the relative advantage of less restrictive policies is translated into an explicit net gain for this region. Regional production and consumption levels adjust in the usual manner in response to the prices changes.

<Insert Table 4 about here>

Welfare impacts are presented in Table 5, as percent changes from the base case. As with prices, regional welfare changes are comparable across all policies within each market. Relative to free trade, Canada as a whole is clearly worse off. As all but one Canadian region is a net supplier, the losses in producer surplus largely surpass the modest gain in consumer surplus. Taken as a whole, the US is also significantly worse off with trade sanctions. With all but one US region importing lumber, the losses to consumers largely exceed producer gains. The two countries in aggregate experience a net loss. However, ignored in these conclusions are the policy-induced revenues – tariff payments, quota rents and unit export fees (which are shown below). The country collecting these revenues gains considerably.

<Insert Table 5 about here>

Also provided in Table 5 are estimates of the dead weight losses (DWL)

[16] This price wedge was determined using the average price differences between Canadian supply regions (excluding AC) and the US demand regions to which they export.

associated with each trade policy. These are an indicator of the welfare loss that occurs in moving away from free trade. It is important to emphasize that, although the DWL estimates are significant, ranging from roughly \$27 million to \$63 million in 2003, income redistributions play a much greater role. The most important of these is the transfer of surplus from US consumers to those collecting the policy-induced rents. [17]

Comparing Results between Markets

A comparison of the price impacts across policies in the 'All SWL' and the 'Structural SWL' markets reveals some interesting results. Most notably, in the 'Structural SWL' market the prices in Canadian supply regions fall by less, while the prices in US demand regions increases by more compared to the price changes in the 'All SWL' market. The explanation for this result can be found by examining the price wedge structures in both markets. Using the model with structural lumber, consumption and production dynamics are altered, with Canada's share of total US-Canada production increasing from 48% to 55%. The direct implication of these changes is a partial transfer of the tariff burden from Canadian producers to US consumers. A general case for Canada and the US is illustrated in Figure 1, where 'St' subscripts denote 'Structural SWL' and 'All' refers to 'All SWL'. As an example, given an average lumber price of \$300/mbf, US consumers move from a \$25.3/mbf price rise to a \$30.6/mbf price rise when the price results of the Structural market are used instead of the All SWL market.

A comparison of welfare impacts in the 'All SWL' and 'Structural SWL' market approaches follows intuitively from the price results. Although Table 5 provides some

[17] With respect to the current softwood lumber duties, tariff revenues collected by the US government may be further reallocated to US producers under the highly contentious Byrd amendment.

indication as to how welfare changes in absolute terms in the two markets, it is important to note that these figure are not directly comparable since they represent changes relative to two unique base cases (with the former inclusive of non-structural lumber). However, it is worthy to note that the welfare loss to the US is greater in absolute terms in the Structural market even though the welfare losses associated with non-structural lumber are not captured. Overall, the loss in welfare is greater for US importing regions and less for Canadian supply regions when the 'Structural SWL' market is considered rather than the 'All SWL' market.

Figure 2 illustrates the changes in US welfare for a given tariff level in a simple fashion. Rightward movement along the horizontal axis corresponds to an increasing demand to supply ratio. Where the curve crosses the horizontal axis, US domestic demand is perfectly satisfied by US domestic supply. An import tariff imposed at this point would have no impact on US welfare. To the right of this intersection, US domestic demand is greater than supply and lumber is imported. With an import tariff imposed in this situation, the US experiences a net loss in welfare, since the loss in consumer surplus more than offsets the gain to US producers. Whereas welfare estimates based on the traditional market may have fallen around a point such as A, controlling for the substitute bias is associated with a downward movement, perhaps to point B. In this analysis, point A is associated with a 0.9% loss in welfare based on the traditional SWL market, while point B corresponds to a 1.2% welfare loss obtained from the 'Structural SWL' market.

Sensitivity Analysis

As supply and demand elasticities play a key role in our SPE model estimates, alternate values were tested in order to assess the robustness of our results. Specifically, we consider a demand elasticity of –0.34 (double the original value), and then double all supply elasticities. With more price responsive (elastic) demand, consumers are better able to adjust their spending behavior and hence a smaller amount of consumer surplus is lost. This comes at the expense of producer gains, and is observed irrespective of the trade policy. Conversely, when supply becomes more elastic, producers can react to price signals with more flexibility and hence capture a larger in share of the surplus that would have otherwise gone to consumers. Results of the sensitivity analysis for the 'Structural SWL' market are provided in Table 6. Changes in elasticities influence the size of welfare changes, but not the rankings of winners and losers.

5. CONCLUSIONS

In this study, we examined the impacts of removing non-structural SWL, a product that has been argued to be complementary rather than competitive with structural SWL, from the SPE framework used to investigate the impacts of Canada-US trade disputes in softwood lumber. We find that the scale and delineation of estimated policy impacts are fundamentally altered: The negative impacts exerted by trade policies on US consumers become more pronounced, whereas injury to Canadian producers is reduced. In the context of current import duties, the tariff-induced price increase in the US is approximately 21% higher when modeling the 'Structural SWL' market rather than the traditional 'All SWL' market. This corresponds to an additional $37 million in losses, exclusive of the direct losses incurred from consuming tariff-induced higher priced non-structural lumber. In contrast, Canadian prices fall almost 15% less when only 'Structural SWL' is considered, resulting in gains of nearly $200 million, though we expect this would be slightly lower if changes in the non-structural lumber market were also taken into account.

From a supply perspective, restricted trade has promoted growth in US lumber imports from non-covered (or less covered) regions, and non-covered products coming from regions affected by the trade sanctions. Since the imposition of the quota in 1996 (and through the subsequent tariff period), US imports of softwood lumber from non-Canadian regions have risen by over two billion board feet, representing more than a six fold increase (USDA, 2004-05). In addition, US bound softwood lumber exports from Atlantic Canada (which was excluded from the SLA quota and exempt from the countervailing portion of the current duties) nearly doubled during this same period (Statistics Canada, 2004b). In relation to exempt products, Canadian raw log exports to the US have increased approximately 5½ times since 1996, even with various domestic impediments in place (USDA, 2004-05). Moreover, US imports of many value-added products from Canada have experienced significant growth.[18]

On the demand side, the persistence of restricted trade has directly impacted lumber consumption. The disparity in Canadian and US lumber prices resulting from the price wedge is clearly reflected in consumption statistics. From 1996 to 2003, per capita lumber consumption increased by 71% in Canada, but only by 3% in the US. Higher US lumber prices have played a role in both discouraging construction and promoting substitution to non-lumber products. The results of this study highlight this point as it indicates that US consumers incur even greater losses when we control for the substitution of various types of lumber. Canadian new home construction increased by

[18]US imports of various Canadian value-added wood products not covered by the trade restrictions have increased significantly since 1996. For instance, Canadian wood door and frame exports to the US have more than tripled and pre-fabricated building exports have increased nearly nine times since 1996.

75% between 1996 and 2003, but US housing starts rose only by some 25%. The significance of this trend is evident considering home construction and supporting industries have been important drivers of the US economy in recent years. Furthermore, it was estimated that US lumber use in wall, floor and roof framing decreased by 11%, 29% and 22%, respectively, between 1995 and 1998 (Cintrafor, 2000). The use of engineered wood products (glulam beams, I-joists, etc.) and non-wood products, such as steel and concrete, are increasing at the expense of lumber.

It is unlikely that the structural shifts occurring in US markets for softwood lumber will easily be reversed. Inroads by overseas producers and substitute products have been significant and their market shares will probably continue to grow. Overall, it is likely that the success, which the US CFLI has had in lobbying for restrictions on Canadian lumber imports will be eroded over time as a result of these structural changes, which continue to shrink the potentially exploitable margins.[19]

The latter conclusions are not altogether firm because the spatial price equilibrium model is static. Future research needs to take into account dynamic aspects of supply and demand, as some have suggested that the inter-temporal equivalence of trade policies, and the concomitant characteristics of their impacts, can diverge significantly due to underlying structural movements in demand and supply (Adams and Haynes, 1981; Stennes and Wilson, 2005; Schwindt et. al., 2004).

Future research also needs to examine in greater detail the complementarity and substitutability among various wood products, and non-wood products, used in construction. While we have demonstrated that distinguishing between structural and

[19] The Coalition for Fair Lumber Imports (CFLI) is an assemblage of US producers and timberland owners.

non-structural softwood lumber is important, the extent to which Canadian softwood lumber exports compete with various US lumber products is an issue that requires further study.

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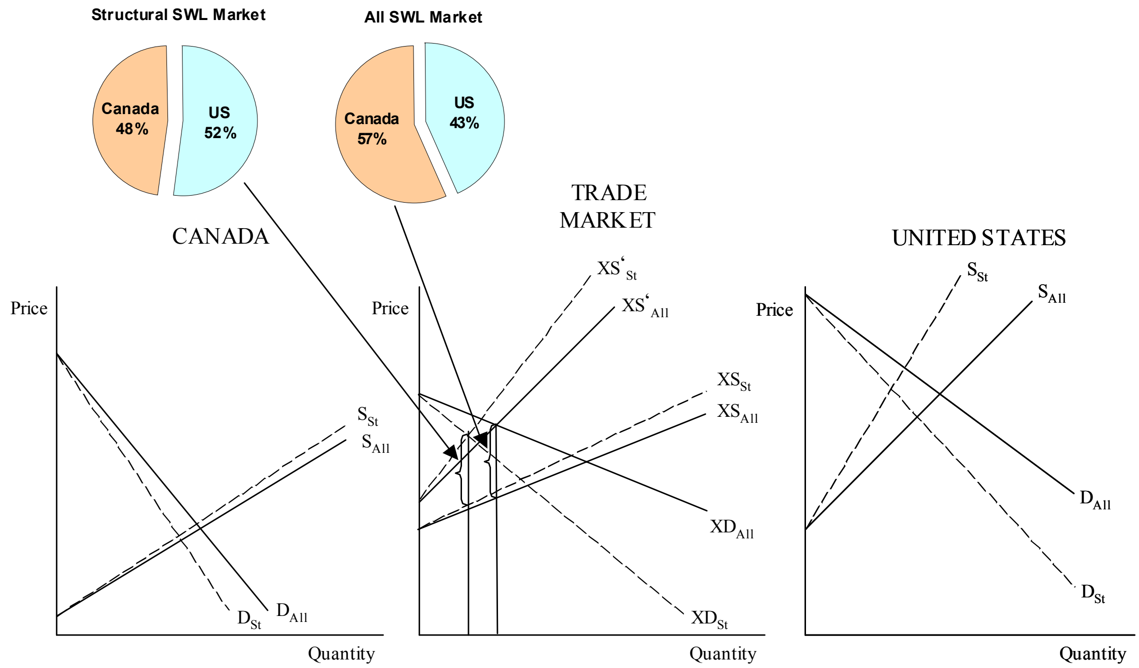

Figure 1. Price Wedge Structures and Shares of the Tariff Burden

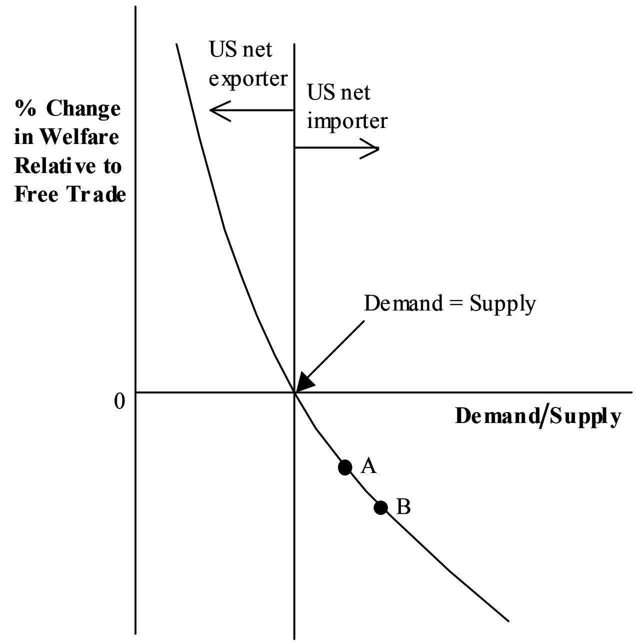

Figure 2. Welfare and the US Domestic Economy for a given Tariff Level

Table 1: Production, Consumption & Prices in the Two Model Formulations, 2003 with Tariffs

Region	All SWL			Structural SWL		
	Prod.	Cons.	Prices	Prod.	Cons.	Prices
	---------- mmbf --------		US$/mbf	---------- mmbf -------		US$/mbf
BC	15,010	1,724	257	14,122	1,614	245
AB	3,195	1,579	266	3,195	1,579	253
ROC	686	245	272	686	238	260
EC	11,295	6,055	286	10,690	5,826	274
AC	2,568	635	324	2,497	594	309
ECD	0	1,314	331	0	1,063	317
Canada	*32,754*	*11,552*		*31,460*	*10,814*	
CAL	2,627	6,016	384	1,502	4,757	368
SE	7,116	12,228	411	4,412	9,669	394
NE	1,319	8,531	396	716	6,746	380
NC	589	11,657	386	455	9,217	370
SC	9,794	10,220	390	5,961	8,081	374
MTN	3,630	5,618	380	2,851	4,442	364
PNW	10,871	2,086	334	9,646	1,649	318
US	*35,497*	*56,355*		*25,542*	*44,562*	
RWS	1,947	0	269	965	0	267
RWD	0	2,741	359	0	2,591	346

Table 2: SPE Model & Actual Trade Flows to the US in 2003

Region	Model Flows	Actual Flows
BC	10,000	10,127
AB	1,616	1,591
ROC	441	453
EC	5,240	5,368
AC	1,634	1,672
Total	18,931	19,211

Table 3: Production, Consumption and Prices in the Two Model Formulations, 2003
Free Trade (Base Case)

Region	All SWL			Structural SWL		
	Prod.	**Cons.**	**Prices**	**Prod.**	**Cons.**	**Prices**
	---------- mmbf ---------		US$/mbf	---------- mmbf ---------		US$/mbf
BC	16,255	1,678	298	15,121	1,578	277
AB	3,408	1,536	308	3,379	1,443	288
ROC	732	238	317	726	232	296
EC	12,380	5,882	335	11,887	5,679	314
AC	2,557	636	322	2,460	597	301
ECD	0	1,286	372	0	1,044	352
Canada	*35,332*	*11,256*		*33,573*	*10,573*	
CAL	2,559	6,095	355	1,455	4,831	334
SE	6,621	12,378	381	4,047	9,810	360
NE	1,301	8,640	366	704	6,848	346
NC	551	11,809	357	420	9,361	336
SC	9,097	10,352	361	5,456	8,205	340
MTN	3,385	5,692	350	2,621	4,512	330
PNW	10,547	2,117	304	9,301	1,679	284
US	*34,061*	*57,083*		*24,005*	*45,247*	
RWS	1,624	0	239	782	0	233
RWD	0	2,679	406	0	2,540	386

Table 4: Change in Price Relative to the Free Trade Case (%)

	---------------All SWL---------------			---------------Structural SWL---------------		
Region	Tariff	Quota	Export Tax	Tariff	Quota	Export Tax
BC	-13.6	-13.6	-14.8	-11.8	-11.9	-13.2
AB	-13.8	-13.8	-14.3	-12.1	-12.1	-12.7
ROC	-14.0	-14.0	-13.9	-12.4	-12.4	-12.3
EC	-14.4	-14.4	-13.2	-12.9	-12.9	-11.6
AC	0.8	0.8	2.1	2.6	2.6	4.0
ECD	-11.1	-10.9	-11.9	-9.7	-9.4	-10.4
CAL	8.4	8.4	8.4	10.1	10.1	10.1
SE	7.8	7.8	7.8	9.4	9.4	9.4
NE	8.1	8.1	8.1	9.8	9.8	9.8
NC	8.3	8.3	8.3	10.1	10.1	10.1
SC	8.2	8.2	8.2	9.9	9.9	9.9
MTN	8.5	8.5	8.5	10.3	10.3	10.3
PNW	9.7	9.7	9.7	11.9	11.9	11.9
RWS	12.4	12.4	12.4	14.5	14.5	14.5
RWD	-11.6	-10.0	-10.9	-10.4	-8.6	-9.5

Table 5: Changes in Welfare by Region from Free Trade for both "All SWL" and "Structural SWL" Formulation

	Tariff		Quota		Unit Tax	
Region	All SWL	Structural	All SWL	Structural	All SWL	Structural
BC	-11.9%	-10.3%	-12.0%	-10.4%	-13.0%	-11.5%
AB	-3.8%	-3.5%	-3.8%	-3.5%	-3.9%	-3.7%
ROC	-5.7%	-5.1%	-5.7%	-5.1%	-5.7%	-5.1%
EC	-3.7%	-3.3%	-3.7%	-3.3%	-3.4%	-3.0%
AC	0.4%	1.4%	0.4%	1.4%	1.1%	2.1%
ECD	4.4%	3.8%	4.3%	3.6%	4.7%	4.0%
Canada	-5.1%	-4.5%	-5.2%	-4.5%	-5.2%	-4.6%
$ Change	**-$882,515**	**-$686,834**	**-$886,378**	**-$691,852**	**-$900,784**	**-$705,691**
CAL	-1.3%	-2.0%	-1.3%	-2.0%	-1.3%	-2.0%
SE	-1.0%	-1.5%	-1.0%	-1.5%	-1.0%	-1.5%
NE	-2.0%	-2.6%	-2.0%	-2.6%	-2.0%	-2.6%
NC	-2.4%	-2.9%	-2.4%	-2.9%	-2.4%	-2.9%
SC	-0.2%	-0.8%	-0.2%	-0.8%	-0.2%	-0.8%
MTN	-0.9%	-1.1%	-0.9%	-1.1%	-0.9%	-1.1%
PNW	5.3%	6.9%	5.3%	6.9%	5.3%	6.9%
US	-0.9%	-1.2%	-0.9%	-1.2%	-0.9%	-1.2%
$ Change	**-$643,856**	**-$681,157**	**-$643,606**	**-$681,157**	**-643,873**	**-$681,278**
Revenue/Rent	**$1,302,329**	**$1,208,579**	**$1,304,479**	**$1,211,547**	**$1,312,797**	**$1,219,840**
ROW	**$180,719**	**$132,329**	**$162,829**	**$114,129**	**$172,503**	**$123,259**
DWL	**-$43,323**	**-$27,083**	**-$62,676**	**-$47,334**	**-$59,357**	**-$43,870**

Table 6: Aggregate Welfare with Alternative Supply & Demand Elasticities ('000s $US) (Structural SWL)

	Tariff			Quota			Unit Export Tax		
	Original Elast.	Double Demand	Double Supply	Original Elast.	Double Demand	Double Supply	Original Elast.	Double Demand	Double Supply
Canada									
CS	377	396	361	376	396	360	362	382	345
PS	-1064	-1141	-1049	-1068	-1149	-1051	-1068	-1147	-1051
Total	-687	-745	-688	-692	-753	-691	-706	-765	-705
United States									
CS	-1519	-1426	-1588	-1519	-1426	-1588	-1520	-1423	-1591
PS	838	783	846	838	783	846	838	781	848
Total	-681	-643	-742	-681	-643	-742	-681	-641	-743

APPENDIX A

Table A1: Model Regions & Elasticity Estimates Used in the SPE Model

Acronym	Region[a]	Supply Elasticity[b]	Demand Elasticity
BC	British Columbia	0.529	-0.17
AB	Alberta	0.415	-0.17
ROC	Saskatchewan Manitoba	0.415	-0.17
EC	Ontario Quebec	0.57	-0.17
AC	New Brunswick Nova Scotia Prince Edward Island Newfoundland & Labrador	0.57	-0.17
ECD	n.a.	n.a.	-0.17
CAL	California	0.335	-0.17
SE	South East US	0.963	-0.17
NE	North East US	0.188	-0.17
NC	North Central US	0.848	-0.17
SC	South Central US	0.937	-0.17
MTN	US Mountain	0.866	-0.17
PNW	Pacific Northwest	0.335	-0.17
RWS	Rest of World Supply	1.5	n.a.
RWD	Rest of World Demand	n.a.	-0.17

[a] Regions are consistent with those used in Stennes and Wilson, 2005 (slightly modified from Haynes, 2003) with the exception of a slight change in ECD.

[b] Supply elasticities are consistent with those used in Stennes and Wilson (2005). One exception is that a supply elasticity of 1.5 was used for the RWS region, as was assumed by Adams (2003).

Sources: Stennes and Wilson (2005); Adams (2003); Adams and Haynes (1996); Latta and Adams (2000); Zhang (2001).

APPENDIX B: DATA ELEMENTS

Production & Consumption

Reported data on total softwood lumber production was utilized in the 'All SWL' model formulation, though a few figures were estimated (US Census Bureau, 2004; Statistics Canada, 2004a, 2005a; NRCan, 2004; Forest Resources, 2005; Newfoundland and Labrador Department of Finance, 2005; Spelter & Alderman, 2003; WWPA, 2004; SFPA, 2005). In the 'Structural SWL' formulation, the production data was adjusted to exclude production of non-structural species (as defined in this paper). With non-structural production volumes reported for major non-structural producing regions, remaining volumes were allocated based on various estimates and assumptions. Non-North American supply was derived from Canada and US overseas imports (USDA, 2004-05; Statistics Canada, 2004b).

Consumption in the 'All SWL' model formulation was determined by allocating (national level) total apparent consumption of All SWL to the (country) regions, where apparent consumption is defined as domestic production plus imports minus exports. (USDA, 2004-05; Statistics Canada, 2004b; WWPA, 2004; US Census Bureau, 2005; National Association of Realtors, 2005; Canada Mortgage and Housing Corporation, 2004; Statistics Canada, 2005b; Random Lengths, 2004; Global Wood, 2005; World Forestry Institute, 2005.). In the 'Structural SWL' formulation, apparent consumption of structural SWL was used in place of 'All SWL'. Non North American demand was based on Canada and US overseas exports (USDA, 2004-05; Statistics Canada, 2004b).

Prices

Representative prices (Rp), used to anchor the range of endogenous prices, were determined using four lumber composite price indexes: framing lumber, low-grade random dimension lumber, shop & molding lumber, and boards (Random Lengths, 2005). The framing lumber index was used as the Rp in the 'Structural SWL' formulation. A non-structural lumber index was approximated based on the remaining three indexes. The Rp in the All SWL formulation was determined using an average of the structural and non-structural lumber indexes, based on respective shares of total production in 2003.

Transportation Costs

Transportation costs are defined between excess supply and excess demand regions. These costs reflect a fixed and a variable component. The fixed segment (equivalent across all supply regions and independent of distance) represents the cost of moving lumber to the rail point within a region. The variable segment signifies the cost of moving lumber between net supply regions and net demand regions in North America (BNSF, 2004; CN Rail, 2004; CPR, 2004; CSX Corporation, 2004; Norfolk Southern Corporation, 2004; Union Pacific Railroad, 2004). Container costs were used synonymously with rail costs for movement between North America and the rest of the world (Maersk Sealand, 2004; P&O Nedlloyd, 2004). Costs are adjusted to 2003 real US dollars. Transportation costs used in the 'All SWL' formulation are shown in Table B1. The transport cost matrix used in the 'Structural SWL' formulation was similar with the following exceptions: RWS to CAL, MTN, SE, and SC were 178.24, 168.40, 127.01 and 144.47, respectively.

Table B1: Transportation Costs (2003 $US per thousand board feet)

To/From	CAL	MTN	SE	SC	NE	NC	ECD	RWD
BC	56.82	52.59	83.81	63.28	85.50	58.89	74.17	108.22
AB	61.82	58.08	73.20	60.02	74.89	48.27	67.07	125.74
ROC	62.79	49.44	66.42	48.95	67.51	39.96	n.a.	133.38
EC	67.56	51.88	46.27	47.56	31.45	39.80	n.a.	109.28
AC	99.79	83.33	63.02	66.83	44.39	59.99	53.87	109.28
PNW	54.11	48.78	76.66	56.53	80.76	52.48	81.68	114.44
RWS	127.36	169.37	157.17	158.08	127.01	153.62	149.63	n.a.