Log Export Policy for British Columbia

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June 2014

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Summary

Almost no topic in British Columbia forestry has been more controversial than what to do about log exports. Unions and some politicians argue for a complete ban, while previous economic analysis has favoured free trade in logs. Meanwhile, the current government has been happy to allow limited log exports, so long as these logs are not of the highest quality and are deemed surplus to domestic needs. This paper compares three policy options for British Columbia's log exports: a ban, an export quota, and free trade.

In 2011, British Columbia exported over 5 million cubic metres of logs to China, Japan, Korea, and the United States. These log exports represent a relatively small percentage of the total BC harvest, but a large percentage of the Coastal harvest, where most logs for export originate. Over the past decade, China has become the largest foreign buyer of BC logs.

Despite the demand for BC logs on foreign markets, log exports are restricted by the provincial and federal governments. In most cases, to export a log from the Coastal region, the producer must secure a federal export permit if the area logged is under federal jurisdiction or both federal and provincial permits if under provincial jurisdiction. To obtain a permit, a log must be harvested and then offered first to domestic buyers on the Vancouver Log Market. A government-appointed committee then applies a Surplus Test to determine whether that particular log is deemed surplus to domestic needs and judges whether any domestic offers of purchase are "fair". The provincial government also imposes additional prohibitions on the export of certain species (like Red Cedar) and the highest grades of logs for timber that falls under provincial jurisdiction.

Because of the restrictions on exports, logs sell for substantially less to domestic buyers on the Vancouver Log Market than those sold to foreign buyers. In 2011, the average price of logs sold domestically on the Vancouver Log Market was $74.28 per cubic metre, while the average price of logs exported was $108.35 per cubic metre. Furthermore, the current export approval process, and the Surplus Test in particular, adds significant delays and uncertainty into the operations of logging companies. The current log export process prevents log owners from securing long-term contracts with foreign buyers to shelter from price volatility, prevents log owners from sorting logs per

customer request, and imposes delays that increase log-handling costs and ties up capital. A streamlined process, such as an export quota, would eliminate these costs while continuing to restrict exports.

This paper develops a partial equilibrium trade model that reflects the BC Coastal log market and the international market for BC logs to analyze three possible policy options: a ban on exports, an export quota, and free trade in logs. Using 2011 market data, the model suggests that an export quota that restricts log exports to current levels is more beneficial to British Columbia than an export ban or free trade. The intuition behind this result is that limiting BC log exports allows BC log owners, as a group, to exercise market power in the international market. Sensitivity analysis suggests that the results partially hinge on how substitutable BC logs are for logs from other jurisdictions: if BC logs are very substitutable, then free trade in logs is more beneficial than an export quota.

One thing is exceedingly clear from the analysis: an outright prohibition on log exports from British Columbia, as advocated by many pundits, politicians, and interest groups, is very costly compared to all alternatives. Both free trade in logs and a quota policy allowing limited log exports are preferable to a ban on exports.

Although free trade in logs is not the preferred policy from a BC perspective, it certainly is from a global perspective. Chinese, Japanese, and Korean log consumers directly benefit from British Columbia allowing more log exports. This presents an opportunity. Canada is currently in talks to join the Trans Pacific Partnership, which includes Japan. There have also been calls in the media and policy circles for the commencement of trade negotiations with China in the future. It is possible that removing all restrictions on log exports as part of a trade agreement could leverage concessions of a similar size that would benefit British Columbia and Canada.

1 Introduction

Forestry and logging remain critical economic activities in many parts of British Columbia, and the province retains some comparative advantage in the sector. But there is a legitimate concern that the province may not be getting the most value out of the sector because of a multitude of policies restricting log exports. For example, in 2011 Hemlock and Balsam logs sold, on average, for $60.98[1] per cubic meter (m^3) on the Vancouver Log Market (VLM), but received $104.51/ m^3 on world markets[2] (BC-MTICS-BCS, 2013c; BC-MFLNRO-TPB, various dates; author's calculations). Past investigators (Margolick and Uhler, 1992; Zhang, 1996; Uhler, 2000; Fooks et al., 2013) have found that the restrictions on British Columbia's log exports impose net costs in the millions of dollars on the BC economy. However, many of these studies are dated: for example, Margolick and Uhler (1992) use log market data from 1983. Others are flawed: for example, Fooks et al. (2013) assume that British Columbia has an outright ban on all log exports, which is not the case. More recent work by Van Kooten (2014) suggests that a quota on log exports may be preferred to free trade in logs contingent on how efficient the export approval process is. However, there are certainly reasons to believe the current export process is inefficient.

Forests in Britsh Columbia are largely owned by the provincial government, which sells timber to the private sector for processing at variable rates. Those rates depend on timber quality, logging costs, and market conditions. This "stumpage" regimen makes the BC government an active business partner that should want to secure the highest price for its product. However, with an umbrella of regulations and restrictions that affect both private and public timber, the provincial and federal governments actually restrict exports of logs from British Columbia, resulting in a suppression of local prices for logs below what can be secured in international markets. BC log exports are further restricted through export fees levied by the provincial government

1. Average value for "Hembal" logs grades B to M.
2. Average value for "Hemlock, (sawlogs or veneer logs)" and "True fir (including Balsam), (sawlogs or veneer logs)".

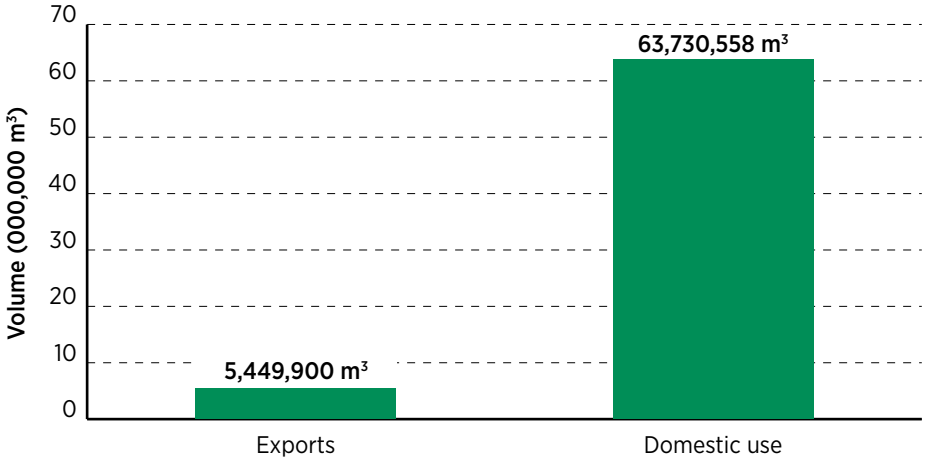
on logs not wanted by local processors. Restrictions on log exports may serve political ends but may also reduce economic efficiency and prevent the logging sector from fulfilling its potential.

In 2011, British Columbia's "Forestry and Logging"[3] sector harvested over 69 million m^3 of timber (NFD, 2013a) and contributed $1.77 billion to British Columbia's gross domestic product (BC-MTICS-BCS, 2013b). Out of the total timber harvest in 2011, only just under 5.5 million m^3 was exported (BC-MTICS-BCS, 2013c). The amount exported and the amount that went to domestic uses are displayed in **figure 1**. Log exports in 2011 actually represented a high-water mark for British Columbia, as over 7% of BC's log harvest was exported, higher than any other year between 1990 and 2011 (BC-MTICS-BCS, 2013c; NFD, 2013a; author's calculations). And in the Coastal Region, where the majority of BC log exports originate, over 25% of the Coastal harvest was exported in 2011 (author's calculations). **Figure 2** displays British Columbia's log exports and domestic use over time between 1990 and 2011.

The goals of this paper are three-fold. The first goal is to provide an overview of British Columbia's current place in the global market for logs. The second goal is to provide a concise overview of the many rules and regulations, both provincial and federal, that restrict log exports in British Columba. The third goal is to focus on the Coastal region and compare the welfare effects of three possible new policy options for exporting logs from British Columbia: an export ban, an export quota, and free trade in logs.

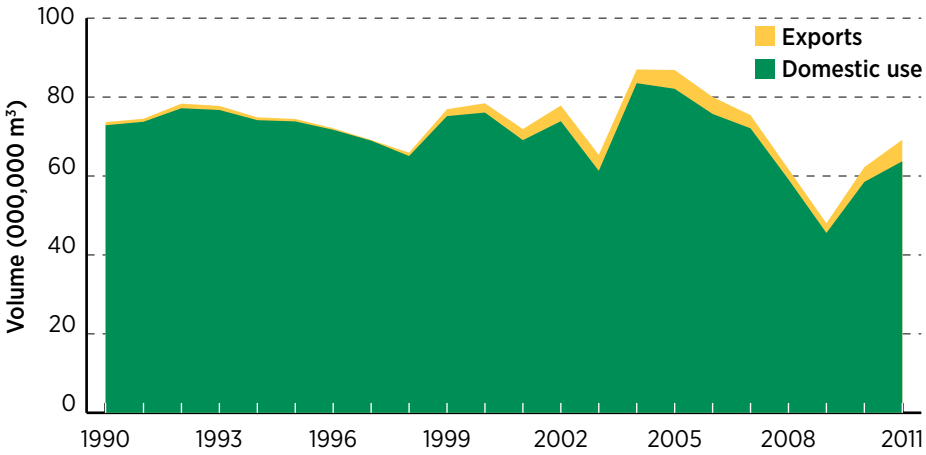
3. This does not include the "Wood Product Manufacturing" sector, that is, the wood processing sector.

Figure 1: British Columbia timber harvest, 2011



Sources: BC-MTICS-BCS, 2013c; NFD, 2013a.

Figure 2: British Columbia timber harvest, 1990–2011



Sources: BC-MTICS-BCS, 2013c; NFD, 2013a; author's calculations.

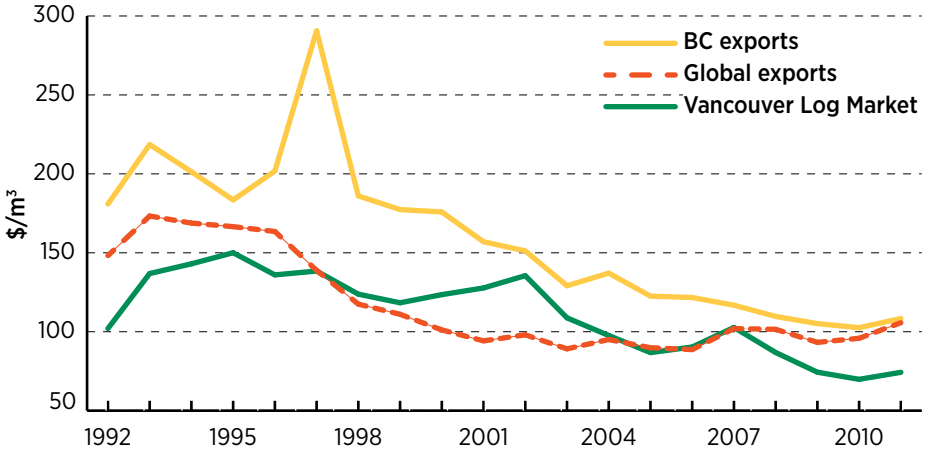
2 British Columbia's Logs in the Global Market Place

Log exports from British Columbia constituted over 99% of the total exported from Canada in 2011 (BC-MTICS-BCS, 2013c; FAO, 2013; author's calculations). Many species of logs are able to command much higher prices on the world market than domestically. Taking a simple annual average (that is, the annual total value of logs sold divided by the annual total volume) suggests that in 2011 coniferous logs sold on the Vancouver Log Market[1] for $\$74.28/m^3$ while those exported sold for $\$108.35/m^3$ (BC-MTICS-BCS, 2013c; BC-MFLNRO-TPB, various dates; author's calculations). Data on exports of coniferous logs from the Food and Agricultural Organization of the United Nations suggests that globally, the simple average price in 2011 was $\$105.71/m^3$ (C-SC, 2013; FAO, 2013; author's calculations).

Figure 3 plots the simple average prices for coniferous logs for the Vancouver Log Market, BC exports, and the world market between 1992 and 2011. As the figure shows, the simple average price obtained through export is persistently above the simple average price on the Vancouver Log Market and the world average export price. However, the figure also demonstrates that the situation is more complicated: the average price for log exports around the world has been below the Vancouver price for several years in the past. Given this fact and that BC log exports can consistently obtain prices higher than the world average suggests that BC coniferous logs may be higher quality in general than those traded internationally; if they were not, then British Columbia would have been importing logs in some years to take advantage of the price differential. It also highlights that comparisons of log prices are inherently difficult given that logs differ in species and quality ("grade"), so a simple average price can be misleading. This is a point we will return to in later sections. It should also be noted that despite high prices received for logs

1. The Vancouver Log Market represents trading of logs between domestic buyers and sellers in the Coastal region centred around Vancouver and Howe Sound. It does not capture the selling of logs to foreign buyers or the tranfer of logs directly to domestic processing facilities within vertically integrated forestry companies. The BC government collects data on all log sale transactions in the VLM.

Figure 3: Log prices ($CA 2011) for Vancouver Log Market, BC exports, and global exports, 1992–2011



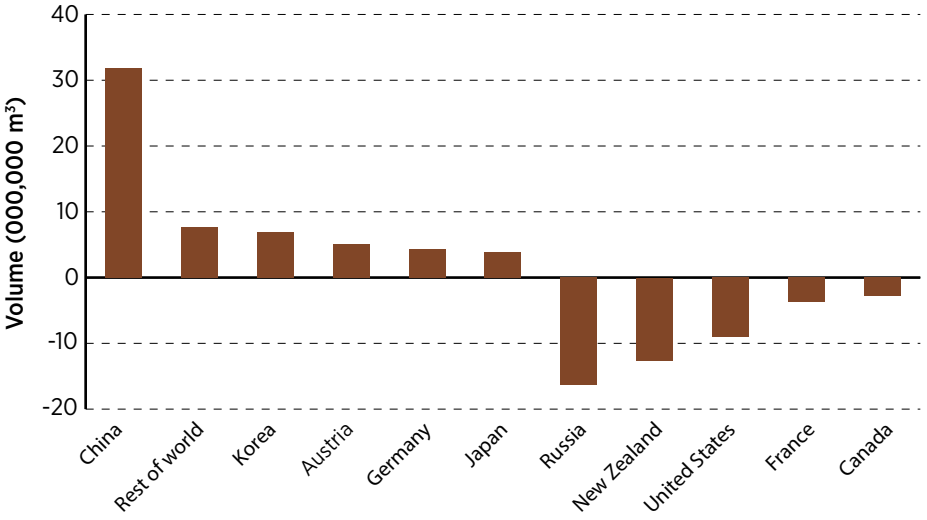
Notes: The figure plots annual simple average log prices for BC log exports, global log exports, and the Vancouver Log Market. Only coniferous logs are included.

Sources: BC-MTICS-BCS, 2013a; BC-MTICS-BCS, 2013c; BC-MFLNRO-TPB, various dates; C-SC, 2013; FAO, 2013; author's calculations.

exported from British Columbia in the mid-1990s, the volume of logs allowed to be exported was greatly restricted relative to current levels of exports.

Turning to focus more on the world market for logs, figure 4 displays the countries that were the largest net importers and the largest net exporters of logs in 2011. Canada as a whole is the fifth-largest net exporter of logs; the vast majority of exports are from Coastal BC, whereas the rest of Canada

Figure 4: Net imports of logs by various countries, 2011



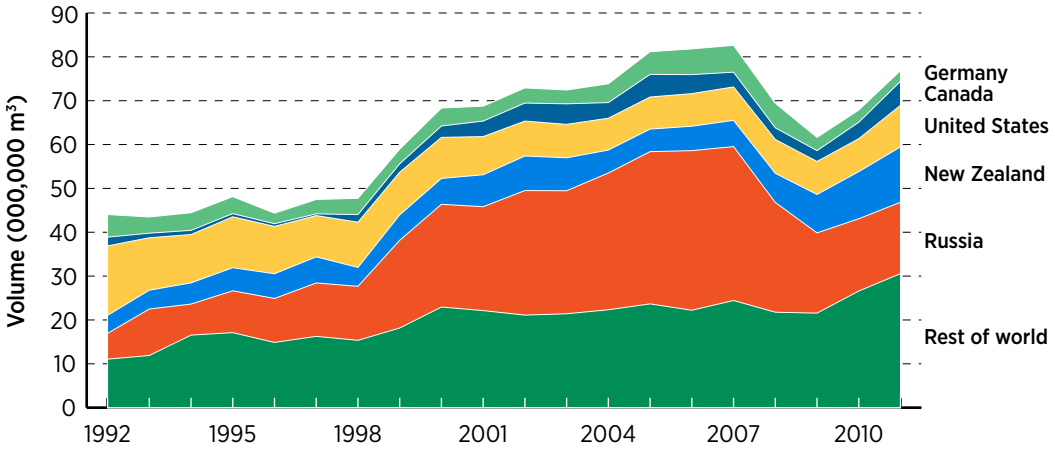
Notes: These data are restricted to coniferous logs.

Sources: FAO, 2013; calculations by author.

is a net importer of logs.[2] China was the largest net importer by a large margin in 2011. As for British Columbia's competition in log exports, Russia is the dominant exporter and has been for quite some time. Russian exports declined in recent years due to the imposition of a tax on log exports.

Figure 5 displays the exports of the five largest exporters of logs between 1992 and 2011: Russia, Canada, the United States, New Zealand, and Germany. The figure also includes the log exports from the rest of the world. In 2011, Canada was the source of 7% of global log exports, whereas Russia was the source of over 20% (FAO, 2013; author's calculations).

Figure 5: Log exports from various countries, 1992–2011



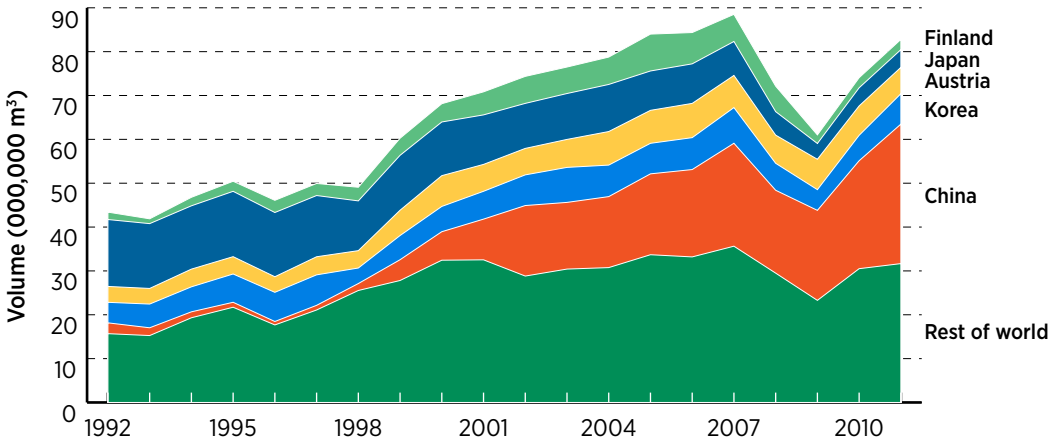
Notes: These data are restricted to coniferous logs.

Source: FAO, 2013.

Figure 6 displays the imports of the five largest importers of logs between 1992 and 2011. The rise of China as the dominant destination for logs is striking. In 2011, China imported over 38% of the logs traded on world markets (FAO, 2013; author's calculations). In the 1990s and early 2000s, Japan was the largest importer but has since reduced the amount of logs it imports. Trade in BC logs largely reflects this shift. Figure 7 displays the volume of logs exported from British Columbia to particular destinations in 2002 and 2011. In 2002, most BC logs for export went to the United States (50%) or Japan (44%); less than 1% of exports went to China. By 2011, the trade landscape had shifted and over 50% of British Columbia's log exports were destined for China. Log exports to South Korea from British Columbia have also grown drastically since 2002, and in 2011 they received 20% of British Columbia's log exports. Japan is still an important market for BC logs, but now has only the third largest share.

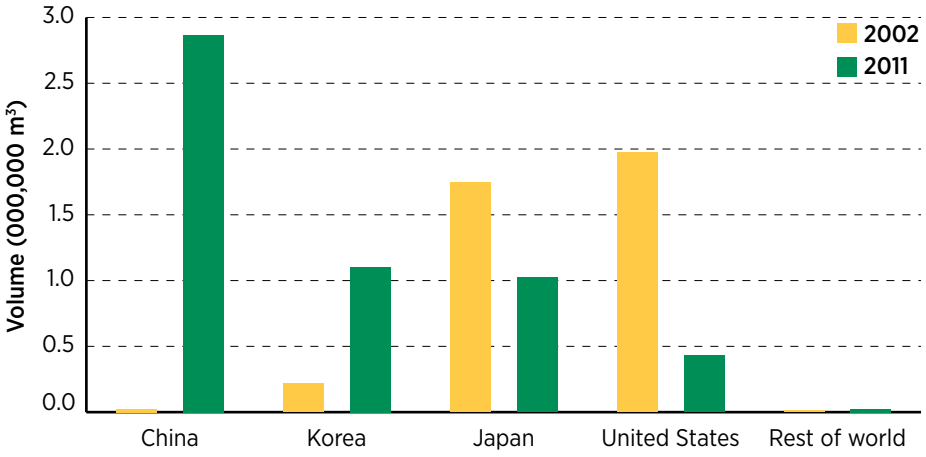
2. According to the FAO (2013), in 2010 Canadian log imports were almost all from the United States where the transport costs would be low, for example, from Maine to New Brunswick.

Figure 6: Log imports into various countries, 1992–2011



Source: FAO, 2013.

Figure 7: Destinations of logs exported from BC, 2002 and 2011



Sources: BC-MTICS-BCS, 2013c.

3 Government Restrictions on Log Exports from British Columbia

Forests in British Columbia can fall under provincial or federal jurisdiction depending on the ownership and history of the land. The majority of forest falls under provincial jurisdiction and is owned by the Crown. Provincial jurisdiction also covers land made private after March 12, 1906 and land made private before March 12, 1906 that falls in a tree-farm license area. There is a small, but productive, area of forests that fall under the powers of the federal government. These lands are a mix of privately owned timberlands and First Nations land.

Provincial restrictions and prohibitions

The Provincial government has long imposed restrictions and, at times, outright prohibitions on the export of logs from forests that fall under its powers. The Forest Act actually stipulates the following:

> [T]imber that is harvested from Crown land, from land granted by the government after March 12, 1906 or from land granted by the government before March 12, 1906 in a tree farm licence area … must be (a) used in British Columbia, or (b) manufactured in British Columbia into wood products to the extent of manufacture specified by regulation.

In other words, unless an exemption is obtained, logs cut on lands under provincial jurisdiction are for domestic manufacture, not export. Therefore, any timber cut from these lands must be used domestically unless an export exemption is granted by the Minister of Forests, Lands, and Natural Resource Operations. The requirement that one must obtain government permission in order to export logs has contributed to the development of a very complicated export process that favours domestic buyers.

In the Coastal region, for example, the government requires any log intended for export to be cut, scaled, and brought to market. The log producer is then required to offer the log for sale to local buyers. If no domestic buyer can be found, the log producer can apply for both provincial and

federal export permits from a government-appointed log-export committee. The log-export committee applies a Surplus Test "to determine if timber is surplus to requirements of timber processing facilities in British Columbia" (BC-MFLNRO-CIB, 2013b). Logs from some areas are not subject to the Surplus Test due to receiving Order-in-Council blanket exemptions. If the export permit is granted, then the log producer pays a fee-in-lieu of manufacture to the government, the fee depending on the log species, grade, and price differential between domestic and world markets. For all practical purposes, the fee-in-lieu of manufacture is basically an export tax. Provincial permits are also required for inter-provincial log exports.

The export process in the Coastal region imposes a large degree of uncertainty and financial cost on log producers. Rather than securing a buyer and price before timber is cut, producers must expend money to cut and scale logs and then wait what might be months to obtain an unknown price. According to the website of the Ministry of Forests, Lands, and Natural Resource Operations, the log export approval process takes around seven weeks if no domestic offer is received, but takes nine to 13 weeks if domestic offers are received. Haley (2002) highlights three detrimental effects on timber owners of the current process of granting log export permits:

1. it prevents log owners from securing long-term contracts with foreign buyers to shelter from price volatility;
2. it prevents log owners from sorting logs per customer request;
3. it imposes time delays that increase log-handling costs and ties up capital.

The export process differs for the interior region of British Columbia, as timber is not required to be cut and scaled before applying for export approval. The fee-in-lieu of manufacture is also set at a much lower and flat rate of $1 per cubic meter. Haley (2002) argues that in the interior the Surplus Test being applied to standing timber leads to "blocking".

> This takes place when a wood processor who does not "need" the logs being advertised nevertheless puts in a bid for them simply to prevent, or block, their export … When logs are advertised for export as "standing green", the bidder is unlikely to be required to take delivery at the bid price since, in most cases, in the absence of an export permit, the stand in question is simply not harvested. Under these circumstances, frivolous bids bear no consequences and are difficult to detect. (Haley, 2002: 6)

There are also restrictions imposed by the provincial government on the species and quality of logs that are eligible for export permits. Exporting logs of Red and Yellow Cedar is prohibited. There are also restrictions on

the grades of logs that can be exported for Hemlock, Douglas Fir, Pine, and Spruce. The grade restrictions prohibit the export of the highest quality logs of these species.

Federal restrictions

Lands under federal jurisdiction are subject to a similar process for export approval, as the federal system was set up to mirror the provincial process, but only require a federal export permit. The federal log-export committee even shares members with its provincial counterpart. There are a few differences at the federal level though, as there is no fee-in-lieu of manufacture, and no restrictions on species or grade. British Columbia is the only province where forest lands under federal jurisdiction are subject to a log-export approval process. These differences suggest that log producers under federal jurisdiction will be able to obtain higher prices than their counterparts under provincial jurisdiction for some species and grades of logs.

In 2011, around 60% of the export permits granted fell under provincial jurisdiction and 40% under federal (BC-MFLNRO-CIB, 2013a). Over 85% of these export permits were for the Coastal region (BC-MFLNRO-CIB, 2013a) as it is less costly to transport logs by water. About three quarters of the export permits under provincial jurisdiction were for the Coastal region, as were almost all of the permits under federal jurisdiction (BC-MFLNRO-CIB, 2013a).

4 Graphical Analysis

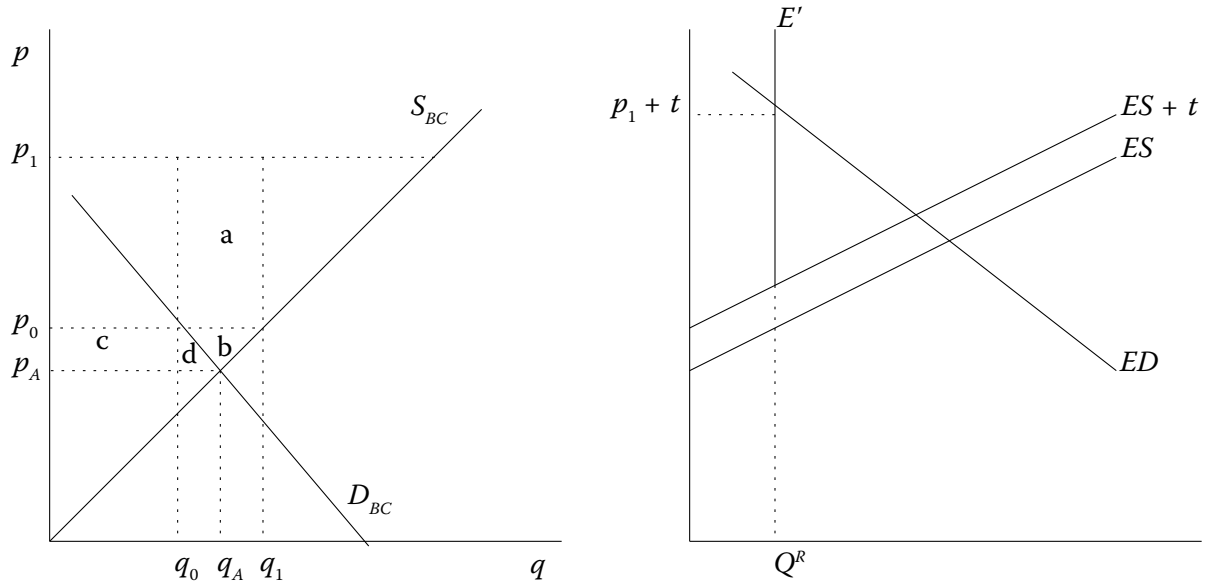
The export process is complex but, for analytic convenience, Van Kooten (2014) abstracts it as an export quota system. However, this abstraction is potentially misleading as it does not reflect the inefficiencies caused by the current restrictions, regulations, and the Surplus Test process. Measuring the inefficiencies of the current export approval regime is difficult without access to sufficient private information about costs. This paper follows Van Kooten (2014) and models an export quota policy, but acknowledges it as an available policy option rather than a representation of the current policy. Under an export quota policy, log producers are restricted to export a fixed amount of logs. Unlike the situation under the current export policies, under a quota system there is no uncertainty over whether a particular log will be allowed to be exported or not. An export quota system can eliminate all three inefficiencies of the current process mentioned in the previous section. A quota system would allow quota holders to sign long-term contracts with foreign buyers, sort logs per buyer request, and deliver logs in a much timelier manner to export markets. For analytic convenience, the hypothetical export quota policy modelled here sets the quota amount equal to the amount exported under current restrictions. As demonstrated by Van Kooten (2014), the optimal level of quota exports may be lower than the current amount of logs exported.

Export quota versus export prohibition

Figure 8 displays a graphical representation of the market for logs faced by BC log owners and producers under an export quota policy. The graph on the left is a simple supply-and-demand representation of the domestic log market. The graph on the right shows the excess demand curve for BC logs in the world market and the excess supply curve for BC logs. The costs of transporting logs to their export destination are t. Exports are restricted to Q^R by the export quota, therefore the excess supply curve, ES is vertical at Q^R. D^{BC} and S^{BC} are the domestic demand and supply curves for logs. The current price in the domestic market for logs is p_0, but any logs exported receive p_1 net of transport costs. At price p_0, q_0 logs are purchased by domestic processors and $Q^R = q_1 - q_0$ logs are exported.

If the government were to introduce a complete ban on log exports (force $Q^R = 0$), then the domestic price drops from p_0 to p_A. At this lower

Figure 8: Export quota versus export ban



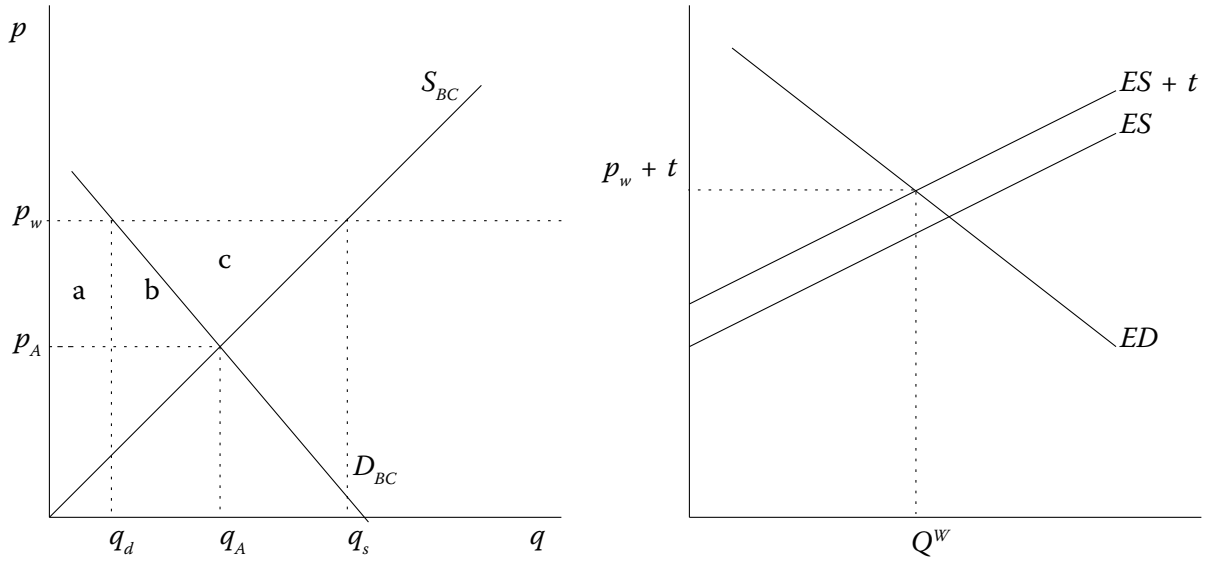
domestic price, and with no opportunity for exports, domestic harvest of logs decreases from q_1 to q_A. The change in policy from allowing restricted log exports to allowing no log exports leads to a loss of social welfare represented by the areas labelled *a* and *b* in figure 8. Log owners and producers lose areas *b*, *c*, and *d*, and domestic log consumers (e.g., mills) gain areas *c* and *d*. Area *a* is the quota rent that is created when British Columbia sells a restricted amount of logs on the world market. When exports are prohibited, the quota rent is lost. Clearly, restricting log exports through a quota system generates more value for British Columbia than prohibiting log exports altogether.

Free trade versus export prohibition

Figure 9 is similar to figure 8 but, instead of the export quota policy, it displays the market for logs under a policy of free trade or unrestricted exports. This is essentially the focus of the previous analyses of Margolick and Uhler (1992), Zhang (1996), and Fooks et al. (2013). Under free trade in logs, the export price is determined where the excess demand and excess supply curves intersect, denoted p_w net of transport costs. Under free trade, domestic log owners will receive price p_w regardless of whether they export logs or sell them domestically. They harvest q_s logs at this price. Domestic processors purchase q_d at this price, and a total of $Q^W = q_s - q_d$ logs are exported.

If the government were to ban log exports, the price drops to p_A, resulting in a decreased harvest of q_A (all of which is obviously sold to domestic buyers). Areas *a* and *b* are transferred from producers to consumers of logs, and area *c* is lost entirely. Margolick and Uhler (1992) and Fooks et al. (2013) focus on estimating area *c* in this graph.

Figure 9: Free trade versus export ban



Export quota versus free trade

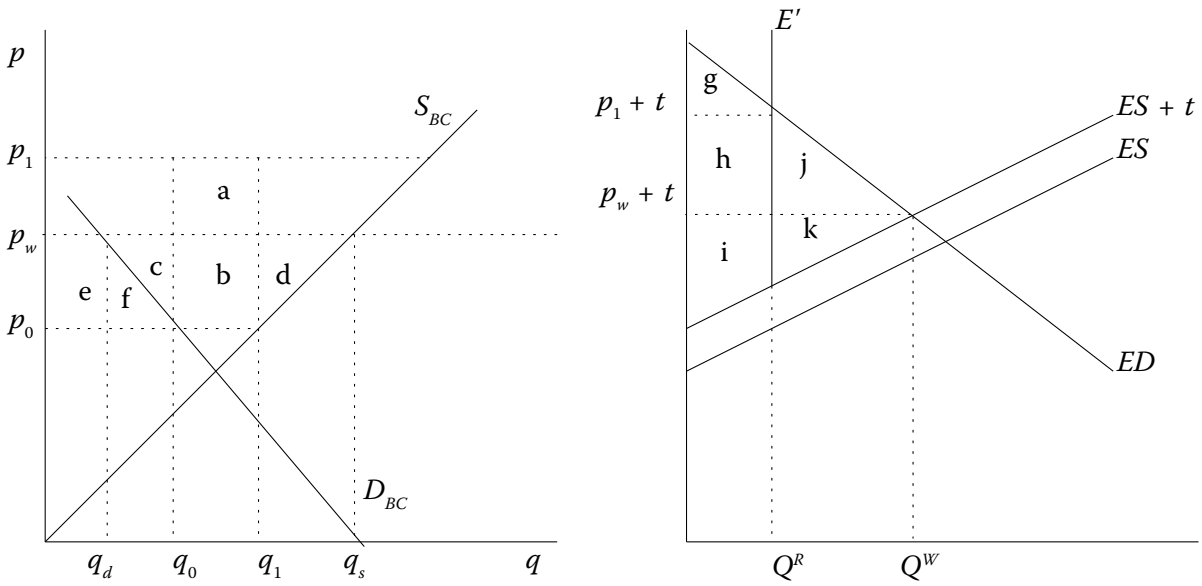
The situation not considered by past studies, other than Van Kooten (2014), is comparing a quota policy of export restrictions to a policy of free trade in logs. Figure 10 displays the market for logs under an export quota and under free trade in logs. Under the export quota, exports are restricted to Q^R resulting in excess supply curve, E'. Exports receive price p_1 net of transport costs; q_0 logs are sold on the domestic market for price p_0. Total domestic harvest is q_1.

Now suppose the government lifts all restrictions on log exports; that is, the excess supply curve is now $ES + t$. The world price is where excess supply and excess demand intersect, and is p_w net of transport costs, which is lower than p_1. The quantity of exports increases from Q^R to Q^W. The domestic price increases from p_0 to p_w, and the domestic quantity demanded decreases from q_0 to q_s. The total harvest increases from q_1 to q_d.

Focusing on the graph on the left side of figure 10, we can see domestic log owners and producers gain areas *b*, *c*, *d*, *e*, and *f* in the switch to free trade, but lose area *a*. Domestic log consumers lose areas *e* and *f* since they now pay more for fewer logs. The net change in welfare is a gain of areas *c* and *d*, but a loss of area *a*. Which of the two policies is preferred comes down to the empirical question of whether areas *c* and *d* are larger than area *a*. This question has been answered for British Columbia as a whole by Van Kooten (2014), and will be answered for just the Coastal region in the numerical analysis of this paper.

An equivalent way of accounting for the change in welfare is by instead focusing on the graph on the right side of figure 10. Under the log export quota, the surplus that accrues to British Columbia comes from areas *h* and *i* (these areas exactly correspond to areas *a* and *b* on the graph to the left).

Figure 10: Export quota versus free trade



Log consumers in other countries secure surplus of area *g*. After the change to free trade in logs, British Columbia gets areas *i* and *k*, and foreign log consumers get areas *g*, *h*, and *j*. Whether British Columbia is better off under free trade depends on area *k* being larger than area *h* (this is exactly equivalent to the question in the preceding paragraph of whether areas *c* and *d* are larger than area *a*). However, looking at this graph adds additional insight. Taking the perspective of British Columbia alone, it is very possible that British Columbia is better off under an export quota policy than under free trade; however, from a global perspective, free trade improves total welfare; that is, a net gain of areas *j* and *k*, as area *h* is just transferred from British Columbia to foreign log consumers.

5 Numerical Analysis

The analysis now turns to measuring the various areas highlighted in the graphical analysis. Many of the parameters needed to do this can be obtained from existing market data, that is, p_1, p_0, q_1, q_0, and Q_R. However, to obtain estimates for many other parameters (e.g., p_A, q_A, p_W, Q^W), it is necessary to provide a mathematical representation of the partial equilibrium trade model that was reflected in the graphs (figures 8, 9, and 10).

Export quota versus export prohibition

As mentioned above, the parameters under export restrictions (p_1, p_0, q_1, and q_0) can be obtained from existing market data. However, a mathematical model is required to obtain parameters reflecting the counterfactual of a prohibition on exports. Suppose the domestic demand curve is linear and is given by

$$p_d = \alpha - \beta q_d, \quad \alpha, \beta \geq 0. \tag{1}$$

Likewise, the domestic supply curve is given by

$$p_s = a + b q_s, \quad a, b \geq 0. \tag{2}$$

If no exports are allowed, then $q_s = q_d$ and $p_d = p_s = p_A$ in equilibrium. Equating equations (1) and (2) gives the domestic equilibrium quantity of logs when no exports are allowed,

$$q_A = \frac{\alpha - a}{b + \beta}.$$

The equilibrium price when exports are prohibited is then obtained by substituting q_A into either of equations (1) or (2) and solving for p:

$$p_A = \frac{b\alpha + \beta a}{\beta + b}.$$

The problem remains that the parameters a, b, α, and β are unknown. However, several studies have estimated the elasticity of supply and demand for British

Columbia's log market, two parameters which can be used to derive these other parameters. The elasticity of demand,

$\varepsilon_d = \frac{\partial q_d}{\partial p_d}\frac{p_d}{q_d}$ can be used to obtain

$\beta = \frac{-p_0}{\epsilon_d q_0}$, a function of parameters that we have known values for.

This value for β, p_0, and q_0 can then be substituted into equation (1) to obtain a value for α. Similarly, the elasticity of supply,

$\varepsilon_s = \frac{\partial q_s}{\partial p_s}\frac{p_s}{q_s}$ can be used to obtain

$b = p_0 / \varepsilon_s q_1$. The values for b, p_0, and q_1 can then be used with equation (2) to solve for a.

The quota rent that is lost when log exports are no longer allowed (that is, area a of figure 8) can be calculated as

$$(p_1 - p_0)(q_1 - q_0). \tag{3}$$

The lost producer surplus from a move to ban log exports (area b of figure 8) can be calculated as

$$(p_0 - p_A)(q_1 - q_0)/2. \tag{4}$$

Free trade versus export prohibition

If exports are allowed, the excess supply curve is obtained by rearranging and subtracting equations (1) and (2). Adding in transportation costs yields

$$ES + t = \frac{\beta a + \alpha b}{b + \beta} + t + \left(\frac{b\beta}{b+\beta}\right)Q = \gamma + \delta Q, \tag{5}$$

where $Q = q_s - q_d$. The excess demand curve is represented as

$$ED = A - BQ, \quad A, B \geq 0. \tag{6}$$

The free trade equilibrium quantity of Canadian logs sold on the world market can then be found by setting equation (3) equal to equation (4) and rearranging:

$$Q^W = \frac{A - \gamma}{B + \delta}$$

The free trade equilibrium price, p_W can be then solved for by plugging Q^W into either equation (3) or (4).

Again, the issue is that A and B are unknown. However, given an estimate of the elasticity of excess demand for Canadian logs, we can calculate them. The elasticity of excess demand is given by

$\varepsilon_{ED} = \frac{\partial Q}{\partial p}\frac{p}{Q}$, which can be used to obtain

$B = -(p_1 + t)/\epsilon_{ED} Q^R$. The values for B, Q^R and $ED = (P_1 + t)$ can be substituted into equation (6) to solve for A. We can then calculate q_d and q_s by inserting p_W into equations (1) and (2), respectively.

When comparing a switch from free trade in logs to no trade in logs, the net loss in welfare is area c in figure 9. This area can be calculated as

$$(p_W - p_A)(q_s - q_d)/2 \tag{7}$$

Export quota versus free trade

As discussed in section 4, a switch from an export quota that allows a restricted amount of log exports to allowing unlimited log exports results in a change in welfare equal to areas $c + d - a$ in figure 10. These three areas are calculated as follows

$$\frac{(p_W - p_0)(q_0 - q_d)}{2} + \frac{(p_W - p_0)(q_s - q_1)}{2} - (p_1 - p_w)(q_1 - q_0). \tag{8}$$

The change in global welfare from a move by British Columbia to free trade in logs is given by areas j and k on the right-hand side of figure 10. This area can be calculated by the following expression

$$\frac{(p_1 - p_W)(Q^W - Q^R)}{2} + \frac{(p_W - p_0)(q_0 - q_d)}{2} + \frac{(p_W - p_0)(q_s - q_1)}{2}. \tag{9}$$

5.1 Data and parameters

Log Prices: p_1 and p_0

Log price data from the Vancouver Log Market can be used as a value for the current domestic price. The log export data maintained by BC-MTICS-BCS (2013c) provides information on species and a rough indication of quality; specifically, they indicate whether logs are "pulp logs" or "sawlogs or veneer logs" with the latter being from higher quality grades than the former. The monthly *Log Market Reports, Historical Coast*, published by the Timber Pricing Branch of the BC Ministry of Forests, Lands, and Natural Resource Operations provides the most detailed information, as they classify logs of each species sold into individual grades from "B" to "Z". But these reports

only cover domestically bought and sold logs, not exports. Furthermore, these reports only have data for logs that actually reach the Vancouver Log Market, and a large percentage of the Coastal timber harvest goes straight to mills instead. Without estimates of the shadow prices of these logs, it is difficult to know whether the Vancouver Log Market prices are reflective of the actual domestic price of logs.

For the analysis in this paper, the simple average export price from 2011 is used as p_1, and the simple average price of logs traded on the Vancouver Log Market from 2011 is used as p_0. These values are displayed in **table 1** along with the other parameters required for the analysis. Different possible price pairs are considered in a sensitivity analysis section.

Table 1: Assumed parameter values

Parameter	Value	Unit
Domestic log price, p_0	74.28	$/m^3
Current export price, p_1	108.35	$/m^3
Coastal log consumption, q_0	13,394.1	000 m^3
Coastal log harvest, q_1	18,844	000 m^3
Elasticity of supply, ε_s	1.0302	
Elasticity of demand, ε_d	−1.1008	
Elasticity of Excess Demand, ε_{ED}	−1.54	
Transportation cost, t	10	$/m^3

Note: Parameter value selection is discussed in the text.

Log supply on the BC coast: q_1 *and* q_0

As displayed in figure 1, in 2011, British Columbia's total timber harvest was 69 million cubic meters. However, because the log price data is from the Vancouver Log Market, which mainly trades in coastal timber, the analysis in this section will focus on the BC Coastal region. Furthermore, almost all log exports from British Columbia are coastal timber (BC-MFLNRO-CIB, 2013a). In 2011, the BC Coastal timber harvest was 18.8 million m^3; this will be used as the value for q_1. Just under 5.5 million cubic meters were exported as logs in 2011, leaving 13.4 million m^3 for domestic consumption, that is, q_0.

Elasticity of domestic supply and demand: ε_s and ε_d

As mentioned earlier in this section, elasticity estimates can be used to obtain values for a, b, α, and β. Fooks et al. (2013) use econometric methods to estimate these elasticities for British Columbia. They estimate the price elasticity of demand to be –1.1008. This means that a 1% increase in price will lead to a 1.1008% decrease in quantity demanded by domestic log consumers. This elasticity estimate is less responsive to price than the one used by Uhler (2000) of –1.43; this could be because Uhler focuses only on the Coastal region. Devadoss (2008) surveys the forestry economics literature for elasticity estimates, and finds estimates for British Columbia that range from –0.12 to –2.01. The recent estimate by Fooks et al. (2013) falls in the middle of this range, and is selected as the base parameter for the economic analysis conducted here. The range of estimates provided by Devadoss (2008) is used in a sensitivity analysis later in the paper.

Fooks et al. (2013) also estimate that the price elasticity of supply is 1.0302; in other words, a 1% increase in price leads log producers to increase their cut by 1.0302%. Uhler (2000) takes a different approach to estimate this elasticity; he instead looks at the marginal cost of timber production in the coastal region for 1997. He estimates the elasticity of supply on the coast to be 0.65 at 1997 harvest levels, but decreasing to 0.33 as harvest approaches the annual allowable cut. These estimates indicate that at 1997 coastal harvest levels, a 1% increase in price leads producers to increase the quantity supplied of logs only by 0.65%. The difference in elasticity estimates could be due to the fact that Fooks et al. (2013) use time-series data for the province as a whole, while Uhler (2000) uses data for one year for only the Coastal region. However, the fact that the majority of logs exported from British Columbia are from the coast due to transportation-cost advantages, the lower estimate cannot be dismissed. It will be used as a lower bound when conducting a sensitivity analysis. Margolick and Uhler (1992) and Zhang (1996) use an elasticity estimate of 0.3. Van Kooten (2013) assumes an elasticity of supply of 1.0, but mentions that estimates range from 0.8 to 1.1 in regions around the world. For the purposes of the present analysis, the recent estimate provided by Fooks et al. (2013) of 1.0302 is used. However, in the sensitivity analysis, 0.3 is used as a lower bound and 1.49 (the upper 95% confidence bound of the estimate from Fooks et al., 2013) is used as an upper bound.

Elasticity of excess demand: ε_{ED}

In order to calculate values for the parameters A and B, we need an estimate of the elasticity of excess demand. Niquidet and Tang (2013) estimate the elasticity of demand in the Chinese and Japanese log markets while controlling for the country of origin. For Canadian logs, they find an elasticity of demand of –1.40 in China and –1.67 in Japan. Their estimate for the Japanese market is statistically significant; however, the one from the Chinese market is not.

Unfortunately, Niquidet and Tang (2013) do not provide standard errors for their estimates. Following Van Kooten (2014), the mid-point between the two estimates (–1.54) is selected as the preferred parameter estimate and a range from –1.25 and –1.83 is used in a sensitivity analysis. A further sensitivity analysis is conducted on this parameter, allowing for values ranging from close to 0 to –1,000, while holding all other parameters constant.

Transportation cost: t

Very little information about the cost of transporting logs is easily available. Van Kooten (2014) assumes that transport costs are $10 per cubic meter, but allows for a range of values from $5/m^3 to $12/m^3 in his simulations. However, Van Kooten (2013) suggests that the cost of transporting logs may be closer to $50/m^3 based on the cost of transporting lumber. The current analysis will follow Van Kooten (2014) and use $10 as the preferred estimate, but will use a range between $5 and $50 in a sensitivity analysis.

5.2 Numerical analysis

This section uses the parameters outlined in the previous subsection to calculate changes in welfare as outlined in equations (3), (4), (7), and (8). Table 1 displays the selected parameter values for the analysis.

Export quota versus export prohibition

The first row in the body of table 2 provides the results for a change in policy from a quota restricting log exports to a complete ban on all log exports. The second column indicates the new domestic price under an export ban using the selected parameter value; under an export ban, the domestic price decreases 16% from $74.28 to $62.43 per cubic metre. In response to not being able to receive both a higher domestic price and an even higher export price, coastal log producers reduce their harvest to 15,746 thousand m^3. The policy change results in a loss of welfare (given by equations (3) and (4)) of $217.9 million.

Free trade versus export prohibition

The second row in the body of table 2 displays the results for a switch from the hypothetical policy of free trade in logs to a total ban on log exports. The price decreases 21% from $78.83 to $62.43. The loss in welfare as given by equation (7) is $61.9 million.

Export quota versus free trade

The final row of table 2 has results from a change from a quota policy restricting exports to allowing unlimited log exports. The price paid by domestic log

Table 2. Results of changes in log export policy

Policy change	Domestic price ($/m^3)	Log exports (000 m^3)	Change in BC welfare (CA$ 000,000)
Export quota to export ban	62.43	0	−217.9
Free trade to export ban	62.43	0	−61.9
Export quota to free trade	78.83	7,543.2	−156.1

Source: Author's calculations.

consumers increases 6% from $74.28 to $78.83. The price net of transportation costs of exported logs decreases substantially: a 27% decrease from $108.34 to $78.83. Under free trade, the coastal harvest increases 6% and the quantity of logs exported increases 38%. However, the change in BC welfare given by equation (8) is –$156.1 million. This is much higher than the estimate from Van Kooten (2014), for the whole BC log sector rather than just the Coast, of –$72.8 million, though the net impact is still negative.

This result highlights the pitfalls of analyzing public polices as a dichotomous choice, that is, a ban on exports versus free trade (Margolick and Uhler, 1992; Zhang, 1996; Fooks et al., 2013), rather than a continuum of choices. Van Kooten (2014) also calculates the optimal export quota and notes that it is less than exports currently are. This is under the abstraction that, other than transportation costs, the export system is costless. However, as outlined in section 3 and by Haley (2002), there are several reasons to believe the current export process is more costly than a simple export quota system. Comparison of the results of the three systems suggests that the policy focus should now move past the dichotomous choice and focus on ensuring that the export approval process is as efficient as possible to ensure log producers and the government (through stumpage and the fee-in-lieu of manufacture) are capturing most of the quota rent.

Another potential implication is that there may be an opportunity to use the log export restrictions as an, albeit extremely small, piece of leverage in future trade agreement negotiations. The change in global welfare from a move to free trade in logs (as calculated by equation (9)) is $35.7 million; a move to free trade in logs is a net gain from a global perspective but not from a British Columbia's perspective. However, it presents a situation where British Columbia and China could both be made slightly better off if a trade concession of similar value could compensate British Columbia for the loss of the rents from a log export quota.

5.4 Sensitivity analysis

When undertaking economic analysis it is important to attempt to identify how robust results are to changes in key parameters. This section attempts to identify two things: first, how sensitive the results are to the assumed log prices and year chosen; and, second, how sensitive the results are to changes in the other key parameters.

Sensitivity to log prices

The results of the analysis are sensitive to the assumptions made about log prices. Due to data limitations, simple average log prices were used for both the domestic average price and the world market average price.

The analysis uses simple average prices but in reality the composition of logs exported from British Columbia differs in species and grade from those traded on the Vancouver Log Market (VLM). A more detailed comparison is difficult for several reasons. First, the log export classification system differs from the grade classifications used on the VLM. Second, there are export prohibitions on higher log grades under provincial jurisdiction, but not under federal jurisdiction. Third, it is time consuming to convert the log-grade data in VLM monthly reports to a format that facilitates conversion into the log export classification categories. Despite these difficulties, VLM reports for 2007 and 2011 were used to calculate several alternative price pairs.

The grade classifications in the monthly log market reports can be used to roughly categorize the domestically sold logs into similar categories as those provided for exported logs by BC Stats. Grades B to M match up as "sawlogs or veneer logs", and grades U to Y match up as "pulp logs". The average domestic price weighted by species and these quality categories works out to be $73.11/m^3 for 2011. For BC log exports this weighted average price is $114.33/m^3. This is likely an underestimate as it ignores over 80,000 m^3 of exported coniferous logs for which the species was not specified, but received an average price of $118.59/m^3. The price estimate is also lower than it could be since export of higher-grade logs and all cedar logs from public lands is prohibited though they can be sold on the domestic market. The associated values for 2010 were $66.30 and $115.67, respectively. Table 3 displays these prices for the years 2007 to 2011.

At the same time, these estimates could be too high considering that low-grade logs (U to Y) are a small percentage of the logs exported, but make up a relatively large portion of the volume traded in the Vancouver Log Market. When only "sawlogs and veneer logs" are considered the average domestic price for 2011 is $90.67/m^3 and the average export price is $110.65/m^3. Another option is to weight the average prices by the species and quality composition of BC log exports. These prices are also reported in table 3 for 2007 to 2011. This is done for all logs, and then just for "sawlogs and veneer logs".

Table 3. Results under different log price assumptions

	Year	Simple Average			VLM mix—all		
		p^1	p^0	Welfare change	p^1	p^0	Welfare change
Quota Exports to Export Ban	2007	110.26	96.98	−58.8	122.08	95.34	-103.4
	2008	105.74	83.71	−67.2	108.36	81.16	-80.5
	2009	101.34	71.67	−83.7	112.01	69.85	-114.1
	2010	100.18	68.23	−134.8	115.67	66.3	-199.4
	2011	108.35	74.28	−218.0	114.33	73.11	-256.4
Free trade to Export Ban	2007	110.26	96.98	−19.2	122.08	95.34	-23.3
	2008	105.74	83.71	−15.2	108.36	81.16	-16.1
	2009	101.34	71.67	−20.0	112.01	69.85	-22.9
	2010	100.18	68.23	−30.2	115.67	66.3	-36.0
	2011	108.35	74.28	−61.9	114.33	73.11	-66.5
Quota Exports to Free Trade	2007	110.26	96.98	−39.6	122.08	95.34	-80.1
	2008	105.74	83.71	−52.0	108.36	81.16	-64.4
	2009	101.34	71.67	−63.6	112.01	69.85	-91.1
	2010	100.18	68.23	−104.6	115.67	66.3	-163.4
	2011	108.35	74.28	−156.1	114.33	73.11	-190.0

Notes: Numbers are in nominal Canadian dollars. Simple Average refers to the price calculated by dividing the total value of logs by the total volume of logs, of BC log exports, and the Vancouver Log Market (VLM) respectively. VLM mix-all refers to the log price when weighted by the species and grades traded on the VLM. VLM mix- structural refers to the average price of structural logs, i.e., sawlogs, veneer logs, or Grades B to M, weighted by the species composition of structural logs traded on the VLM. Export mix- all refers to the price of logs weighted by the species and quality composition of BC log exports. Export mix- structural is the average log price when only considering structural logs, weighted by the species mix of exports. VLM price, volume, and value data was taken from 3-month VLM reports for 2008 and 2011, and 12-month report for 2007.

VLM mix—structural			Export mix—all			Export mix—structural		
p^1	p^0	Welfare change	p^1	p^0	Welfare change	p^1	p^0	Welfare change
141.05	112.23	−112.9	109.96	96.67	−58.74	110.37	97.23	−58.3
136.77	103.17	−99.8	105.42	86.28	−59.94	105.92	86.99	−59.5
125.06	85.71	−109.5	101.42	76.32	−73.12	101.39	76.75	−72.1
125.01	83.38	−174.4	100.14	82.66	−83.98	99.77	83.68	−79.0
110.65	90.67	−148.3	108.18	81.48	−180.94	107.42	82.57	−171.3
141.05	112.23	−26.8	109.96	96.67	−19.12	110.37	97.23	−19.2
136.77	103.17	−20.4	105.42	86.28	−14.82	105.92	86.99	−14.9
125.06	85.71	−25.2	101.42	76.32	−19.54	101.39	76.75	−19.5
125.01	83.38	−38.3	100.14	82.66	−27.53	99.77	83.68	−27.1
110.65	90.67	−58.2	108.18	81.48	−59.64	107.42	82.57	−58.6
141.05	112.23	−86.1	109.96	96.67	−39.62	110.37	97.23	−39.2
136.77	103.17	−79.4	105.42	86.28	−45.12	105.92	86.99	−44.6
125.06	85.71	−84.4	101.42	76.32	−53.58	101.39	76.75	−52.6
125.01	83.38	−136.1	100.14	82.66	−56.45	99.77	83.68	−51.9
110.65	90.67	−90.1	108.18	81.48	−121.30	107.42	82.57	−112.7

Sources: BC-MTICS-BCS, 2013c; BC-MFLNRO-TPB, various dates; author's calculations.

Table 4. Monte Carlo simulation assumptions

Parameter	Mode	Min	Max	Distribution
p_1	—	99.77	141.05	Resampled
p_0	—	66.3	112.23	Resampled
q_1	—	10,731.9	19,327.8	Resampled
q^0	—	8,274.20	15,988.97	Resampled
Elasticity of supply	1.0302	0.3	1.49	Triangular
Elasticity of demand	−1.1008	−0.12	−2.01	Triangular
Elasticty of excess demand	−1.54	−1.83	−1.25	Triangular
Transporation costs	10	5	50	Triangular

Notes: The parameters p_1, p_0, q_1, and q_0 are the price and quantity data used in table 3 for years 2007 to 2011; here they are resampled with replacement as a quadruplet. The other parameters are drawn 10,000 times from triangular distributions with the given mode, minimum, and maximums. q_1 and q_0 are in thousands of cubic metres.

The welfare changes for each of the many price pairs are calculated and are displayed in table 3. For each possible policy comparison, there are 25 price pairs between 2007 and 2011. Overall, the sign of the results are insensitive to the price pairs used, though the magnitude of the results changes. The welfare changes when using 2011 prices and quantities tend to be higher than when prices and quantities from previous years are used.

Monte Carlo simulation

A Monte Carlo simulation was conducted to see how sensitive the results are to changes in all parameters. Table 4 displays the assumptions made for each of the parameters. To reflect changes in prices, the price pairs and their associated quantities from table 3 are resampled with replacement as quadruples 10,000 times. In other words, when a draw is taken, it will reflect one of the 25 price pairs and the quantities (q_1, q_0) for the year of the drawn price pair. For each of the elasticity parameters and the transportation cost parameter, the triangle package in *R* was used to take 10,000 draws from a triangular distribution with mode, minimum, and maximum values as specified in table 4. This then provides 10,000 values for each parameter that can be used to create 10,000 values for the estimated change in welfare of a policy change. Figures 11, 12, and 13 are histograms of simulated welfare changes for the three policy changes evaluated in table 2. The sign of the results do not change, signifying that they are robust to the parameter range specified in table 4.

Figure 11: Quota exports to export ban

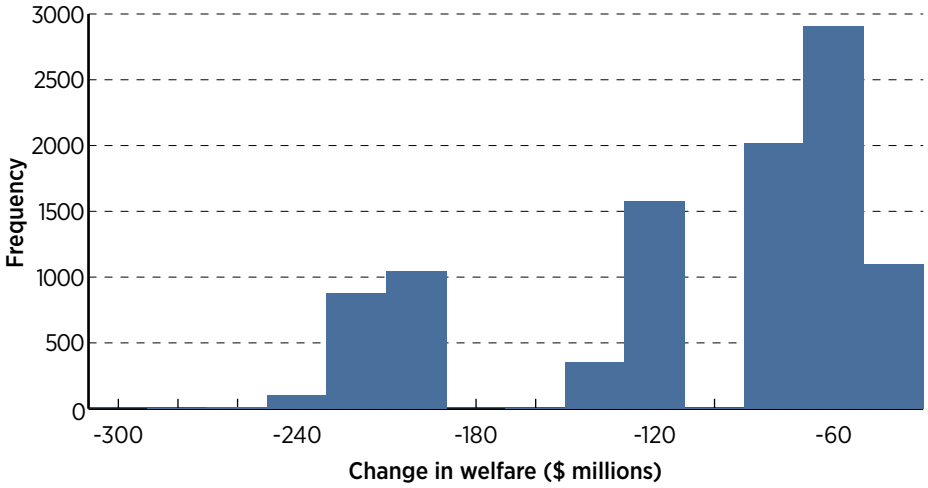


Figure 12: Free trade to export ban

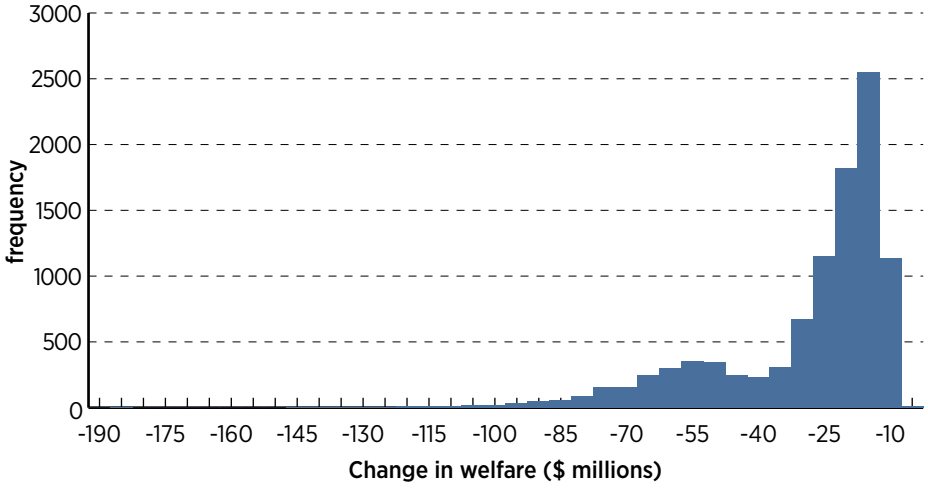


Figure 13: Quota exports to free trade

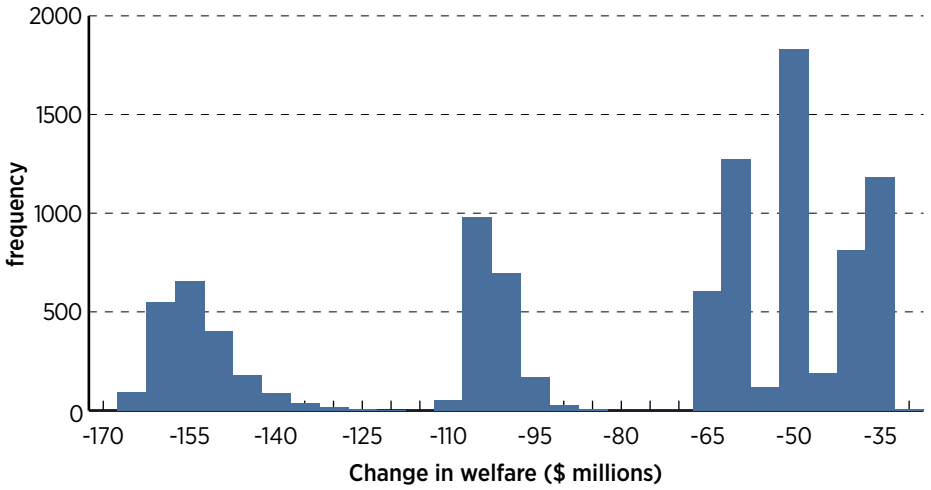
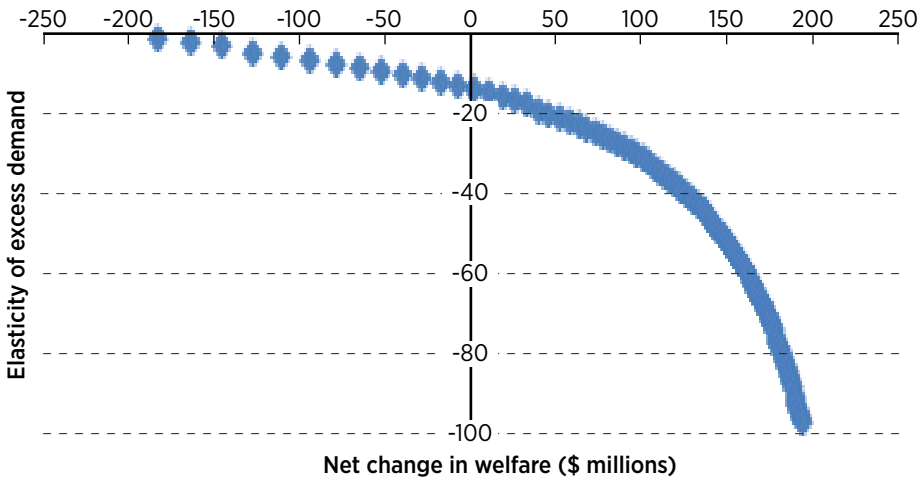


Figure 14: Sensitivity to elasticity of excess demand



Sensitivity to the responsiveness of excess demand

To see how sensitive the results are to the responsiveness of world prices to changes in BC log exports, a further sensitivity analysis is performed on the parameter ε_{ED}. Specifying a vector of values for this parameter ranging in unit increments from 0.1 to 1,000, the results for each of the policy changes are calculated. The result for a change from a quota export policy to a full ban on log exports is impervious to different values of ε_{ED}. The loss in welfare from moving from a policy of free trade to a ban on exports increases as the value for ε_{ED} decreases, and appears to limit towards –$480 million. In other words, the magnitude of the result is affected, but not the sign. However, the results of a change from an export quota policy to free trade are affected by changes in ε_{ED}. Figure 14 displays the net change in welfare from the policy change at different values of ε_{ED} up to –100. As ε_{ED} increases, the net loss in welfare shrinks, and becomes zero around ε_{ED} equal to –12.5. As ε_{ED} continues to decrease further towards negative infinity, the change in welfare appears to limit toward $267 million. A move to free trade in logs is preferable to an export quota system if excess demand is very elastic, that is, if BC logs are very substitutable with most logs traded on the world market. However, the empirical estimates noted earlier provided by Niquidet and Tang (2013) suggest, though it is elastic, excess demand is far from –12.5.

6 Conclusions

The provincial and federal governments employ a wide range of policies that restrict the export of logs cut from BC forests. Log exports from British Columbia have increased recently, and China has become the largest importer of BC logs. Although log exports are allowed, the export process is in many cases complex and potentially unduly costly for log owners and producers. Due to these restrictions, logs sell for substantially less on the domestic market than when exported.

The analysis in this paper focuses on the BC Coastal region where the overwhelming majority of log exports originate. The graphical and numerical analysis in this paper, adapted from Van Kooten (2014), suggests that a quota policy that restricts log exports provides net benefits to BC when compared to policies of prohibiting exports or allowing free trade in logs. The intuition behind this result is that limiting BC log exports allows BC log owners, as a group, to exercise market power in the international market. This result is contrary to the results in support of free trade found by Margolick and Uhler (1992), Zhang (1996), and, most recently, by Fooks et al. (2013). The difference stems from the contrary studies failing to model adequately the price response of the international market to an increase in BC log exports and the failure to consider policy options other than free trade and no trade.

One thing is exceedingly clear from the analysis, an outright prohibition on log exports from BC, as advocated by many pundits, politicians, and interest groups, is very costly relative to all alternatives. Both free trade in logs and a quota policy allowing limited log exports are preferable to a ban on exports.

The results indicate that it will likely be beneficial to move the policy discussion away from the dichotomous debate of choosing between export prohibitions and free trade in logs. It is beyond the scope of the current analysis to measure how inefficient the current export process is; however, there is reason to believe that the current process is not efficient. The current log export process prevents log owners from securing long-term contracts with foreign buyers to shelter from price volatility, prevents log owners from sorting logs per customer request, and imposes time delays that increase log handling costs and ties up capital. Future research and debate should focus

on measuring the costs of these inefficiencies and identifying reforms to the export process. Evaluating a move from the current export process, involving the Surplus Test, to an export quota system may be a good place to start.

Although free trade in logs is not the most desirable policy from British Columbia's perspective, it is from a global perspective. The scarcity rent that accrues to British Columbia from export restrictions becomes a welfare gain for foreign buyers of BC logs. Furthermore, there are additional welfare gains from having more BC logs on the world market. There is a potential opportunity, albeit a small one, to use the restrictions on BC log exports as a bargaining chip in trade negotiations. Canada is currently in talks to join the Trans-Pacific Partnership, which includes Japan. There have also been calls in the media and policy circles for the commencement of trade negotiations with China in the future. It is possible that removing restrictions on log exports as part of a trade agreement could leverage concessions of a similar size that would benefit British Columbia and Canada.

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Acknowledgments

The author would like to thank Kenneth P. Green and two anonymous reviewers for insightful comments and suggestions. Any remaining errors or oversights are the sole responsibility of the author. As the researcher has worked independently, the views and conclusions expressed in this paper do not necessarily reflect those of the Board of Trustees of the Fraser Institute, the staff, or supporters.

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Date of issue

June 2014

ISBN

978-0-88975-306-8

Citation

Joel Wood (2014). *Log Export Policy for British Columbia.* Fraser Institute. <http://www.fraserinstitute.org>.

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