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Is Free Trade the End All Be All? The Case of Log Exports

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Is Free Trade the End All Be All?
The Case of Log Exports

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Abstract

The government of British Columbia imposes restrictions on the export of logs from public and private forestlands, primarily to promote local processing and associated employment benefits. Economists wholeheartedly oppose BC's export restrictions, arguing that BC's citizens are worse off as a result of the government's measures. In this paper, it is shown that, while free trade in logs might well maximize global wellbeing, it might not necessarily result in the greatest benefit to British Columbia. Indeed, both economic theory and a follow-up numerical analysis indicate that some restrictions on the export of logs can lead to higher welfare for BC than free trade.

Keywords: international trade; log exports; forest industry; quota rents

JEL categories: F13, F14, Q23, Q27, Q28

1. INTRODUCTION

Regardless of their political stripe (socialist or free market), governments in many jurisdictions attempt to manage or regulate their forest resources to achieve the greatest possible employment. This has resulted in log export restrictions in countries as diverse as the United States, Russia and Canada. In the U.S. Pacific Northwest, Oregon imposed a ban on the export of logs from state owned lands in 1961 in an effort to protect local manufacturing jobs; California followed suite in 1972. Then in 1973 the U.S. Congress prohibited the export of any logs harvested on federal lands west of the 100th Meridian, followed in 1990 by a ban on log exports from Washington's state-owned lands and harvest reductions on all forestlands in the PNW to protect the Spotted Owl as permitted under the Endangered Species Act of 1973. Log exports from the PNW soared from about 1.0 million m^3 in the early 1960s to 8.7 million m^3, or 24% of the total harvest, by 1988, before falling back down to just over 1.0 million m^3 by the early 2000s (Daniels 2005). In 2010, 2.6 million m^3 of logs were exported, but this still constituted 19% of the total harvest (Kerr 2012). Of course, the exported logs came from private lands.

In Russia, investments in sawmilling and other processing capacity has historically lagged resource availability; by 2001, only two regions processed more than 25% of harvested logs while the other five regions utilized less than 10% (see Simeone and Eastin 2012). This led the government to incentivize investment in processing capacity by restricting log exports. An ad valorem export tax of 6.5% was imposed beginning January 1, 2007; the tax was increased to 20% on July 1, 2007 and then to 25% on April 1, 2008; and it was set to increase to 80% on January 1, 2009, but this was delayed indefinitely as a result of the financial crisis and pressure from the Scandinavian countries. The trade measures reduced roundwood log exports from 51.1 million m^3 in 2006 to 21.9 million m^3 in 2011, although some of this decline could be attributed to the global recession. On August 22, 2012, Russia officially joined the World Trade Organization (WTO) and, as part of its accession package, it agreed to reduce tariffs on log exports to 8% by 2015. However, since Russia was permitted to establish a volume tariff rate quota (TRQ), the 8% rate only applied to log exports below the quota. For exports above the quota, an export tax of 80% could be applied; in essence, then, the quota would be effective.

British Columbia has likewise restricted log exports from provincial forestlands, including private lands that account for only about 4% of the province's commercial forestland (Wilson et al. 1998, p.13).[1] A total ban on log exports from Crown (publicly-owned) land was put in place as early as 1891, but legislation to allow exemptions already came a decade later (1901). The Timber Manufacture Act (1906) extended the ban on log exports from Crown land to private lands that had previously been granted to the private owner by the provincial (as opposed to federal) government; this was followed in December 1907 by Order-in-Council #901 that put a halt to the further transfer of Crown land to private ownership.[2] An amendment to the Timber Manufacture Act in 1909, however, provided a means for obtaining exemptions to the log export ban. Since then, enforcement of the export ban has been relaxed or tightened depending on the economic and political situation, but the government has always maintained some flexibility to permit log exports (see Dumont and Wright 2006).

Forest companies in BC currently can only export logs if they are declared 'surplus' to domestic requirements – that is, no domestic buyer for the logs is forthcoming, or offers to purchase 'surplus' logs are deemed inadequate. A provincial Timber Export Advisory

[1] It is important to note that private forestlands are often managed as part of an integrated Tree Farm License that consists primarily of publicly-own timberlands (see Wang et al. 2014). This then provides some justification for government control over log exports from private forests.

[2] The federal government had granted land to the Canadian Pacific Railroad (CPR) for constructing a transcontinental railway; National Parks are also federal. Private forestlands were thus purchased from or granted by the province, or purchased from CPR. An example of the latter is the Darkwoods property in southeastern BC that is now owned by the Nature Conservancy of Canada (see van Kooten et al. 2012).

Committee (TEAC) advises on disparities between offers and bids, permitting log exports when 'warranted'.[3] Companies exporting logs pay a fee in 'lieu of manufacture' – a payment (or penalty) for lost opportunities in the processing sector – and must obtain an export permit from the Canadian Border Services Agency (a payment to the federal government). The former fee depends on domestic and export prices and is in addition to any stumpage fees the logging company pays to the province.

Historically, log exports rose when lumber markets were weak, but fell as demand picked up. Today, despite regulatory oversight, log exports from BC have become an important feature of BC's external trade. In 1987, BC exported nearly 4 million m^3 of raw logs, but a decade later exports had fallen to less than ½ million m^3. Log exports rose dramatically since 1997; by 2005, they reached nearly 5 million m^3, falling to about 3 million m^3 by 2009 as a result of the global financial crisis, and then rising rapidly to 5.7 million m^3 in 2012 and an estimated 6.5 million m^3 or more in 2013 (Figure 1). Meanwhile, exports of softwood lumber remained relatively constant from 1988 to the early 2000s, then rose rapidly to a peak of 32.8 million m^3 in 2006 before falling to 17.8 million m^3 in 2009, after which they began to climb back towards historic levels. In 2012, BC's log exports were valued at $576.8 million compared to $4,204.0 million for softwood lumber exports, or 13.7% of lumber export value; for January through September 2013, log exports were valued at $596.7 million compared to lumber exports of $3,955.1 million, or 15.1% of lumber export value.

[3] TEAC falls under the purview of the Ministry of Forests, Lands and Natural Resource Operations. Information about the steps required to be able to export logs can be found at the provincial website http://www.for.gov.bc.ca/het/export.htm and, since a federal export permit is also required, at the website of Foreign Affairs, Trade and Development Canada http://www.international.gc.ca/controls-controles/logs-bois/index.aspx?view=d (both viewed 21 November 2013).

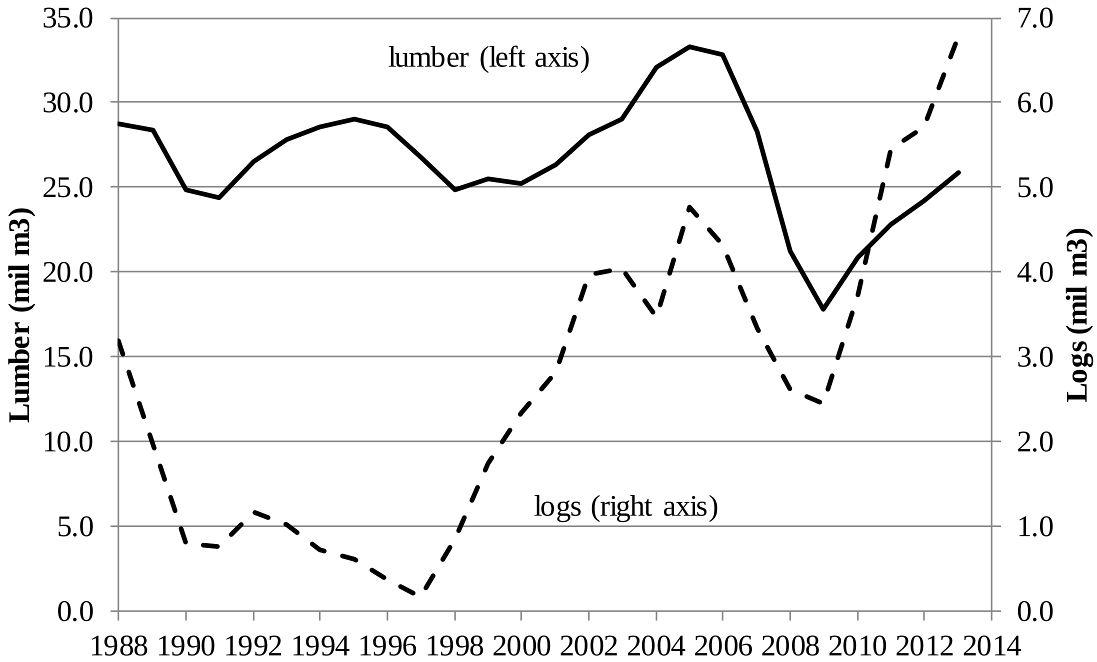

Figure 1: British Columbia log and softwood lumber exports, 1988-2013 (Source: BC Stats 2013a)

The debate about log exports assumes that the scale of British Columbia's log exports is sufficiently large to affect world prices (Margolick and Uhler 1992; Zhang 1996; Fooks et al. 2013). Empirical support for this assumption has recently been provided by Niquidet and Tang (2013). Some support for this is also provided in Figure 2. As BC's log exports rose beginning in the late 1990s (Figure 1), export and domestic prices began to converge.

Demand for BC logs has come almost exclusively from countries in the Pacific Rim, particularly Japan, China, South Korea and even the United States. China has become a major importer of raw logs, now accounting for nearly half of BC's log exports. From importing an insignificant amount of logs in the mid-1990s, China now purchases well over 20 million m^3 annually, with nearly 3 million m^3 coming from BC (2013). Given its proximity, Chinese imports of Russian logs rose rapidly from almost nothing in 1997 to over 20 million m^3 in 2007, after which Russia's exports of raw logs declined significantly (as discussed above). Given China's apparently insatiable demand for logs, the Russian policy caused log prices to rise and, along with the financial crisis and accompanying recession in the developed countries, this provided the opportunity for New Zealand, the U.S. and Canada to increase log exports to China as indicated in Figure 3.

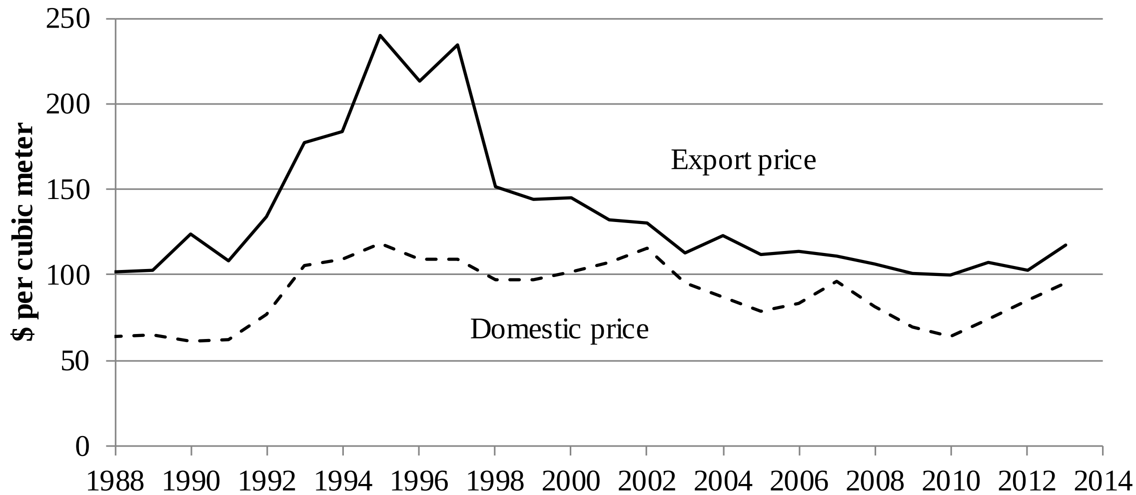

Figure 2: Domestic and export prices for British Columbia logs, 1988-2013 (Source: BC Ministry of Forests, Land and Natural Resource Operations 2013; BC Stats 2013b)

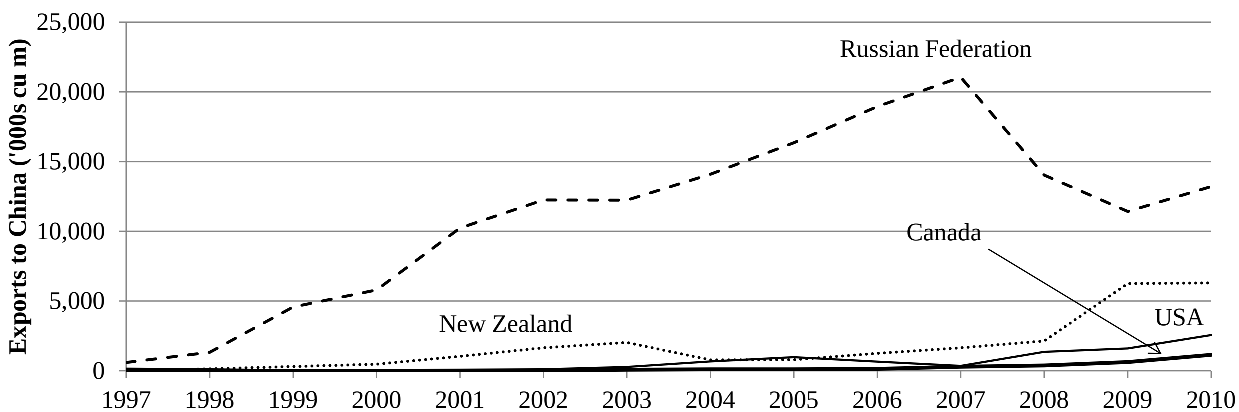

Figure 3: Exports of industrial roundwood logs to China by major supplier, 1997-2010 (Source: FAO 2012)

Trade economists are almost all agreed that "log export bans and restrictions could have detrimental effects on the overall economic efficiency of a nation or region" (Fooks et al. 2013, p.1103). Indeed, in their empirical investigation of BC's log export policy, Fooks et al. (2013, p.1111) conclude that the province has substantial potential to gain from the removal of its export restrictions.[4] Margolick and Uhler (1992) and Zhang (1996) make similar arguments in favour of removing all restrictions on BC's log exports. By eliminating restrictions on log exports, producers will generally gain more than consumers lose and, as a result, the economy as a whole benefits. As demonstrated in this paper, this conclusion is not necessarily supported theoretically or empirically. The reason is that none of the aforementioned studies includes the potential scarcity rents that one finds in log markets (see van Kooten and Folmer 2004, pp.38-44; van Kooten and Johnston 2014).

As opposed to a static argument against log export restrictions, a dynamic one might have greater traction. By permitting log exports, timber owners receive higher prices for logs than they would otherwise. This provides an incentive to increase investment in the production of logs – in activities that increase the commercial timber value of stands. In so doing, more logs are produced, log prices fall and local manufacturers can also benefit. Employment in forest-level activities increases but it might not come at less job loss in downstream manufacturing than initially anticipated. Yet, even in this case, the outcome depends on how scarcity rents created by log export restrictions are allocated. Clearly, if they are wasted through needless transaction costs imposed on firms seeking to export logs, the situation differs from that where the log producer (or landowner) captures the (scarcity) rents from restricting log exports.

The purpose of the current paper is to examine this issue using applied welfare economic analysis. In particular, it answers the question of whether British Columbia should change its policy regarding limited log exports. We begin in the next section by developing a theoretical

[4] The authors make no distinction between a log export ban and log export restrictions, using the terms interchangeably throughout.

framework for analysing the policy. This is followed by an empirical investigation of the BC policy, and a concluding discussion.

2. WELFARE ECONOMICS OF LOG EXPORT RESTRICTIONS

The initial situation and case for free trade in logs (or some other commodity) can be examined with the aid of Figure 4. Price and quantity under autarky are P^A ($/m^3) and q_A (m^3), respectively. With complete free trade, BC faces an excess demand for logs from the rest of the world given by ED, while ES is BC's excess supply and $ES' = ES + T$ is the relevant excess supply as it includes transportation costs of $$T$/m^3. The gains from trade are determined as follows: Compared to autarky (no trade), consumers in British Columbia lose (β+γ), but producers gain (β+γ+δ) for a net gain to the province from trade of δ. This gain can be represented in the international market as well, with δ = X+Y; the gain to foreigners, on the other hand, is given by area Z, although it is not possible in this diagram to determine the extent to which foreign producers lose and foreign consumers gain. However, since the price in the foreign market ($P^w_{Int'l}$) is less than the excess demand choke price (equal to the autarkic price in the foreign market), foreign consumers must gain more than producers lose. Finally, notice that the price in the international market exceeds that in the BC domestic market $P^w_{Int'l} > P^w$, as a result of transportation costs, which amount to area ($\varepsilon_1 + \varepsilon_2$).

Now consider an alternative situation where the starting point is not autarky, but one where limited log exports are already permitted. Let $Q^R = q_1 - q_0$ be the level of log exports that British Columbia permits in any year, although it does not permit free trade. The discussion of the changes in welfare in going from restricted log exports to free trade in logs is facilitated with the aid of Figure 5, which expands upon Figure 4.

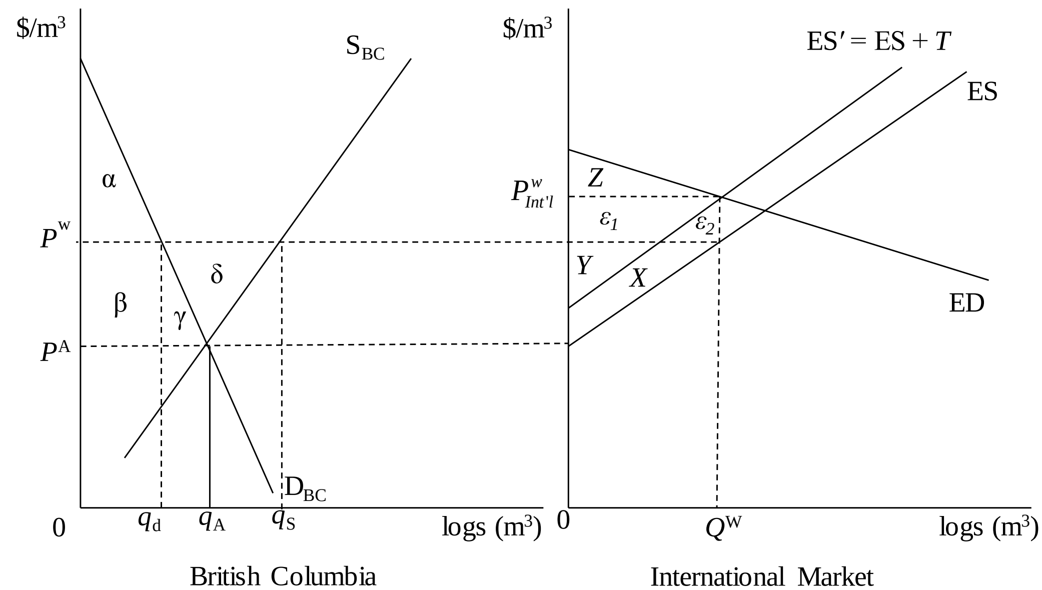

Figure 4: Analysis of British Columbia Permitting Free Trade in Logs

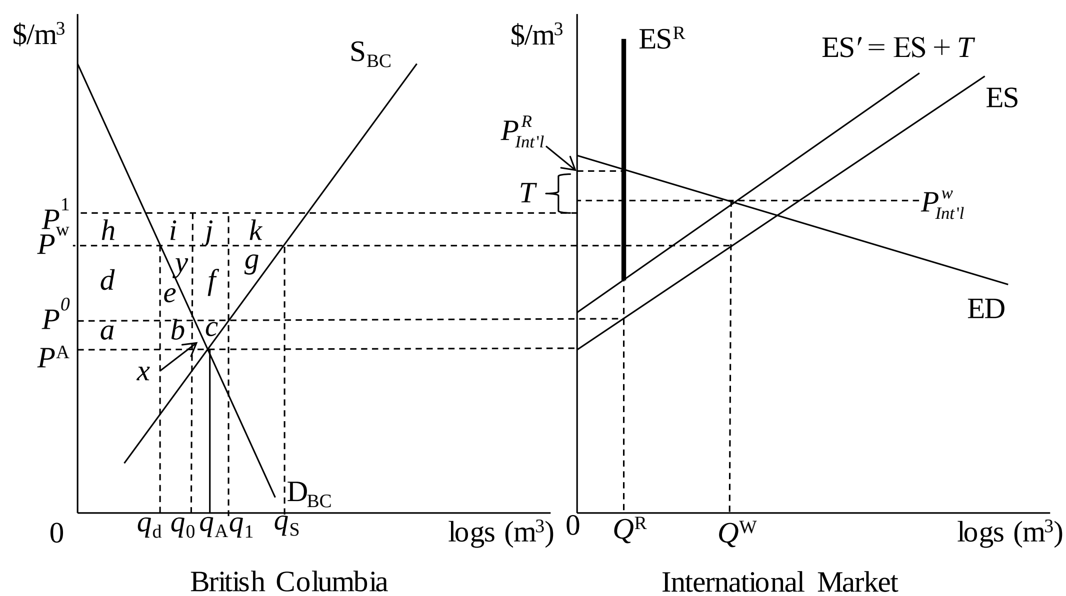

Figure 5: Analysis of the Welfare Impacts to British Columbia of Free Trade in Logs when Log Export Restrictions Exist

If BC restricts log exports to the amount Q^R ($=q_1–q_0$), this shifts the relevant excess supply function to ES^R. Logs are sold at price $P^R_{Int'l}$ in the international market, but the price received by domestic log producers is P^1 as a result of transportation costs T. To clear the domestic market, however, the price that BC consumers pay under restricted log exports is P^0. Compared to autarky, the limited export of logs causes domestic consumers to lose (a+b+x) while producers gain (a+b+x+c) for a net gain of c. In addition, area (j+f) is a surplus created by policy-induced scarcity; it could be wasted through the export-permitting process, or captured by the log exporter, public or private landowner, government, or some other entity.

Starting from limited exports, if log exports are now freely permitted, the world price P^w becomes relevant for BC and it exports Q^W logs (at the price given in the international market). Compared to the restricted log export situation, free trade in logs causes BC consumers to lose (d+e) and producers to gain (d+e+y+g–j), assuming for simplicity that areas f and j accrued to the producers when log trade was restricted to Q^R. The net gain to BC is thus (y+g–j) with j lost because of the price decline in the international market as monopoly power is removed. Most analyses of log export restrictions ignore this policy-induced scarcity-rent component of the trade restriction. If the elasticities of supply and demand in each of the markets are known, it would be possible to calculate the relevant welfare areas and determine whether international free trade in logs is preferred to limited trade.

3. IMPLEMENTING THE TRADE MODEL

Margolick and Uhler (1992), Zhang (1996), and Fooks et al. (2013) approach the trade restriction in the same fashion. They estimate supply and demand functions for logs in British Columbia and then employ assumptions about how prices in international markets are impacted by changes in BC log exports. Indeed, Margolick and Uhler (1992) and Zhang (1996) construct demand and supply curves for the foreign market (presumably equivalent to the international market in Figures 4 and 5), with Zhang even estimating the supply and demand functions for both BC (as do Fooks et al. 2013) and the PNW. Nowhere do any of these authors construct excess supply and demand curves, or otherwise explicitly link the domestic and foreign markets. This requires them instead to make arbitrary assumptions about the extent to which prices in other markets are impacted by changes in BC log export policy.

Demand and Supply Assumptions

To quantify the welfare impacts of log export restrictions, linear supply and demand functions are assumed. In particular, we assume the following domestic supply and demand functions:

[1] $P^d = \alpha - \beta q \qquad \alpha, \beta \geq 0$

[2] $P^s = a + bq, \qquad a, b \geq 0$

We can solve for the excess supply function as the quantity difference between supply and demand at each given price:

[3] $P^{ES} = \dfrac{\beta a + \alpha b}{b+\beta} + \dfrac{b\beta}{b+\beta} q$ and

[4] $P^{ES'} = \dfrac{\beta a + \alpha b}{b+\beta} + T + \dfrac{b\beta}{b+\beta} q$,

where T is the transportation cost.

The respective domestic demand and supply elasticities are given by:

[5] $\varepsilon_d = \dfrac{dq}{dp}\dfrac{p}{q} = -\dfrac{1}{\beta}\dfrac{p}{q}$ and $\varepsilon_s = \dfrac{dq}{dp}\dfrac{p}{q} = \dfrac{1}{b}\dfrac{p}{q}$.

We can then calculate the parameters in [1] and [2] as a function of ε_d, ε_s, p and q, which are the available from various sources (as discussed below). The parameters for domestic supply and demand functions are thus:

[6] $\beta = \frac{-1}{\varepsilon_d}\frac{p^d}{q}$, $\alpha = p^{\mathrm{d}}(1 - \frac{1}{\varepsilon_d})$, $b = \frac{1}{\varepsilon_s}\frac{p^S}{q}$, and $a = p^{\mathrm{s}}(1 - \frac{1}{\varepsilon_s})$.

We can do the same for an assumed linear excess demand function, $P^{ED} = k_0 - k_1 q$. The price elasticity of ED is given by:

[7] $\varepsilon_{ED} = \frac{dq}{dp}\frac{p^R_{Int'l}}{Q^R} = -\frac{1}{k_1}\frac{p^R_{Int'l}}{Q^R}$,

so that $k_1 = \frac{-1}{\varepsilon_{ED}}\frac{p^R_{Int'l}}{Q^R}$ and $k_0 = p^R_{Int'l}(1 - \frac{1}{\varepsilon_{ED}})$. In these cases, $p^R_{Int'l}$ refers to the excess demand price in the international market for the quota-constrained quantity of logs Q^R exported by British Columbia (Figure 5).

In the Appendix, we demonstrate that the optimal level of log exports that maximizes the quota rent is $Q^{R*} = ½\, Q^W$, but the level that maximizes the overall benefit to British Columbia is $Q^B = \left(\frac{2w+2k_1}{3w+4k_1}\right)Q^W$. Finally, it is shown that $0 < Q^{R*} < Q^B < Q^W$. These relations are worth considering when evaluating BC policy regarding log export restrictions. However, empirical values of the various parameters are needed to determine whether BC's policy is preferred to the alternative of free trade.

Parameter Values

To determine the welfare areas identified in Figure 5, it is necessary to have information on domestic consumption and production of logs, exports of logs (quota amount), the elasticities of domestic demand and supply, and the elasticity of excess demand. Elasticity of demand and supply estimates for British Columbia are available from various sources. For example, Fooks et al. (2013) estimated a price elasticity of demand of –1.10, while Zhang (1996) employs an estimate of ε_s = –0.76. In a survey of the forest economics literature, Devadoss (2008) finds estimates for BC range between –0.2 and –2.0.

As to the price elasticity of supply, van Kooten and Johnston (2014) found estimates ranging from 0.8 to 1.1, but employed ε_s = 1.0 because it has the convenient property that any linear supply function with an elasticity of 1.0 passes through the origin. Fooks et al. (2013) estimate the elasticity of supply to equal 1.03, while Zhang (1996) estimated an unusually low elasticity of supply for BC of ε_s = 0.11. Since logs for export originate almost exclusively on the BC coast, Margolick and Uhler (1992) employ ε_s = 0.3 (for the BC coast only).

Finally, we require estimates of the elasticity of excess demand for BC logs. Niquidet and Tang (2013) estimate Marshallian excess demand elasticities for Canadian log imports by China and Japan. Since imports of Canadian logs originate entirely from British Columbia, these estimates constitute the excess demand elasticities for the purposes of our model. The estimates are as follows: ε_{ED} = –1.40 (China) and ε_{ED} = –1.67 (Japan).

A summary of the reference data is provided in Table 1. Log sales and price data come from BC Stats (2013a), with log export data also available from BC Stats (2013b). Price elasticity data come from the sources indicated above. Given that there are various estimates of the domestic demand and supply elasticities, a 'most likely' value and range of values from 'lowest possible' to 'highest possible' are provided. For the elasticity of ED for BC logs, an average of the Chinese and Japanese values is taken as the 'most likely' with the lowest and highest 10% below and above the Japanese and Chinese estimates, respectively. Finally, the transportation costs are derived from van Kooten and Johnston (2014), but since there is anecdotal evidence suggesting that the actual costs might be lower (e.g., in containers as backhaul), high and low values are constructed about the point estimate (Table 1). In the simulation analysis discussed below and for convenience, the elasticity and transportation values are assumed to be drawn from triangular distributions.

Table 1: Data used to Analyze Economic Impacts of Log Export Restriction for Base Years 2011 and 2007

Item	2011	2007
Domestic log price ($/m^3)	74.03	96.33
World price ($/m^3)	107.61	110.68
Total log harvest ('000s m^3)	69,328.0	72,166.3
Domestic log consumption ('000s m^3)	63,878.1	68,827.4
Log exports from BC ('000s m^3)	5,449.9	3,338.8
	Range of Values for Simulations ['Lowest', 'Most Likely', 'Highest']	
Elasticity of supply	[0.3, 1.0, 1.1]	
Elasticity of demand	[-0.2, -1.1, -2.0]	
Elasticity of excess demand	[-1.25, -1.54, -1.83]	
Transportation cost ($/m^3)	[5.0, 10.0, 12.0]	

4. RESULTS

Monte Carlo simulation is used to calculate the welfare measures in Figure 5. In each iteration, values of the three elasticities and the transportation cost are drawn from a triangular distribution with parameters given in Table 1. We employ 10,000 iterations with random draws from triangular distributions about each of the parameters in Table 1 using the 'Runuran' package in R (version 3.0.1). In addition to the base values provided in Table 1, we examine situations where the parameters of the triangular distribution are changed for each of the four random variables independently. We also examine conditions for 2011 and 2007 as these represent a year of low North American lumber demand conditions and one of high demand, respectively. A comparison of the free trade and optimal levels of log exports across years and scenarios is provided in Table 2, while the welfare results are provided in Tables 3 and 4 for 2011 and 2007, respectively.

Table 2: British Columbia Log Exports under Free Trade, Maximization of Quota Rent, and Maximization of Domestic Benefits[a]

	2011			2007[b]		
Scenario	Free Trade	Quota Rent	Domestic Benefit	Free Trade	Quota Rent	Domestic Benefit
1. Base case	7.251	3.625	3.659	3.512	1.756	1.768
(as in Table 1)	(0.136)	(0.068)	(0.070)	(0.029)	(0.015)	(0.015)
2. Lower transport	7.451	3.726	3.760	3.596	1.798	1.810
cost [5.0,8.5,10.0]	(0.102)	(0.051)	(0.053)	(0.024)	(0.012)	(0.013)
3. Lower BC ε_s	7.313	3.656	3.690	3.596	1.798	1.810
[0.1,1.0,1.1]	(0.101)	(0.050)	(0.052)	(0.024)	(0.012)	(0.013)
4. Less elastic BC ε_d	7.303	3.652	3.690	3.595	1.797	1.811
[-0.2,-1.1,-1.2]	(0.099)	(0.050)	(0.052)	(0.024)	(0.012)	(0.013)
5. Greater ε_{ED}	7.503	3.751	3.789	3.622	1.811	1.825
[-1.25,-1.54,-2.25]	(0.221)	(0.111)	(0.116)	(0.038)	(0.019)	(0.020)
6. Much greater ε_{ED}	7.664	3.832	3.874	3.645	1.822	1.837
[-1.54,-1.80,-2.25]	(0.147)	(0.074)	(0.077)	(0.031)	(0.016)	(0.016)

Notes:
[a] Standard deviations of 10,000 randomly determined values provided in parentheses.
[b] For 2007, the lower transportation costs of scenario 2 are used in scenarios 3 through 6 as well.

The results in Table 2 indicate that, in a low demand year (2011), the optimal level of log exports should be greater than in a year when domestic demand for logs is high (2007). Thus, both the theoretical and actual levels of BC log exports were higher in 2011 than 2007 because demand for lumber and other wood products in the former year was much lower than in 2007 – the year before the collapse in the U.S. housing market due to the financial crisis. More importantly, however, is the comparison between the actual and optimal levels of log exports. BC exported 7.86% (5.4 million m^3) of the logs harvested in 2011, and 4.63% (3.3 million m^3) of total log production in 2007. Yet, when compared to optimal log export restrictions, actual log exports from British Columbia exceeded the level (Q^B) that would yield the greatest benefit to the province, by some 45% in 2011 and 85% in 2007. It would seem that, while the government has adjusted log exports to economic conditions, it has landed at a level of exports that lies somewhere between that which yields the highest net benefits to the province and free trade amount. Nonetheless, a policy that increases exports toward the free trade level would likely reduce rather than enhance the wellbeing of British Columbians as shown in Tables 3 and 4.

For the scenarios in Tables 3 and 4, there is always an overall net gain to British Columbia in going from autarky to free trade in logs. Indeed, this is the conclusion that commentators such as Fooks et al. (2013), and Margolick and Uhler (1992), use to justify free trade in raw logs and removal of any restrictions on log exports. However, the results in Table 3 clearly indicate that, once log exports are in place, British Columbia would be made worse off by moving to complete free trade in logs. This conclusion is robust across the range of elasticities and transportation costs explored here. It would seem, therefore, that the current level of BC log exports is preferred to free trade in logs. Is this always the case?

The unambiguous answer to this question is that, in the static model where BC faces a downward sloping excess demand curve for its logs, the province will always be better off by restricting log exports than it would be with free trade in logs. The results in Table 4 are ambiguous, however, because actual log exports for 2007 (3.34 million m^3) are already close to the free trade amount (3.6 million m^3). For example, if transportation costs are significantly high compared to the excess demand choke price, the province could benefit from free trade in logs.

The reason is that the high transportation costs reduce the available quota rent, and thereby it pays to increase exports to the free trade level. For the lower transportation cost scenarios 3 through 6, there remains a cost to moving to free trade in logs, although the associated high standard deviations suggest that this is not always the case. That is, area (*y*+*g*) in Figure 5 is almost always but not unambiguously smaller than area *j*.

Table 3: Welfare Analysis of the Costs of Log Export Restrictions, 2011 ($ millions)[a]

	Autarky to free trade	Welfare impacts of moving from the current restricted level of log exports to free trade in logs				
Scenario[b]	Net Gain	Gain to consumers	Gain to producers	Net gain	Quota rent	Transport cost
Base case	53.608	-50.576	-22.243	-72.819	119.843	83.902
(as in Table 1)	(3.911)	(6.047)	(9.911)	(10.717)	(7.008)	(8.065)
Lower transportation cost [5.0,8.5,10.0]	46.353	-56.168	-37.263	-93.431	133.199	68.087
	(1.902)	(5.977)	(7.253)	(3.752)	(2.320)	(2.988)
Lower BC ε_s	51.448	-52.310	-26.802	-79.112	123.976	79.185
[0.1,1.0,1.1]	(2.144)	(5.636)	(7.203)	(4.831)	(3.076)	(3.753)
Less elastic BC ε_d	53.057	-59.552	-18.893	-78.445	123.976	79.081
[-0.2,-1.1,-1.2]	(1.847)	(3.343)	(5.026)	(4.790)	(3.076)	(3.748)
Greater ε_{ED}	53.108	-57.590	-19.862	-77.452	123.976	81.241
[-1.25,-1.54,-2.25]	(2.778)	(8.172)	(10.434)	(5.149)	(3.076)	(4.369)
Much greater ε_{ED}	54.516	-62.073	-13.971	-76.044	123.976	82.986
[-1.54,-1.80,-2.25]	(2.389)	(7.068)	(8.726)	(4.945)	(3.076)	(4.015)

Notes:
[a] Based on data for 2011. Standard deviations of 10,000 randomly determined values provided in parentheses.
[b] In order, the values in [ ] refer to the 'lowest possible', 'most likely' and 'highest possible' values for the triangle distribution. The base case scenarios are provided in Table 1.

Table 4: Welfare Analysis of the Costs of Log Export Restrictions, 2007 ($ millions)[a]

	Autarky to free trade	Welfare impacts of moving from the current restricted level of log exports to free trade in logs				
Scenario[b]	Net Gain	Gain to consumers	Gain to producers	Net gain	Quota rent	Transport cost
1. Base case	22.366	-6.476	14.066	7.589	11.747	38.028
(as in Table 1)	(0.855)	(1.248)	(1.806)	(2.671)	(1.885)	(1.679)
2. Lower transportation	19.940	-9.589	9.102	-0.488	17.398	32.853
cost [5.0,8.5,10.0]	(0.721)	(1.287)	(1.692)	(2.051)	(1.421)	(1.342)
3. Lower BC ε_s	19.940	-9.589	9.102	-0.488	17.398	32.853
[0.1,1.0,1.1]	(0.721)	(1.287)	(1.692)	(2.051)	(1.421)	(1.342)
4. Less elastic BC	20.444	-10.944	10.520	-0.424	17.398	32.844
ε_d [-0.2,-1.1,-1.2][c]	(0.632)	(1.053)	(1.324)	(2.045)	(1.421)	(1.342)
5. Greater ε_{ED}	20.113	-10.577	10.262	-0.315	17.398	33.094
[-1.25,-1.54,-2.25]	(0.738)	(1.734)	(2.075)	(2.051)	(1.421)	(1.358)
6. Much greater ε_{ED}	20.259	-11.416	11.248	-0.168	17.398	33.299
[-1.54,-1.80,-2.25]	(0.717)	(1.592)	(1.803)	(2.038)	(1.421)	(1.333)

Notes:

[a] Based on data for 2007. Standard deviations of 10,000 randomly determined values provided in parentheses.

[b] The values in [ ] refer to the 'lowest possible', 'most likely' and 'highest possible' values for the triangle distribution. The base case scenarios are provided in Table 1; scenarios 3 through 6 also employ the lower transportation costs of scenario 2.

[c] Results are similar if the absolute value of ε_d is increased from 1.1 to 1.5 or reduced to 0.8.

5. CONCLUDING DISCUSSION

Economists have generally condemned British Columbia's log export policies, arguing that the province is forgoing significant benefits from failing to permit free trade in logs. The province's policy regarding log exports is primarily designed to protect and promote downstream processing jobs, a questionable objective at best. Yet, historically the government has recognized the potential employment and other benefits that can be captured by permitting some log exports when lumber and other wood product markets are weak. Because log exports continue as in the past, albeit at various levels depending on (sometimes arbitrary) factors that affect policy, the proper comparison in evaluating BC's restrictions on log exports is the benefit that is gained in moving from current levels of log exports to those expected under free trade.

The theoretical and empirical results in this paper suggest that British Columbia's current policy of restricting log exports is preferred to free trade, ceteris paribus. As demonstrated here, the level of log exports that maximizes the total economic surplus available to British Columbians is slightly greater than one-half of the free trade level of exports, or slightly more than the level that garners the greatest quota rent. Any other level of log exports is inferior. From this perspective, too many logs may have been exported in both 2007 and 2011, at least given the assumptions upon which the analysis used in this study are based.

Should British Columbia strive to permit free trade in logs? This is a different question. For one thing, it depends on what happens to the policy-induced, scarcity (quota) rent. If it is entirely wasted via high transaction costs associated with obtaining log-export permits, the province might be as well off promoting free trade in logs. If the available rents are captured by importers or exporters that subsequently transfer the windfalls out of the province, free trade may also be preferred. However, if the government is able to capture the rents and/or if rents are used to promote investment in R&D, silviculture and manufacturing facilities, then log export restrictions are to be embraced. Indeed, export restrictions might make logs even more valuable than they would be under free trade, thereby promoting investment in growing forests.

There remains one aspect of BC's log export restrictions that favours free trade. In a global economy, log export restrictions are viewed as an impediment to trade. As such, they could be the target of counter measures, whether duties on imports of other Canadian goods, a bargaining chip used against Canada in trade negotiations, or some other measure that harms British Columbia or Canada more broadly. Then the case for free trade in logs is a stronger one.

Finally, the results in this study are driven by the linearity assumptions. While the assumption of linear supply and demand underlies the majority of studies in forest products trade, Fooks et al. (2013) assume semi-logaritmic functional forms because the price elasticities of supply and demand remain constant throughout. Whether this is assumption leads to significantly different results than those identified above is a subject for further research. Our view is that the use of nonlinear supply and demand functions greatly increases the complexity of the analysis, but with little in the way of additional insights.

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7. APPENDIX

Following van Kooten (2002), we begin by examining the quota rent available in the international market as a function of the quantity traded:

[8] $R(Q) = (P^{ED} - P^{ES'})\, Q = [(k_0 - k_1\, Q) - (r + w\, Q + T)]\, Q,$

where Q refers to the quantity of logs exported by BC, $r = \frac{\beta a + \alpha b}{b + \beta} = P^A$ (autarkic price), and $w = \frac{b\beta}{b + \beta}$. By setting $P^{ED} = P^{ES'}$, we find the respective free-trade quantity and price:

[9] $Q^W = \frac{k_0 - r - T}{w + k_1}$ and $P^w = \frac{rk_1 + w(k_0 - T)}{w + k_1}$.

The quota rent $R(Q)$ is given by area $Q^R \times (P^R_{Int'l} - T)$ in Figure 5; it varies as Q changes, with $R(Q{=}0) = 0$ and $R(Q^w{=}0) = 0$. Upon setting the first derivative of $R(Q)$ to zero and solving, we find the level of log exports that maximizes the quota rent:

[10] $Q^{R*} = \frac{k_0 - (r + T)}{2(w + k_1)} = ½\, Q^W$.

Substituting [10] into [9] gives:

[11] $R(Q^{R*}) = ¼\left(\frac{(k_0 - r - T)^2}{w + k_1}\right)$.

The quota rent accrues to logging companies and forest landowners in British Columbia.

When there is a quota on log exports, however, provincial log producers forego some quasi-rent as a result of reducing output below the unrestricted free trade amount.[5] The reason is that, while a quota increases the demand price in the international market compared to free trade, the supply price falls; in the domestic market it is the supply price that determines the price processors pay for logs (see Figure 5). Naturally, domestic lumber and other wood product manufacturers prefer zero log exports since this keeps the price of logs at their lowest (at P^A in Figure 5).

To find the optimal level at which to restrict log exports (or quota) from the perspective of British Columbia, it is necessary to determine the level of trade that maximizes the sum of the quasi-rents accruing to log producers (producer surplus) and wood processors (measured as a consumer surplus under the derived demand function) plus the quota rent in the international market:

$$[12] \quad B(Q) = ½\,(P^{ES} – a)\,(q_d + Q) + (P^{ED} – P^{ES} – T)\,Q + ½\,(\alpha – P^{ES})\,q_d\,,$$

where P^{ES} is the (excess) supply price and P^{ED} the (excess) demand price found in the international market; q_d represents logs consumed domestically; and $Q = q_s – q_d$ refers to exports of logs, with q_s the amount harvested in BC. The first term on the right-hand-side of [12] refers to the quasi-rent accruing to log producers, the second term to the quota rent (if any), and the third term to the quasi-rent (consumer surplus) accruing to domestic lumber and other wood product manufacturers.[6]

As the first term deals with the producer surplus in the domestic log market, we substitute

[5] Quasi-rent refers to the quantity sold multiplied by the supply price minus the variable cost of supplying that quantity (area under the supply curve); it does not include the policy-induced scarcity (or quota) rent, which we measure separately. See van Kooten and Folmer (2004, pp.38-44) for further discussion.

[6] As van Kooten and Johnston (2014) show, the surplus area under the derived demand curve for logs is a quasi-rent measured as a (producer) surplus above the supply curve and below the output price faced by lumber manufacturers and other wood processors.

for Q and rewrite equation [12] as:

[13] $B(Q) = ½ (P^{ES} – a)\, q_s + (P^{ED} – P^{ES} – T)\, Q + ½ (\alpha – P^{ES})\, q_d$.

Clearly, if there are no log exports, the benefit to BC is as follows:

[14] $B(Q=0) = ½ (P^A – a)\, q_A + ½ (\alpha – P^A)\, q_A = ½ (\alpha – a)\, q_A = ½ \dfrac{(\alpha - a)^2}{b+\beta}$,

since $q_A = (\alpha – a)/(b+\beta)$. Notice that wellbeing depends only on the intercept and slope parameters of the domestic supply and demand functions, and these in turn depend on the elasticities of supply and demand.

When there is free trade, Q^W is exported but there is no quota rent (as noted above) so the surplus can be measured solely in the domestic market:

[15] $B(Q=Q^W) = ½ (P^w – a)\, q_s + ½ (\alpha – P^w)\, q_d$.

Substituting $q_s = 1/b\, (P^w – a)$ and $q_d = 1/\beta\, (\alpha – P^w)$ into [15] gives:

[16] $B(Q=W^w) = \dfrac{1}{2b}(P^w - a)^2 + \dfrac{1}{2\beta}(\alpha - P^w)^2 = \dfrac{1}{2b}(P^w - a)^2 + \dfrac{1}{2\beta}(P^w - \alpha)^2$.

Upon substituting for P^w from [9],

[17] $B(Q=Q^W) = \dfrac{1}{2b}\left(\dfrac{(\beta a + \alpha b)k_1 + b\beta(k_0 - T)}{b\beta + (b+\beta)k_1} - a\right)^2 + \dfrac{1}{2\beta}\left(\dfrac{(\beta a + \alpha b)k_1 + b\beta(k_0 - T)}{b\beta + (b+\beta)k_1} - \alpha\right)^2$

$$= \frac{1}{2b}\left(\frac{(\alpha - a)bk_1 + (k_0 - T - a)b\beta}{b\beta + (b+\beta)k_1}\right)^2 + \frac{1}{2\beta}\left(\frac{(a - \alpha)\beta k_1 + (k_0 - T - \alpha)b\beta}{b\beta + (b+\beta)k_1}\right)^2 .$$

Again wellbeing depends on the intercept and slope parameters of the domestic supply and demand functions, and hence the price elasticities of supply and demand, as well as the intercept and slope parameters (and thus the price elasticity) of the excess demand function.

Finally, we consider whether some degree of log exports between zero and Q^W would lead to greater welfare to British Columbians than an amount Q^W. In this case, we set the first derivative of $B(Q)$ in [13] to zero and solve for Q.

[18] $B'(Q) = ½\, wq_s – (k_1 + w)Q + (P^{ED} – P^{ES} – T) – ½\, wq_d = 0.$

$=> ½\, w\, (q_s – q_d) – (k_1 + w)Q + k_0 – k_1Q – r – wQ – T = 0$

$=> ½\, w\, Q – (k_1 + w)Q + k_0 – k_1Q – r – wQ – T = 0$

$=> – 3/2\, w\, Q – 2\, k_1Q + k_0 – r – T = 0$

Then,

[19] $$Q^B = \frac{k_0 - r - T}{\frac{3}{2}w + 2k_1} = \left(\frac{k_0 - r - T}{\frac{3}{2}w + 2k_1}\right)\left(\frac{w + k_1}{w + k_1}\right) = \left(\frac{w + k_1}{\frac{3}{2}w + 2k_1}\right)\left(\frac{k_0 - r - T}{w + k_1}\right) = \left(\frac{2w + 2k_1}{3w + 4k_1}\right)Q^W .$$

$Q^B > 0$ as long as $(k_0 – r – T) > 0$, which will be true as long as there is adequate external demand for British Columbia’s raw logs and transportation costs are not too large – that is, trade occurs. Further, $Q^B < Q^W$ because the denominator in [19] is greater than the numerator. Finally, from result [10], if $\left(\frac{2w + 2k_1}{3w + 4k_1}\right) < ½$ then $Q^B < Q^{R*}$. This implies that $4w + 4k_1 < 3w + 4k_1$, or that $4w < 3w$, which is clearly not the case. Thus, we conclude that $0 < Q^{R*} < Q^B < Q^W$. However, numerical analysis is required to shed further light on these results for the case of British Columbia.