Essays on the economics of British Columbian timber policy

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V. Pricing the social contract in the British Columbian forest sector

This chapter is from Niquidet, K. Nelson, H. and Vertinsky, I. 2007. Pricing the social contract in the British Columbian forest sector. Accepted April 13, 2007. Canadian Journal of Forest Research.

Abstract

In this paper we investigate the impact of various socio-economic conditions on the value of timber tenures in the province of British Columbia. Two timber tenure models were created, one for short-term Timber Sale Licenses and the other for longer term Forest Licenses. The short-term model revealed that timber sales which were awarded according to a combination of employment, revenue and manufacturing criteria yielded \$8.63/m^3 less revenue than timber sales awarded based on revenue alone. Similarly, the long-term model indicates that manufacturing and employment conditions significantly reduce the bid on Forest Licenses. In both instances, we suggest that such conditions distort the use of timber, labour and capital. Therefore we conclude that recent forest policy changes in the province that removed several of these conditions greatly improved economic efficiency. Nevertheless, distribution impacts are likely to be important, as resource rents have potentially been re-distributed away from rural communities to the provincial government.

Introduction

In Canada, forest ownership is predominately held by provincial governments. Each province has created its own unique tenure system which grants harvesting rights to private forest companies. In the largest timber producing region, British Columbia, there exists a complex array of tenure arrangements which vary according to their management responsibilities, term, and structure (i.e. area vs. volume based). Comprehensive descriptions of each tenure type can be found in numerous sources (van Kooten and Folmer 2004; Luckert and Haley 1990; Cashore et al. 2001) and are therefore not repeated in this paper. Prior research has shown that the nature of these arrangements has a significant impact on investments in enhanced silviculture (Zhang and Pearse 1996) and reforestation (Zhang and Pearse 1997), as well as on the value of the tenure itself (Zhang 1996).

Historically, many timber tenure arrangements in British Columbia, and in Canada for that matter, have been designed to meet a variety of socio-economic goals such as increasing regional employment and value added, as well as providing opportunities for small operators. Collectively these tenure conditions have been dubbed as being part of a broader "social contract" between forest dependent communities and license holders. Virtually no work however has been done on quantifying the costs or benefits of these various tenure conditions.

To a large extent the lack of work in this area has probably been the result of the inadequate market transactions for timber tenures throughout the country. Tenures in Canada are often awarded via bilateral negotiations between industry and government or on the basis of non-price criteria, and transactions between companies regularly include other assets, making the assessment of the value of tenure on its own difficult.[1] Zhang (1996) notes this restriction, limiting his analysis in British Columbia to the Timber License tenure, the only tenure where he had a sufficient amount of market transactions. Timber Licenses however govern a very small portion of the annual timber harvest in the province and their award has ceased. Furthermore, unlike many of the other tenures in the province, they are relatively free of employment and manufacturing conditions.

Tenures coming from the province's Small Business Forest Enterprise Program (SBFEP) on the other hand were full of such conditions. The SBFEP was designed to facilitate new entrants and to provide timber supplies to smaller loggers and manufacturers, particularly those with a focus on job and value added creation. As part of the province's 2003 forestry revitalization regime, the SBFEP was restructured, increasing in size and receiving a new, revenue focused, directive. To reflect this, many of the socio-economic tenure conditions were dropped and the program was re-named British Columbia Timber Sales (BCTS). The primary goal of this paper is to assess the benefit of dropping these conditions, or seen another way, to assess the cost in terms of forgone rents of the various SBFEP aspirations. The results of this study can help guide policy makers both in Canada and in other forest jurisdictions who have similar socio-economic goals.

The structure of the paper is the following. In the first section some background is provided which outlines the organization and goals of the SBFEP, this is followed by a description of BCTS, its organization, and its mandate. The ensuing section presents the methodology for two timber market models, one for short-term timber tenures and the other for longer term tenures. The goal of each model is to establish the shadow price of various employment, processing and size constraints. The results of these empirical models are then presented in the next section. A discussion and our conclusions follow in the subsequent sections.

Background

Small Business Forest Enterprise Program

The creation of the SBFEP in 1980 resulted from the recommendations of the royal commission conducted by Pearse (1976). In his report he voiced concern about the

1 This was largely due to appurtenancy clauses which tied timber tenures to manufacturing facilities.

lack of opportunity new entrants and smaller producers had in the forest sector, which stemmed from the full allocation of Annual Allowable Cuts (AACs) to major integrated forest products companies. The program began small, as it was initially allocated a small portion of the provincial AAC, but this was expanded in the late 1980s and 1990s in an effort to reverse the declining employment and value added in the provincial forest economy (M'Gonigle and Parfitt 1994). These expansions brought the size of the program up to approximately 13% of the provincial AAC.

There were three types of registrants in the SBFEP:

1. *Category 1* - market loggers, who harvest timber and do not do any processing.
2. *Category 2* – sawmill owners who had no replaceable tenure, value added primary processors and remanufactures.
3. *Category 3* – registrants who do not have a mill or processing facility but commit to building one. Corporations holding licenses with an AAC greater than 10,000 m^3 are not eligible, however. Once category 3 registrants are awarded a timber sale and a timber processing facility is built, they would then enter category 2.

Each of these registrants was eligible, in varying degrees, for the award of public timber.

Section 20 of the program awarded short-term timber sale licenses (TSLs) to eligible registrants solely on the basis of revenue. This was accomplished by a first price, sealed bid auction. Unlike many of the other provincial tenures, a TSL carried with it no pre-harvesting management responsibilities, as the SBFEP designed the logging unit and submitted the various management plans to the appropriate government ministry for approval. Furthermore, the license holder was not responsible for reforesting the site after harvesting, as this duty was also carried out by the SBFEP. Effectively the license was strictly for the right to harvest and sell the designated timber within the unit boundaries within an established time frame, which was usually around a year but occasionally up to 4 years. The majority of section 20 sales were open to market loggers registered in category 1. In some cases, however, the sale only offered a small volume or required labour intensive extractive methods (e.g. horse logging), which had the effect of deterring larger companies. In addition, on frequent occasions bidding was restricted to those with registration in category 2.

The other major type of SBFEP TSL was Section 21 sales. These sales targeted firms who planned to maintain, expand or build value added processing facilities. As a result, eligible bidders were restricted to category 2 registrants, but occasionally were open to category 3 members. Unlike section 20 sales however, the award of section 21 TSLs was based on a combination of revenue and non-revenue criteria. Accordingly, section 21 sales were often termed bid proposals. This was reflected in the stated objectives of the section 21 program (British Columbia Ministry of Forests and Range 2006):

1. To provide opportunities for innovation and entrepreneurs in independent smaller firms;
2. To encourage and promote greater employment and community stability through economically sound and viable remanufacturing and the production of specialty wood products by independent remanufactures in British Columbia; and,
3. To award sales competitively.

The usual criteria and the respective weighting each criterion received in the award of a bid proposal are shown in table 1 (*Ibid*).

Table 1. Criteria and weighting for the award of Bid Proposals

Criterion	Weighting (percent)
Employment	30
Proximity	10
Existing Plant	10
New capital investment	10
Labour value-added	5
Change in value-added	15
Revenue	20

The SBFEP also awarded longer term non-replaceable Forest Licenses (NRFLs) to those registered in categories 2 and 3. Unlike the TSLs, NRFLs did not specifically identify the timber which was to be harvested. Instead they grant an annual cut level within a broad geographical area and the licensee is responsible for pre-harvest planning, including the design and inventory of the logging unit and reforesting the site after harvesting. Prior to the Forestry Revitalization Plan (FRP) these NRFLs were typically awarded through the SBFEP based on what the application brought in terms of revenue (as offered by lump sum bid), employment and processing. Furthermore, unlike TSLs where stumpage fees are determined by the auction bid, timber harvested from NRFLs is subject to a volumetric administered stumpage fee, which is derived from a pricing formula.

British Columbia Timber Sales

BCTS came into existence on 1 April 2003 following the announcement of the FRP. In contrast to the SBFEP its stated objective is:

> "BCTS aims to generate the best possible financial return to the Crown from publicly-owned timber, provide timber opportunities, and set a credible reference point for the price and cost of timber harvested from Crown land." (BCTS 2006)

To meet the first objective, BCTS no longer offers section 21 sales, reallocating this volume to section 20 where it is awarded strictly to the highest bidder. Furthermore, major integrated tenure holders who hold greater than 10,000 m^3 of AAC will no longer be excluded from registering in category 1. For an undisclosed temporary period however, some sales will continue to be restricted to category 2 registrants. In addition, BCTS will presumably increase the size of its sales and will eliminate the practise of setting aside special horse logging sales, unless forest management objectives dictate.

To meet the other two objectives, increased volumes will flow through the program; moving from approximately 13% of the provincial AAC to 20%. This volume should also lessen any entry barriers as the additional volume will be sourced from the timber "take back" which re-allocates 20% of the volume from long-term renewable tenures held by large integrated forest companies to BCTS, community forest licenses, small woodlots, and first nations groups. With the 20% auctioned under BCTS now to be used to derive a new pricing formula on long-term area and volume based tenures.

BCTS also will no longer auction NRFLs, as all of this volume flowed into section 20. In spite of this, the government has had some additional volume available to it as a result of uplifts to AACs in areas impacted by the mountain pine beetle infestation. With this volume, the Ministry of Forests and Range, rather than BCTS, created and auctioned several new NRFLs. Although the award of these new NRFLs was strictly based on the highest bid measured by revenue, the design of many of these licenses suggests that there was a concerted effort to foster new entrants in processing, particularly in non-lumber forest products. For on several occasions bidding was restricted to those who would commit to building new non-lumber processing capacity. It was hoped that this capacity will divert volume away from U.S. softwood lumber markets, thus attempting to remove the possibility of affecting their domestic producers, who - as history has shown - have been successful at lobbying for trade restrictions.

Methodology: Timber Market Models

Short–term timber sales

A dataset of TSLs issued in the Interior of the Province under both the section 20 and section 21 programs from January 1999 to June 2004 was retrieved from the BC Ministry of Forests and Range. Table 2 summarizes the number of sales in each year by category.

Table 2. Timber sales by category and year

	Section 20		Section 21	
Year	**Category 1**	**Category 2**	**Bid Proposal**	**Total**
1999	312	62	117	491
2000	278	58	90	426
2001	233	42	131	406
2002	283	41	50	374
2003	252	35	17	304
2004	77	3	0	80
Total	1435	241	405	2081

From this data, we sought to develop a hedonic timber model which related a bid (b) on any given TSL (i) to its characteristics (x). The bid for the TSL could be an indication of the available natural resource rent associated with the timber, therefore *a priori* variables that reflected timber and site quality (*Ricardian rent*) as well as location (*von Thunen rent*) were included in x. We also included variables that reflected the derived demand for timber, the logging method, and the size of the timber sale. A detailed description of these variables and a rational for their inclusion is discussed below.

Timber and Site Quality

- Species – Each tree species has its own intrinsic properties which may affect either the selling price of downstream products derived from timber or the costs of extracting and processing timber. For this reason, the fraction of the timber sale composed of balsam (BA), western red cedar (CE), Douglas fir (DF), western hemlock (HE) and white pine (WH) were included in the model. The remaining major commercial species in the Interior (lodgepole pine and spruce), which are often marketed together, were included in the constant.
- Merchantable volume per tree (VPT) – Many higher valued sawnwood products (e.g. appearance grades etc.) are derived from larger trees. Furthermore, larger stems can be expected to improve productivity in timber extraction and processing. We anticipate that diminishing returns to tree size will occur however (indeed at some point larger trees may become a problem for some mechanized logging equipment). As a consequence, we expect bids to increase in VPT at a decreasing rate.
- Merchantable volume per hectare (VPH) – Higher density stands tend to be higher quality (less branching). They also facilitate extraction as equipment does not have to move as much to remove a unit of roundwood. Both factors lead us to believe that timber sales with higher VPH will result in higher bids.
- Fire damage (BURN) – Percent of timber sale volume with fire damage. Residual wood chips often cannot be used once timber is charred by fire and extracting and processing fire damaged timber is particularly hard on equipment, increasing costs. Therefore we expect BURN volume will reduce stumpage.
- Beetle damage (SALVAGE) – Sales that had greater than 30% of their volume infested by bark beetles were classified by the British Columbia Ministry of Forests and Range as Salvage sales. Such sales were denoted with an indicator variable (0/1) as the exact infestation percentage was not given in our data. The reduced quality (blue stain, checking etc.) associated with this infested timber is expected to negatively impact bids.
- Wind damage (BLOWDOWN) – Percent of timber sale volume which is classified as blowdown. Blowdown timber typically contains significant defect and is costly to extract, therefore its presence is expected to devalue the timber sale.
- Average Slope (%) of the terrain (SLOPE) – In general steeper slopes are expected to adversely impact the productivity of timber extraction and hence lower bids. However, the marginal impact of slope may vary throughout its range. Therefore, several functional forms will be tested.

Location

- Round trip haul time (CYCLE) – calculated using distances and road speeds from the timber sale to the nearest manufacturing centre. It also includes an hour for loading and unloading. Given that trucking contracts in the Interior are usually based on a fixed ‘tonne hour’ payment schedule, log transportation costs are expected to increase linearly with cycle time.

- Region – The Interior of the province has been divided into 5 'selling price' zones by the Ministry of Forest and Range for timber appraisal purposes. Each zone corresponding to a different geographical part of the Interior. These zones and the broad geographic areas they represent are: zone 5 (North-central), zone 6 (Northwest), zone 7 (Southeast), zone 8 (Southwest), zone 9 (Northeast). Four of the zones were assigned dummy variables (zones 5, 6, 8, 9) with zone 7 being treated as a reference zone, included in the constant. Such zonal dummy variables being in place in an attempt to capture localized market conditions (competition levels, timber supply, distance to final product markets etc.).

Derived Demand

- Lumber Price Index (LPI) – This variable was constructed by taking the lumber recovery factor (LRF) of the timber sale (in thousand board feet per m^3), which proxies the marginal product of timber, and multiplying it by the prevailing lumber price at the time of the timber sale (CAN $ / thousand board feet). Through the derived demand process, increased lumber prices are expected to translate through into higher timber prices.
- Countervailing Duty (DUTY) – This is an indicator variable (0/1) which denotes those timber sales that were auctioned after countervailing duties were imposed on Canadian lumber destined to the United States (10 August 2001).

Logging Costs

- Logging Method – most timber in the Interior is clearcut and extracted by conventional ground-based equipment (feller buncher/grapple skidder). Due to terrain, soil conditions or other management objectives, alternative extraction methods and partial cutting may be prescribed though. To control for these circumstances, the fraction of the timber sale volume requiring extraction via helicopters (HELI), horses (HORSE), or cables (CABLE) were included as explanatory variables. The fraction of the sale retained after harvesting (PART_CUT) was also included to capture partial cutting applications.
- Net merchantable volume of timber sale (NCV) - This variable was included to consider any economies of scale in logging operations. As such we expect the relationship between bids and the scale of the timber sale to be positive until decreasing returns to scale set in.

After controlling for the above rent producing factors, we thought dummy variables which denote the type of sale could be included, allowing us to estimate the impact of the constraints associated with each type of sale (category 1 sales were treated as reference sales, included in the constant). Descriptive statistics for both the dependent and explanatory variables listed above are included in table 3.

Table 3. Variables in the short-term tenure model

Variable	Abbreviation	Mean	Min	Max
Bid for timber sale (1997 CAN $/m^3)	b	37.18	0.23	112.42
Fraction of timber sale composed of balsam	BA	0.08	0	1
Fraction of timber sale composed of western red cedar	CE	0.03	0	0.88
Fraction of timber sale composed of Douglas fir	DF	0.09	0	1
Fraction of timber sale composed of western hemlock	HE	0.06	0	0.98
Fraction of timber sale composed of white pine	WH	0.004	0	0.29
Lumber price index (1997 CAN $/m^3)	LPI	97.14	27.60	160.69
Percent of timber sale with fire damage	BURN	1.72	0	100
Net merchantable volume of timber sale (000 m^3)	NCV	13.09	0.01	249.69
Fraction of timber sale extracted by helicopter	HELI	0.02	0	1
Fraction of timber sale extracted by horses	HORSE	0.05	0	1
Fraction of timber sale extracted by cables	CABLE	0.07	0	1
Merchantable volume per tree (m^3)	VPT	0.53	0.08	3.45
Volume per ha (m^3)	VPH	281.31	0.30	748.02
Slope of the terrain (%)	SLOPE	20.50	0	86
Percent of volume with wind damage (%)	BLOWDOWN	3.31	0	100
The fraction of timber sale retained after harvesting	PART_CUT	0.07	0	0.99
Round trip haul time (hours)	CYCLE	4.01	1.20	12.00
Sales with more than 30% beetle damage	SALVAGE	0.22	0	1
Sales auctioned after countervailing duties	DUTY	0.50	0	1
Sales in zone 9	NORTHEAST	0.10	0	1
Sales in zone 5	NORTHCENTRAL	0.32	0	1
Sales in zone 6	NORTHWEST	0.07	0	1
Sales in zone 8	SOUTHWEST	0.13	0	1
Section 21 sales	BP	0.20	0	1
Section 20 category 2 sales	CAT2	0.12	0	1
Section 20 category 1 sales auctioned by BCTS	BCTS	0.16	0	1
Reserve price (1997 CAN $/m^3)	RP	28.68	0.22	62.52

A potential problem with our hedonic model though is the presence of 54 timber sales where no sale occurred. In these instances, no bidders were willing to pay the announced reserve price at the auction and so the bid is not observed. The exclusion of these sales could potentially result in a selectivity bias resulting in incorrect parameter estimates for the hedonic model (Huang and Buongiorno 1986, Niquidet and van Kooten 2006). Having the characteristics of these no bid sales, however, allows us to generate a Heckman model to test and correct for selectivity bias.

The Heckman model contains two equations. In addition to the bid equation, known as the outcome equation, there is a selection equation which models the occurrence of a sale. An outcome only occurs (i.e. a bid is observed) when at least one bidder's valuation

(V_i) is greater than the reservation price (RP_i). If we define d_i^* as $V_i - RP_i$, then the model can be summarized as:

[1] $d_i^* = z'_i\gamma - u_i$ selection (sale) equation
[2] $b_i^* = x'_i\beta - \varepsilon_i$ outcome (bid) equation

Where z_i is a vector containing timber sale variables that influence V_i and the RP_i (which is given), x_i is a vector of variables explaining the bid and γ and β are parameters to be estimated. With $u \sim N(0,1)$, $\varepsilon \sim N(0,\sigma)$ and $corr(u,\varepsilon) = \rho$.
Where $d_i = 1$ if $d_i^* > 0$ and 0 otherwise and $b_i = b_i^*$ if $d_i = 1$.

Therefore, the expected bid, conditional on it being observed is (Greene 2000 p. 929):

[3] $E(b_i | d_i^* > 0) = x'_i\beta + \rho\sigma\lambda\,(z'_i\gamma)$

Where $\lambda(z'_i\gamma)$ $\dfrac{\phi(z'_i\gamma)}{\Phi(z'_i\gamma)}$, with ϕ and Φ being the standard normal and cumulative normal probability distribution functions respectively. This term is known as the inverse mills ratio, its inclusion mimics the non-zero expected mean error term brought on by the selection process. If it proves to be significant in the regression, the classical regression model, where observed bids are regressed on x_i only, suffer from a missing variables problem, resulting in inconsistent parameter estimates.

The Heckman model is usually estimated in two different ways. Heckman (1979) proposed a two step procedure by way of limited information maximum likelihood (LIML). In the first step, a probit model is formed and the parameters of the selection equation (γ) are estimated by maximum likelihood. These estimates are used to construct the inverse mills ratio which is used as a regressor in the estimation of equation 3 by OLS. The two step procedure, however, has shown to be unreliable in small samples and when there are no exclusion restrictions (i.e. $x_i = z_i$) (Puhani 2001). This should not be an issue in our timber model as 2081 observations ought to be sufficiently large, and at the very least z_i will contain RP_i whereas x_i will not. Nevertheless, a full information maximum likelihood estimator (FIML), while often computationally difficult, offers a more efficient alternative to the two step estimator, and so it was chosen as our default estimation method, provided we could get convergence.

The consistency of the LIML estimator and the asymptotic efficiency of the FIML technique are both based on the assumed bivariate normality of u_i and ε_i. Pagan and Vella (1989) provide a diagnostic test for this assumption which involves including $(z'_i\hat{\gamma})^j \lambda(z'_i\hat{\gamma})$, j = 1, 2, 3 as additional variables in the outcome equation. If the coefficients on these added variables are jointly zero, then the normality assumption can be maintained.

Longer-term tenures

In order to investigate the cost of the non-lumber capacity restrictions as well as previous tenure restrictions that focussed on employment criteria, we compiled and analyzed the auction results (lump-sum bids) for NRFLs in the Interior of British Columbia. Data on the bids for these NRFLs for the period January 2002 to July 2006 was retrieved from an independent timber price reporting agency operating in the province.[2] Seeing that the timber associated with NRFLs is only broadly specified, our dataset, in large part, contains variables that reflect the characteristics of the license, rather than the timber itself. We do not anticipate this to be a problem as the administered stumpage fee charged at the time of harvesting should capture the differential rents between stands.[3]

As a starting point we hypothesized that the lump sum bid (*BID*) on each license should represent the discounted value of the expected revenue stream accruing to the licensee over the term of the NRFL. Assuming that the annual net revenue (*R*) is simply the annual allowable cut (AAC) multiplied by the expected payment from harvesting per cubic metre (*p*), the expected bid for license *j* is given by:

$$[4]\quad BID_j = R_j\left[\frac{1-(1+r)^{-t_j}}{r}\right] = pAAC_j\left[\frac{1-(1+r)^{-t_j}}{r}\right]$$

Where t is the term of the NRFL in years and r is the discount rate. If we divide each side of equation 4 by the AAC, we can rewrite the condition as:

$$[5]\quad \frac{BID_j}{AAC_j} = p\left[\frac{1-(1+r)^{-t_i}}{r}\right]$$

In our dataset *BID, AAC* and t are all given for each NRFL. If we assume a discount rate, the term in brackets (the discount factor) can also be identified, leaving p as the only unknown. This parameter however, can be easily estimated by the following regression model:

$$[6]\quad \frac{BID_j}{AAC_j} = pd_j + v_j$$

Where d_j is the discount factor in equation 5, and v_j is a disturbance term with mean zero.

The above model is not sufficient though as we suspect the expected payment will vary according the characteristics of the NRFL. Economies of scale may be important in the management of these tenures and the various tenure conditions could prove to be overly restrictive devaluing the expected payment from the tenure. This is reflected in the following equation:

$$[7]\quad p_j = c + \omega CAP_j + \gamma PROB_j + \psi SAL_j + \delta EMPLOY_j + \theta AAC_j$$

2 http://www.woodx.com

3 The administered stumpage fee is based on an equation that contains adjustments for the timber characteristics listed in the short-term tenure model. An additional allowance is also made for the fact that long term tenure holders are responsible for some management planning and reforestation.

Where *c* is a constant term, *CAP* is a dummy variable taking the value of 1 for those tenures where bidders must create or expand non-lumber capacity and 0 otherwise, *PROB* is another dummy variable that takes the value of 1 when the tenure is restricted to problem forest types[4] and 0 otherwise, *SAL* indicates licenses where harvest units are limited to salvage sites less than 10 ha in size, *EMPLOY* indicates licenses that were awarded on the basis of price and by the degree of local employment the bidder offered, all of which were awarded prior to the FRP, and *AAC,* which was defined earlier and could take various functional forms, captures the prospective effect of scale. Descriptive statistics for the variables can be found in table 4.

Table 4. Descriptive statistics for NRFL model

Variable	Abbreviation	Mean	Std. Dev.	Min	Max
Lump sum bid (1997 CAN $)	*BID*	912 288	3 755 567	0	26 600 000
Annual allowable cut (m^3)	*AAC*	111 980	142 816	7 500	700 000
Term of license(years)	*t*	5.74	3.33	2	15
Licenses with manufacturing requirements	*CAP*	0.12	0.33	0	1
Licenses restricted to problem forest types	*PROB*	0.1	0.30	0	1
Licenses awarded by employment criteria	*EMPLOY*	0.08	0.27	0	1
Licenses restricted to salvage sites	*SAL*	0.26	0.44	0	1

Substituting equation 7 into equation 6, we obtain the final model:

$$[8]\quad \frac{BID_j}{AAC_j} = cd_j + \omega CAP_j d_j + \gamma PROB_j d_j + \psi SAL_j d_j + \delta EMPLOY_j d_j + \theta AAC_j x_j + v_j$$

The regression parameters directly yield the shadow price of the various tenure conditions. Once they are estimated, one could also extend the model to value replaceable or "evergreen" Forest Licenses, which are expected to be renewed in perpetuity. For when $t \rightarrow \infty$, equation 5 becomes:

$$[9]\quad \frac{BID}{AAC} = \frac{p}{r}$$

The valuation of replaceable Forest Licenses is especially important as they cover the greatest portion (37%) of the annual harvest in British Columbia (Berry 2006). On several occasions the government has confiscated these licenses to establish parks or in recent times to expand their auction and small tenures program. The provincial *Forest Act* however requires that the license holder be compensated for these takings. As noted by Schwindt and Globerman (1996) the lack of market evidence has made

4 Problem forest types are defined as timber stands that have a volume per tree less than $0.2m^3$

Table 5. Short-term tenure model results

Variable	Bid Equation Coefficent	P-value	Sale Equation Coefficent	P-value
CONSTANT	41.483	0.000	5.336	0.000
BA	-12.317	0.000	-1.803	0.000
CE	9.952	0.000	1.535	0.000
DF	1.549	0.160	0.256	0.082
HE	-12.716	0.000	-1.856	0.000
WH	9.100	0.370	0.960	0.478
LPI	0.168	0.000	0.023	0.000
BURN	-0.207	0.000	-0.016	0.000
NCV	0.145	0.000	0.019	0.000
NCV^2	-0.001	0.000	0.000	0.000
HELI	-38.973	0.000	-5.088	0.000
HORSE	-13.264	0.000	-1.776	0.000
CABLE	-10.160	0.000	-1.260	0.000
LN(VPT)	8.526	0.000	1.144	0.000
VPH	0.020	0.000	0.003	0.000
$SLOPE^2$	-0.002	0.000	-0.0003	0.000
BLOWDOWN	-0.124	0.000	-0.018	0.000
PART_CUT	-4.179	0.000	-0.393	0.014
CYCLE	-1.920	0.000	-0.246	0.000
SALVAGE	-3.589	0.000	-0.488	0.000
NORTHEAST	-11.895	0.000	-1.500	0.000
NORTHCENTRAL	-7.444	0.000	-1.001	0.000
NORTHWEST	-8.152	0.000	-1.036	0.000
SOUTHWEST	-3.695	0.000	-0.490	0.000
DUTY	-2.484	0.000	-0.269	0.000
YEAR_99	1.672	0.001	0.157	0.016
BP	-8.629	0.000		
CAT2	-0.817	0.140		
BCTS	0.012	0.000		
RP			-0.134	0.000
λ	7.499	0.000		
No. Observations	2081 (54 censored)			
Log Liklihood	-7004.615			
$\chi^2(28)$	5012.88	0.000		

these compensation proceedings difficult. Therefore, such modelling could be a useful input in future compensation proceedings, particularly as the sample size of transactions increases. One must use the model with caution however, as replaceable Forest Licenses may carry with them different management responsibilities and therefore might be priced differently.

Results

Short-term timber sale model

We ran several preliminary models allowing each of the explanatory variables to take on different functional forms. A linear relationship with bid in most cases fit the data best, the exceptions being NCV, VPT, and SLOPE, which took on quadratic, natural log and exponential (squared) functional forms respectively. We also searched for other variations in bids throughout time, finding that sales in the year 1999 commanded a premium.[5]

Moreover, the dummy variables denoting the type of sale were excluded from the sale (selection) equation as the no bid sales proved to consist only of category 1 timber sales. One could question the inclusion of these dummy variables on theoretical grounds as well, as there were no restrictions on re-selling timber and hence one could argue that the type of sale would have no impact on the value of the timber in question. The impact of the different sale types rather was through the bidding process; the ability to pay for the timber by other means (employment, existing capital etc.) in the case of bid proposals and reduced competition in the other cases.

Results for both the sale and bid equations stemming from this specification are listed below in table 5, estimated with FIML using *STATA*™ 9.1.

The model as a whole was highly significant, as were most variables in both equations. To confirm the consistency of our estimates, the Pagan and Vella test for normality described earlier was conducted. The coefficients and p-values associated with each of the test variables were: $(z'_i\hat{\gamma})\,\lambda\,(z'_i\hat{\gamma})$ = 2.48 (p-value 0.49); $(z'_i\hat{\gamma})^2\,\lambda\,(z'_i\hat{\gamma})$= 5.05 (p-value 0.15); $(z'_i\hat{\gamma})^3\,\lambda\,(z'_i\hat{\gamma})$= 1.12 (p-value 0.233). A Wald test, which tests if the coefficients are jointly zero, could not be rejected suggesting our estimates are asymptotically efficient (χ^2 3.39, p-value 0.336).

The signs on the coefficients in the sale equation all make good sense as variables that are expected to increase the value of the timber (and bid) also increased the probability of a sale, holding the reserve price constant. Likewise the negative coefficient on the reserve price indicates that increasing the reserve price decreased the probability of a sale, keeping timber value constant. The significance of the inverse mills ratio in the bid equation indicates that even with such a low degree of censoring, including the no bid data is necessary for unbiased estimates, a result consistent with Niquidet and van Kooten (2006).

The coefficient on the variable HORSE suggests that extraction with horses is \$13.26/m^3 more costly than conventional mechanized methods. This added cost may be justified in some cases where the achievement of a light harvesting footprint is called for. However using horse logging simply as a means of generating more employment, as was sometimes done under the SBFEP, is a rather unproductive use of resources. The same can be said for the creation of small timber sales aimed at helping small operators.

5 This might be the result of the price wedge between lumber prices in the U.S. and Canada, owed to the softwood lumber agreement, which was especially high in 1999 (Stennes and Wilson 2005). The higher bids reflecting the increased derived demand coming from those producers who had access to the higher U.S. price (i.e. quota holders).

Table 6. NRFL bid model results: dependent variable *BID/AAC*

Variable	Coefficient	P-Value
d	2.002	0.001
CAP d	-2.222	0.021
EMPLOY d	-2.135	0.054
PROB d	-0.777	0.354
SAL d	1.483	0.076
AAC^2 d	5.17×10^{-11}	0.028
No. Observations	50	
R^2	0.59	
F statistic	10.33	0.000

The coefficients on the NCV variables suggest that economies of scale are important in harvesting operations and reducing sale volume simply to provide for smaller operators has significant costs. The quadratic relationship between the bid and sale size does suggest however that there is a point where these increasing returns to scale become exhausted. We calculated this point by differentiating the bid equation with respect to NCV, finding that the optimum sale size is 101 163 m^3. Comparing bids evaluated at this optimum to the sample mean (13 090 m^3), generates a \$5.58/m^3 difference in bids.[6]

As for the influence of the various types of sales, results are as one might expect. The most restrictive timber sales, Section 21 bid proposals, received the least revenue, some \$8.63/m^3 less than section 20 timber sales auctioned to market loggers. Given that the bid proposal program represented about 7% of the provincial AAC, this result suggests that the provincial treasury can be expected to gain roughly CAN \$ 42.3 million per year, as a result of dropping this program.[7] As indicated by the coefficient on CAT2, some further revenue gains may be available by dropping the set aside program which restricts bidders on certain sales to be registered in category 2. This variable is only significant at the 14 % level however, perhaps explaining why BCTS has continued the program in spite of its new revenue focussed mandate. The positive coefficient on the BCTS indicator variable suggests that the agency has increased revenue on section 20 sales as well. This might stem from a host of timber sale related practices that have changed since BCTS has taken the helm. Perhaps the key change being the elimination of restrictions that prevented major integrated forest product manufacturers from bidding directly on section 20 sales along side independent logging firms. While statistically significant, the magnitude of the coefficient implies that using market loggers as surrogate bidders has little real impact on efficiency.

Long-term tenure model

Seeing that our long-term tenure model is dependent on the choice of an assumed discount rate, we ran the model based on several different rate assumptions (ranging

6 This analysis is based on the full latent distribution (b^*) not the truncated distribution (b). Also the coefficients used were .145 473 for NCV and -.000 719 for NCV^2 rather than the rounded numbers reported in Table 5.

7 Assuming a Provincial AAC of 70 million m^3 and that the same results in the Interior apply to the Coast.

from 4% to 20%). We also experimented with various functional forms for the variable *AAC*, finding that AAC^2 fit the data best. The 8% model was chosen based on the fact that it produced the smallest sum of squared error and the highest F-statistic. The results from this formulation are reported in table 6.

The variables *CAP d* and *EMPLOY d* proved to be negative and significant revealing that the objective of generating a non-lumber industry and the promotion of employment in the forest sector each come with their own respective price tags. The fact that the coefficient for problem forest types is not significant, suggests that in spite of the timber being of substantially lower quality, bidders anticipate that the stumpage system will adjust to reflect these quality differences. Somewhat puzzlingly, however, a higher payout is expected for salvage sites. We can only suggest that this might be due to a timber pricing expectation, as traditionally stumpage breaks are given for damaged timber and small operating units. The positive and significant coefficient associated with AAC^2, shows that economies of scale are important in the management of long-term tenures as well. This result might explain some of the recent consolidation in the Interior and why the provincial government has tended to favour the relatively larger community forests over woodlots, in the tenure re-allocation process.

Next, we calculated the expected value of a replaceable Forest License for the Interior. This was done by taking the estimated expected payment for a regular NRFL, 100,000 m^3 in size ($2.05/$m^3$) and plugging it into equation 9. Assuming that one expects the license to always be renewed in perpetuity and that it requires the same management responsibilities as those in our dataset, the value of such a Forest License is $25.63 per m^3 of AAC.

One must be cautious however, as the overall explanatory power of our model can be considered moderate (R^2 0.59). This could be due to missing relevant explanatory variables that were not available to us or because of the structure imposed on the model (constant expected payment and harvest levels per annum). Such a structure may not accurately depict reality as tenure holders do have some flexibility over when they harvest (transferring AAC from year to year within a 5 year period) and the nature of the stumpage system could mean that they expect different payments at different times in the business cycle (Grafton et al. 1996). This motivated us to seek a better fitting model allowing the relationship between the bid and *t* to take a more generalized form. We found some improvement as a log-log formulation provided some additional explanatory power, although this transformation meant dropping two observations where *BID* was zero (both of which were awarded according to employment). This model is reported in table 7.

We can essentially draw the same conclusions as the sign and significance of the explanatory variables are the same as the previous model, the exception being *SAL* which is now not significant.

Discussion

Costs or Transfers?

The results of the previous section show that the provincial government foregoes

Table 7. NRFL bid model results: dependent variable LN(*BID/AAC*)

Variable	Coefficient	P-Value
constant	-2.195	0.009
LN(*t*)	2.483	0.000
CAP	-6.033	0.000
EMPLOY	-12.791	0.000
PROB	-1.467	0.132
SAL	0.461	0.438
AAC^2	7.38×10^{-11}	0.023
No. Observations	48	
R^2	0.79	
F statistic	25.49	0.000

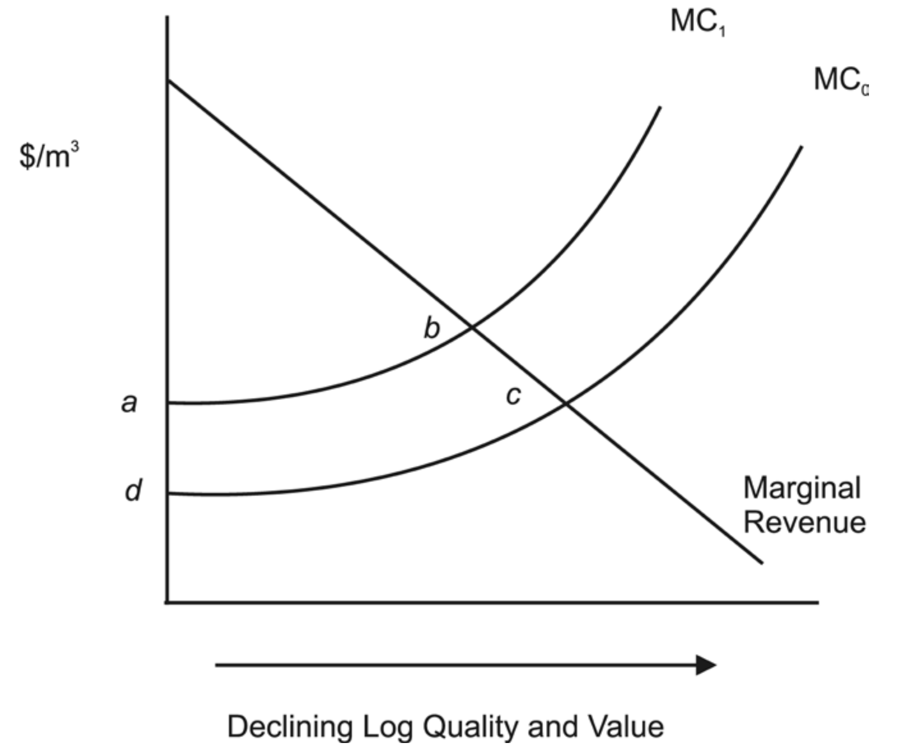
substantial amounts of revenue by imposing several of these tenure conditions. Is this an efficiency issue or a distributional issue? Should all of the revenue losses be viewed as a cost in the sense that they have reduced the overall rent available, or are they simply a transfer of resource rents from the landowner (the government) to owners of capital and labour? The answer to these questions depends to some extent on the tenure condition in question.

In cases where a timber sale could have been re-structured to reduce extraction costs (use machinery, larger timber sale) then clearly there is a loss of available rents and the lost revenue can be seen as the deadweight loss associated with re-distributing rents to smaller operators. This is shown in figure 1 as the increase in the marginal cost of extraction (MC_0 to MC_1) reduces the amount of timber utilized (Q_0 to Q_1) and the available rent by area *abcd*.

On occasions where employment and processing counted as part of the bid for timber, the answer is not as clear. It ultimately depends on whether labour and capital's claim to resource rents through the bidding process contributed to their transfer earnings - the returns required to prevent them from leaving to other uses - which are a reflection of their opportunity cost. If the shift of resource rents was indeed all surplus to the factor's transfer earnings, then these conditions should not be viewed as a cost, but simply a transfer, having no impact on efficiency. However, if the resource rents distort the employment of labour and capital, then the tenure conditions can be viewed as being costly. The cost being the opportunity cost of the factor in production elsewhere in the economy.

As alluded to earlier, since there were no restrictions on re-selling the timber to its highest valued use, or on how the timber was to be extracted, the value of the timber on the stump should not be impacted. Indeed, the common practise for those who were awarded bid proposals was to sell the timber to a major lumber producer in exchange for cash and/or supplies that were inputs to their re-manufacturing facility. The bidding process simply allowed firms to use their employees and capital as a claim towards the resource rents. If this labour and capital use would have occurred in spite of this claim, then this would just be a transfer of resource rents from the government to the firm. However, economic theory would suggest that there was a clear incentive

Figure 1. Resource rents lost from increased extraction costs



to overuse labour and capital, as their marginal value product would have increased because they now had a value in the purchase of timber. The only case where this increased demand for labour/capital would not draw in more of their use, would be if the supply of these factors was perfectly inelastic, reflecting the fact that the factor had no alternate use. This seems completely unlikely, particularly for capital, but also for labour as there has been a general shortage in labour supplies throughout the province. Although, in the short-run, it might apply to some regional labour markets where there is high unemployment and labour is very immobile.

The ultimate test then, is to see how the use of a factor changes once its claim to resource rents is taken away. If there is no change in use, then the resource rents were just a surplus value transferred from government. However, if there is now less employment of labour and capital, then resource rents were contributing to keeping the factor in its use. Recent downward trends in forest sector employment and the capacity utilization of smaller mills identified by Nelson et al. (2006) seems to suggest the latter. So does a study by Parfitt (2005) which shows the value added share of total wood exports falling by 14% between 2003 and 2004, corresponding to the end of the bid proposal program. This suggests that there were gains to dropping the bid proposal program, as resources were freed up for production elsewhere. In addition, government resources are also likely to be saved, as bureaucrats who once spent hours grading bid proposals for their contribution to each of the criteria can now simply award timber to the bidder who is willing to pay the most, a process that is also far more transparent.

Distributional Issues

Regardless of the degree to which the increased revenue collected by government as a result of dropping these tenure conditions will be a transfer or a gain, there are distributional impacts to consider. In particular, resource rents which were once leaked in the form of wages, capital investment, or simply as excess profits to the owners of small local firms, are no longer available. In many cases this will mean a net loss of income for rural regions which are heavily dependent on the forest sector. Alternate opportunities for labour and capital will often be found elsewhere, resulting in regional decline in some cases. Such a result is often counter to a government's objective and politically unacceptable.

To deal with these distributional issues, lump sum transfers could be made to regions that are negatively impacted, helping them make the transition. This may take the form of re-training or new investment in infrastructure; these investments however should also earn their opportunity cost. The government may also think about assigning property rights over forest resources to impacted communities. This is already being done to some extent, by the increase in the issuance of community forests tenures. These tenures however should be free of unnecessary conditions and should be large enough so that economies of scale can be gained, thus not reducing the resource rent available. Moreover, the stumpage fees on these tenures could be reduced, granting the community a greater share of the available rent. The degree to which will depend on the political process. Whatever the circumstance, the rent sharing agreement should be done in a manner that does not distort resource use.

Conclusion

The goal of this paper was to highlight and quantify the costs of several socio-economic tenure conditions in British Columbia. While we feel more work in general is needed on the valuation of timber tenures in the province and in Canada (particularly long-term tenures), our results indicate most of these conditions serve to severely reduce the resource rents collected by the provincial government. In most cases, we suggest that these are more than just wealth transfers as they distort the use of capital and labour. These are real costs that should not be taken lightly in the design of forest tenures. Therefore, we conclude that dropping several of these conditions has been a tremendous benefit to the province and a gain in economic efficiency. While we realize that distributional impacts are likely to be important considerations, effort should be made to design policy such that these distributional goals are met in a manner that is not so costly.

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