Transaction Evidence Appraisal: Competition in British Columbia's Stumpage Markets

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Abstract: As a potential resolution to the softwood lumber dispute, the US Department of Commerce recommends that administered stumpage prices in Canada be determined using information from competitive timber auctions. Previous research indicates that the degree of competition significantly influences bidding behavior. In this article, therefore, a truncated hedonic timber sale model was developed to investigate the influence of competition on stumpage markets in the interior of British Columbia. Results indicate that lower bids in several northern zones of the province are due, at least in part, to lack of competition, but that market power appears limited by spatial arbitrage. In one zone characterized by monopsony, we estimate bids are shaded below their true valuation by \$12.56/m^3, which approximates the calculated transportation costs (\$14.90/m^3) to an adjacent more competitive zone. Furthermore, the significance of the inverse mills ratio suggests that ordinary least-squares regression leads to biased estimates. Our findings have policy implications for the future development and use of transaction evidence appraisal models as a potential solution to the long-standing softwood lumber trade dispute. FOR. SCI. 52(4):451–459.

Key Words: Timber auctions; public forestlands; lumber trade.

In Canada, the vast majority of forestland is owned by provincial governments, with rights to harvest trees allocated to forest companies through a variety of tenure arrangements. Historically, stumpage fees charged forest companies for cutting standing timber have been determined administratively rather than via stumpage markets, although administered prices are loosely linked to market prices of wood products such as lumber. A primary example comes from British Columbia (BC), Canada's foremost timber-producing region that accounts for about one-half of softwood lumber exports from Canada to the United States.

British Columbia has used comparative value pricing (CVP) since 1987 to set stumpage fees on timber from long-term tenures [1]. Under this system, the fee charged a company on any site is given by Stumpage = BR + (VI − MVI), where BR is the base rate (\$/m^3) adjusted by the stand's value index (VI) compared to the volume-weighted mean value index (MVI) of all stands. The BR is based on the government's revenue target, while VI (\$/m^3) is calculated as the difference between output prices (determined as a composite of lumber and chip prices) and operating costs (as determined by an accounting firm) [2]. The CVP system has been criticized domestically for failing to adjust quickly enough to increasing forest management costs and declining market conditions (Grafton et al. 1998); yet the US Coalition for Fair Lumber Imports (hereafter, Coalition) considers the CVP system to be sticky with respect to falling costs and improved output prices, and thus that administered stumpage constitutes a subsidy to Canadian lumber producers.

Not surprisingly, on the expiry of the quota-based Softwood Lumber Agreement (SLA) in 2001, the Coalition successfully lobbied the US Department of Commerce (DOC) to impose countervailing duties (CVD) on softwood lumber from British Columbia and the other major forest provinces since they also use administered stumpage. In 2003, the DOC released a proposed framework by which duties could be dropped as a result of a "changed circumstance" (US DOC 2003). The report stressed that, to show that adequate remuneration is collected, provincial administered stumpage fees needed to be based on information from the sale of a sufficient amount of timber at open auction. In doing so, the DOC stated a "strong preference for regression analysis." The regression approach to stumpage appraisal is a form of transaction evidence appraisal (TEA)—a hedonic technique that relates characteristics of timber sales to bid prices. Such calls are not new, as similar proposals were put forth by Scott (1976), previous Royal Commissions (Pearse 1976, Peel 1991), and representatives from BC industry (MacMillan Bloedel 1998).

Since 1999, the BC Ministry of Forests (MoF) has been using a TEA-based market pricing system (MPS) to establish reservation prices on a small portion of annual harvest auctioned under its Small Business Program (BC MoF 1999). In response to the DOC proposal, the BC government announced its intent to increase the amount of timber sold at auction to 20% and extend the MPS to set stumpage fees on all timber from public land (BC MoF 2003). However, a key issue concerning the potential acceptance of a stumpage pricing scheme based on auctions will be the

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ability of such auctions to replicate a truly competitive market, which may be difficult given potentially low levels of competition. Because timber has low value per unit of weight and is thus costly to transport, stumpage markets may be regionally concentrated (Yin et al. 2002). As Fox (1991) noted, lack of competition is perhaps the biggest drawback to auction-based pricing in British Columbia. However, he did point out that an empirical investigation could be warranted to establish how much of an obstacle this would be.

The main purpose of the current article, therefore, is to analyze the extent to which lack of competition might be an obstacle to the use of market-based pricing in the setting of stumpage fees on public forestlands. To do so, we use data from the BC interior. The focus is on the interior because the vast majority of softwood lumber exported from British Columbia to the United States comes from the interior as opposed to the coast. Furthermore, the structure of the industry and the nature of the timber resource in the interior are more representative of conditions throughout the rest of Canada.

We proceed in the next section by providing a brief overview of timber auction theory and how that has contributed to transaction evidence appraisal modeling, followed by a regression model for analyzing auction data in BC's interior and the estimation results. The implications for administering stumpage to tenure holders and setting reservation prices in auctions are then discussed, followed by our conclusions.

The Development of Transaction Evidence Appraisal Models

The development of TEA models has largely stemmed from theoretical and empirical research on timber auctions that focused on the effects of competition (Johnson 1977, Mead et al. 1983, Brannman 1996), auction design (Johnson 1979, Hansen 1985), and the impact of reservation prices (Huang and Buongiorno 1986, Sendak 1991, Carter and Newman 1998). The underlying framework of the bidding process is a game-theoretic optimum bid strategy (McAfee and McMillan 1987, Bulow and Roberts 1989). A logging company with true value V for timber will win an auction with probability $[\mathrm{F}(V)]^{n-1}$, where n is the number of bidders. The expected payment, contingent on winning, is given by

$$B = V - \frac{\int_u^v [\mathrm{F}(x)]^{n-1}\,\mathrm{d}x}{[\mathrm{F}(V)]^{n-1}}, \tag{1}$$

where u is the minimum bid acceptable to the seller, variously referred to as the reserve price or upset price. The bid B in Equation 1 is the expected value of the second-highest valuation given that V is the highest. Equation 1 predicts that bidders will shade the bid from the true value by an amount representing the bidder's best guess regarding the difference between their valuation and that of the next-highest bidder. Assuming everyone follows this strategy, the average winning bid in a first-price, sealed-bid auction will be the second-highest valuation (Riley and Samuelson 1981).

The bid-shading term is a function of the number of bidders and the reserve price. As n increases, bid shading decreases and bids approach the true valuation, but at a decreasing rate. This theoretical relationship between the number of bidders and the bid for timber has been observed numerous times (Johnson 1979, Mead et al. 1983). Brannman et al. (1987) assigned separate dummy variables for each of $n = 1, n = 2, \ldots, n = 11$, with the sales with $n \geq 12$ excluded to avoid the dummy variable trap. Assuming that auctions with 12 or more bidders are sufficiently competitive, the coefficients on the dummy variables can be interpreted as the bid-shading terms in Equation 1. Likewise, dummy variables not statistically significantly different from zero represent competition levels where bids do not differ from valuations substantially [3]. Consequently, it is possible to predict the best estimate of the high bidder's true valuation (V) for the timber.

The aforementioned studies treated the actual number of bidders in the timber sale model as exogenous, however. Brannman (1996) points out that, with a sealed-bid timber sale, the actual number of bidders is not known a priori, so bids should be based instead on the expected number of bidders. Schuster and Niccolucci (1990) were the first to do this in a timber auction setting, using various timber sale characteristics to predict the number of bidders and then including the expected number of bidders in the bid equation. Furthermore, many models fail to account for "no-bid" information that results when bids are below the reserve price, potentially biasing estimation results. As shown by Huang and Buongiorno (1986) and Sendak (1991), this bias can be overcome by the use of a limited dependent variable (tobit) model.

To account for both problems, Carter and Newman (1998) developed the following system of equations, estimating parameters using a limited dependent-variable, two-stage procedure [4]:

$$B = \mathrm{f}[\mathrm{E}(n_{\mathrm{A}}, u, V_{\max}(\mathbf{X}_1)], \tag{2}$$

$$n_{\mathrm{A}} = \mathrm{g}[u, n_{\mathrm{E}}(\mathrm{E(B)}, \mathbf{X}_2)], \tag{3}$$

where n_{A} is the actual number of bidders, n_{E} is the number of expected bidders, u is the upset or reserve price, $V_{\max}$ is the highest valuation, $\mathbf{X}_1$ is a vector of variables that determines the valuation, and $\mathbf{X}_2$ is a set of variables that determines the number of expected bidders.

Consistent with residual value methods, $\mathbf{X}_1$ will be made up of variables that influence the selling price of products derived from timber or the costs of converting standing timber into various higher-valued wood products. As suggested by the common-values auction paradigm, $\mathbf{X}_2$ would contain variables that influence the heterogeneity of timber values and hence influence presale measurement costs. We would also add that, due to the spatial variation in competition inherent in many stumpage markets, $\mathbf{X}_2$ could also contain a series of regional dummy variables.

Explanatory variables could be in $\mathbf{X}_2$ as well as $\mathbf{X}_1$, thus having an impact on bids both directly through a valuation effect and indirectly through the number of bidders. Isolating these two effects can help solve the dilemma faced by Nelson et al. (2003) who, in their model of timber sales for the BC interior, noted that observed negative coefficients on the regional dummy variables may be partly due to reduced competition in the area and partly the result of legitimately lower valuations associated with things like higher local operating costs. The two effects that a regional dummy variable has on a bid can then be interpreted with Equation 1 in mind. The direct effect reveals the high bidders' true valuations for the resource and the indirect effect reveals the degree to which bids are shaded from that valuation.

A Stumpage Model for The Interior of British Columbia

In this study we use data from British Columbia's Small Business Forest Enterprise Program. Under Section 20 of the Program, timber sales were awarded to the highest bidder on the basis of sealed bids. We have data for the period Jan. 1999 to Aug. 2002 that were provided by the Ministry of Forests (Nelson et al. 2003). The data consist of 639 observations, with summary statistics provided in Table 1.

Model

We use a two-equation model similar to that of Carter and Newman (1998), although it differs in three ways. First, E(B) is estimated using a truncated model rather than a censored model, as we had no data on no-bid sales. The truncated model is specified as

$$B_i|B_i > u_i = \beta' X_i + \sigma\lambda(\alpha_i), \quad (4)$$

where X_i is a vector of variables determining the bid, σ is the standard deviation (SD) of the error term, and $\lambda(\alpha_i)$ is the inverse mills ratio, which is defined as

$$\lambda(\alpha_i) = \frac{f(u_i - \beta' X_i/\sigma)}{1 - F(u_i - \beta' X_i/\sigma)}, \quad (5)$$

where f is the standard normal distribution and F is the cumulative normal distribution. The inverse mills ratio acts as a proxy for the expected non-zero mean error term brought about by the truncation of bids due to the reserve price. If it is significant in the regression, classical models based on OLS, where the observed bid is regressed on X_i only, suffer from a missing variable problem. In such a case, the OLS parameter estimates (β) tend to be biased downward, with the exception of the constant term, which is biased upward (Kennedy 1992). In conducting truncated regression we maximize the following likelihood function with respect to parameters β and σ:

$$L = \Pi\ F[(X_i'\beta - u_i)/\sigma]^{-1}\sigma^{-1}f[(B_i - x_i'\beta)/\sigma], \quad \text{for} \quad B_i \geq u_i, \quad (6)$$

Second, we do not include the upset price as a regressor in the model as preliminary regressions resulted in multicollinearity. This collinearity is due to the fact that upset prices for the data were derived from prior regression-based

Table 1. Summary statistics from BC interior auction sales (639 observations)

Variable	Mean	SD	Min	Max
Bid ($/m^3)	41.55	14.23	0.72	79.75
Truncated upset price ($/m^3)	29.53	10.46	0.23	62.34
Number of bidders	4.915	3.135	1	18.00
CVD (= 1 if sale offered after CVD determination)	0.205	0.404	0	1.00
Lumber price index	103.740	17.147	64.36	160.24
Development cost ($/m^3)	1.632	2.314	0	26.34
% classified blowdown	0.030	0.106	0	1
% of sale helicopter logged	0.028	0.150	0	1
% of sale horse logged	0.029	0.165	0	1
% of sale w/fire damage	0.006	0.078	0	1
% of gross sale retained	0.078	0.177	0	0.940
Slope	20.247	12.137	0	75
Truck haul time (hours)	4.19	1.87	1.40	11.30
Salvage	0.086	0.281	0	1
% western red cedar	0.026	0.098	0	0.88
% Douglas-fir	0.070	0.169	0	0.97
% white pine	0.004	0.027	0	0.32
% hemlock and/or balsam	0.177	0.294	0	1.00
Volume per hectare (m^3/ha)	280.251	117.887	15	748.02
Cruise volume (m^3)	11,669.45	7,790.52	4,000	49,560
Average net cruise volume per tree (m^3)	0.529	0.269	0.08	1.75
2nd quarter (= 1 if timber sale in 2nd quarter, else 0)	0.205	0.404	0	1
Fort Nelson region	0.006	0.079	0	1
Far North region	0.160	0.367	0	1
Central North region	0.163	0.369	0	1
North-West region	0.133	0.340	0	1

MPS models that use many of the same explanatory variables. Therefore, the upset price is very close to being a linear combination of the other variables in the model [5]. Last, to investigate the various competition levels across the interior, we include several zonal dummy variables.

Results

We started off with a preliminary reduced-form bid model that assigned dummy variables to several small subregions and forest districts. Several of the coefficients on these dummy variables were very close in sign and magnitude. Therefore, using Wald tests, we grouped the smaller subregions and districts together to form broader zones. The Northern Interior Region was divided into four zones with each assigned a dummy variable, whereas the Southern Interior Forest Region was treated as a homogenous market and included in the constant term [6]. Regression results for both the reduced-form bid and number of bidders equations are presented in Table 2, as are the results of the OLS reduced-form bid equation. A comparison of the maximum likelihood estimates from the truncated model with the OLS estimates confirms the anticipated bias of the latter estimates. The coefficients on the explanatory variables estimated by OLS are smaller and the intercept higher than the unbiased maximum likelihood estimates. The statistical significance of the inverse mills ratio, $\lambda(\hat{\alpha})$, suggests that this bias is statistically significant.

The variables volume per hectare, percentage western redcedar, "salvage," and the North-West region were the only variables in the bid equation not statistically significant at the 10% level of confidence or better. The lack of statistical significance for salvage, which is attributable to damage by the mountain pine beetle (MPB), is somewhat surprising given that this wood is presumably of lower quality. Furthermore, salvage material often gluts local markets, depressing prices (Prestemon et al. 2001). For the data in our sample, the majority of MPB-salvage timber originates with the Central North Region, so lower prices may be showing up in the coefficient for the dummy variable for this region. Another possible explanation for this result is the log grading system used in the interior. The timber bid is for sawlog grades only; all other grades are charged a flat fee of $0.25/m^3. This flat fee is likely an underestimate of the value of the fiber. Since salvage sales often contain significantly more nonsawlog grades, bidders may bid higher than market value on the sawlogs, knowing they are getting nonsawlog timbers at less than market value. If this phenomenon occurs on a large scale, and is not properly controlled for in the regression, it could potentially distort TEA results. As the current MPB epidemic continues to grow in British Columbia, this may become a significant

Table 2. Reduced form bid and number of bidders equations

Explanatory variable	Bid equation, tobit		Bid equation, OLS		Ln (Number of bidders)	
	Estimated coeff.[a]	Std. error	Estimated coeff.[a]	Std. error	Estimated coeff.[a]	SE
Intercept	14.923*	8.435	18.505***	5.604	1.811***	0.455
= 1 if sale offered after CVD determination	−5.213***	1.343	−3.728***	0.857	0.136*	0.070
Lumber price index	0.287***	0.029	0.271***	0.019	0.000	0.002
Develop. cost ($/m^3)	−0.752***	0.236	−0.646***	0.139	−0.006	0.011
% classified blowdown	−8.774**	4.384	−9.791***	2.781	0.189	0.226
% of sale helicopter logged	−58.595***	5.566	−39.740***	1.986	−0.864***	0.161
% of sale horse logged	−20.052***	3.491	−14.219***	1.868	−0.575***	0.152
% of sale w/fire damage	−20.666***	6.772	−17.105***	3.742	0.097	0.304
% of gross sale retained	−9.790***	3.165	−6.607***	1.999	−0.380**	0.162
Slope of site	0.368***	0.125	0.272***	0.080	0.004	0.007
Slope of site squared	−0.011***	0.002	−0.009***	0.001	0.000**	0.000
Truck haul time (hours)	−2.382***	0.280	−2.089***	0.175	−0.040***	0.014
Salvage (= 1, else 0)	−2.036	1.850	−2.448**	1.246	−0.050	0.101
% western red cedar	5.673	4.504	3.876	3.192	−0.178	0.259
% Douglas-fir	10.964***	2.805	8.255***	1.997	0.556***	0.162
% white pine	32.846**	15.362	20.125*	10.822	−1.876**	0.879
% hemlock and/or balsam	−18.894***	3.256	−13.485***	2.077	−1.064***	0.169
Volume per hectare (m^3/ha)	0.003	0.006	0.008**	0.004	0.001*	0.000
Log of cruise volume	2.109***	0.815	1.696***	0.540	−0.002	0.044
Log of average net cruise volume per tree	10.729***	1.277	9.051***	0.817	0.138**	0.066
= 1 if timber sale in 2nd quarter, else 0	3.720***	1.086	2.723***	0.733	0.323***	0.060
Fort Nelson region	−23.320**	9.888	−11.711***	3.765	−1.031***	0.306
Far North region	−10.671***	1.702	−8.590***	1.020	−0.121	0.083
Central North region	−7.379***	1.378	−5.180***	0.858	−0.217***	0.070
North-West region	1.539	2.654	0.174	1.709	0.184	0.139
Inverse mills ratio, λ	8.542***	0.360				
Adjusted R^2	0.78		0.75		0.29	
Log-likelihood ratio	363.87***					
F-Statistic			79.66***		11.93***	

[a] *** indicates statistical significance at 1% level or better, ** at 5% level, * at 10% level.

issue with future MPS models, requiring that changes be made to the grading system.

The countervail duty (CVD) dummy variable is equal to 1 if the timber sale occurred after the latest CVD was imposed, and zero otherwise. Results indicate that imposition of the latest countervail duty caused bids to drop some $5.21/m^3. Under a market-based pricing system and when faced with lower output values (e.g., due to a CVD), firms will adjust their input costs, leaving output unchanged. Hence, if the goal of US duties is to restrict the flow of wood into the domestic market, an import tax (price) is less likely to succeed than a quantity restriction (quota), as also argued by van Kooten (2002).

If the appraisal is accurate, the coefficient on development costs (road building) should equal one, with values less than one implying that appraised development costs are overestimates. For example, Brannman (1996) found evidence that the "purchaser credit limit" given to loggers on US National Forests for road construction was too generous. However, the appraisal rate is based on an operator of "average efficiency," and presumably the high bidder in a competitive auction is better than average.

The coefficients on northern zones were negative as expected, although the estimated coefficient for North-West was insignificant, suggesting that bids in that region do not differ from the Southern Interior Region. We found this result contrary to prior expectations since the region's manufacturing sector is rather concentrated and, for much of the time in our sample, the largest timber processor was idle due to financial hardship. Further investigation revealed that, because of poor economic conditions in the region at the time, timber was often deemed surplus to domestic requirements and granted exemptions from log export restrictions. Given the region's close proximity to tidewater, timber could have been transported to domestic coastal, United States, and/or Asian markets.

Dummy variables for the Fort Nelson, Far North and Central North zones are highly statistically significant with negative coefficients. Since these variables are also significant (Far North marginally significant) in the number of bidders equation, this suggests that lower bids in these zones are partly attributable to reduced competition. To quantify just how much the lower competition affects the bidding results, it is necessary to obtain the structural coefficients of the bid model. These are provided in Table 3.

Reduced competition in the northern zones affects bids in the following manner: Fort Nelson: $−12.56/m^3 (= 12.185 × −1.031), Far North: $−1.47/m^3 (= 12.185 × −0.121), and Central North: $−2.64/m^3 (= 12.185 × −0.217). If the Southern Interior (which is included in the intercept term) is assumed to have sufficient competition [7] so bids approximately reflect true valuations, the above adjustments can be interpreted as the levels of bid shading. The level of bid shading for Fort Nelson corresponds closely with what one might expect given that there is only one significant manufacturer in this district. The nearest

Table 3. Structural bid equation

Explanatory variable	Estimated coefficient	Standard error
Intercept	6.689	9.636
Sale offered after latest CVD implemented (= 1, else 0)	−6.529**	1.583
Lumber selling price index ($/m£)	0.288**	0.030
Development cost ($/m^3)	−0.712**	0.238
% of sale classified as blowdown	−11.509*	4.672
% of sale logged by helicopter	−48.489**	8.193
% of sale logged by horse	−13.794**	4.881
% of sale with fire damage	−20.406**	6.709
% of the gross sale retained	−1.758	3.273
Slope of site	0.285*	0.132
Slope of site squared	−0.008**	0.003
Truck hauling time (hours)	−1.960**	0.371
Salvage (= 1 if salvage sale, else 0)	−1.043	1.941
% western red cedar	6.453	4.653
% Douglas-fir	6.112	4.049
% white pine	54.814*	22.925
% hemlock and/or balsam	−7.627	7.674
Volume per hectare (m^3/ha)	0.002	0.006
Log of net cruise volume (m^3)	2.074*	0.820
Log of average net cruise volume per tree (m^3)	9.137**	1.484
= 1 if timber sale in 2nd quarter, else 0	1.109	2.060
Fort Nelson region	−9.021	13.362
Far North region	−9.639**	1.803
Central North region	−5.614**	1.808
North-West region	−0.711	2.840
Log of forecasted expected number of bidders	12.185	7.961
Inverse mills ratio, λ	8.593**	0.363
Adjusted R^2	0.78	
Log-likelihood Ratio	362.22**	

[a] ** indicates statistical significance at 1% level or better, * at 5% level or better.

competitor is located in Fort St. John, approximately 380 km away. The amount by which the bid is shaded is about equal to the transportation cost to the nearest alternative sawmill in Fort St. John [8]. This result is also consistent with the optimum bid strategy developed by McAfee and McMillan (1987): bids reflect the bidder's best guess as to the next-highest bidder's valuation.

Bid shading in the Far North and Central North is rather marginal and may not be entirely due to the structure of the underlying manufacturing sector. In the Central North there is a large supply of timber due to increased harvests due to the mountain pine beetle, while in the Far North, alternative supplies from Alberta and the Yukon are available. Many mills have enough wood in their own or associated tenures, and this likely contributes to a lowered expected level of competition at auctions. The 20% tenure take-back currently being implemented by the government will likely increase the expected level of competition at auctions because firms will have to enter the market more frequently to supply their mills. The positive coefficient on the CVD dummy variable in the number of bidders equation lends support to this hypothesis. Since the imposition of the countervail duty, it is widely known that interior mills have increased their capacity in an attempt to drive down unit costs, leading to increased demand for wood and more bidders participating in timber auctions.

The availability of alternate supplies and capacity levels may also influence valuations. Haile (2001) shows the option value of a timber sale is influenced by resale opportunities. When the option value of buying in the resale market is high, bidders' valuations are lower. Furthermore, the value of timber for a firm with excess capacity reflects not only the revenue it can receive from the conversion of the timber, but also the reduced unit costs that come about from increasing output (Schwindt 1992).

Many of the significant variables in the number of bidders equation correspond to the theoretical common-values auction paradigm. Higher bid preparation costs are usually associated with uncertainty, which might explain the reduced number of bidders associated with interior "wet-belt" species such as hemlock, cedar, and white pine. Stands in the interior wet belt have higher rates of decay and are more diverse than other stands. Timber cruises in these stands are subject to higher sampling error, so bidders will probably conduct their own cruises. This results in higher bid preparation costs and a reduced number of bidders.

Implications for Upset Rate and Administered Pricing Policy

Existing market pricing system models used in British Columbia are based on OLS. The significance of the inverse mills ratio in our model suggests that these models are statistically biased and should be replaced by some form of limited dependent-variable model. The higher constant and lower coefficients in the OLS model imply that MPS would tend to overvalue lower-valued stands and undervalue higher-valued stands. Our use of the truncated model was based on data availability. Future analysis should incorporate no-bid sale information and apply more robust modeling techniques, such as the Heckman sample selection model where selection (truncation) is endogenous [9].

Previous researchers have referred to the predicted latent variable ($\mathbf{X}\hat{\beta}$) as the market value (Huang and Buongiorno 1986, Sendak 1991, Carter and Newman 1998, Boltz et al. 2002), but, since the latent variable reflects only the buyer side of the market, the term "market value" may not be appropriate. Buyers' willingness to pay and sellers' willingness to accept determine a market value. The latent variable does not consider the conditions of the seller, so it is referred to as the "unconditional bid." The predicted conditional high bid $\mathbf{X}\hat{\beta} + \hat{\sigma}\lambda(\hat{\alpha})$ is technically a better estimate of the bid one would observe in the market. What then should be the conditions of the seller?

As it stands now, upset prices in British Columbia are set in the same manner throughout the province; the predicted high bid estimated by the MPS model is "rolled back" by 30% to stimulate bidding and accommodate statistical variability in the prediction. The use of a 30% rollback factor was chosen to reflect US Forest Service practice. Using our estimate of $\hat{\sigma}$ given in Table 3 (the coefficient on the inverse mills ratio) and an upset rate given as 70% of the unconditional high bid, we calculated the difference between the two predicted values $[\hat{\sigma}\lambda(\hat{\alpha})]$ for expected unconditional bids ranging from \$1.00 to \$70.00. These are shown in Figure 1.

The difference between the two values reflects the degree of truncation caused by the upset price. The 30% rule has a greater truncation effect on low values than high ones, causing a greater gap between the two predicted values. Such a rule largely ignores the regional variations in competition, however. Furthermore, it no longer concurs with US Forest Service policy as recent timber sale preparation handbooks recommend changing the rollback according to competition levels, ranging from 10% to 20% in competitive regions and 0 to 5% in noncompetitive markets.

We would define competitive timber auction markets as those that have a sufficient number of bidders so that bid shading is small and bids reflect actual valuations. In British

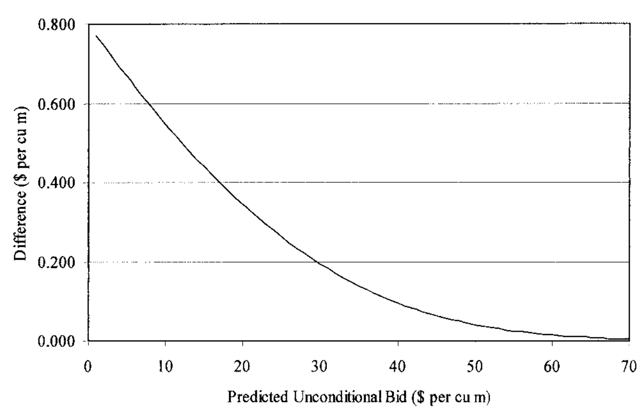

Figure 1. Difference between predicted unconditional and conditional high bids.

Columbia, homogeneity of timber bids and measures of timber processing concentration suggest that the Southern Interior Region fits this definition. Predicted high bids could be rolled back measurably without prompting competition concerns. This will be particularly true if British Columbia relaxed its log export policy, as trucking timber to sawmills in the states of Idaho, Montana, and Washington would be economically feasible [10]. Indeed, we believe evidence of the benefits of log exports on competition levels, and hence bids, is evident in our data for the North-West Region. Allowing more log exports would be consistent with Bulow and Klemperer (2002), who suggest that it is typically more productive for a seller to expand the market rather than attempt to set an optimal reserve price. Nonetheless, to date complete relaxation of log exports has been considered politically infeasible because log exports are viewed as job exports, prompting public outrage, despite research to the contrary (Margolick and Uhler 1992).

Because of high transportation costs, allowing log exports to the United States would do little to improve competition in northern British Columbia, where our research indicates increased competition would be most beneficial. Furthermore, fixed timber supplies and economies of scale also create natural barriers to entry. Thus, bid shading is significant, and policy makers are faced with the decision as to whether to allow spatial arbitrage to continue to occur or to set upset prices to capture the surplus accruing to timber buyers. For the Fort Nelson zone, shading is rather substantial and we would recommend that the province capture the surplus by setting upset rates with reference to adjacent competitive regions with some recognition of local operating conditions, but with little to no rollback. Our model provides a potential mechanism for this as the competitive high bid could be forecast by removing bid shading from the predicted unconditional high bid (B): $E(V) = E(B) + E(\text{bid shading})$. In the predictive process this would mean not using the negative coefficient on the Fort Nelson regional dummy variable in the number of bidders equation. A similar process could be used in the other Northern zones. In these zones, fostering competition in the local timber market may be better accomplished, however, by taking away harvest rights and allocating them to independent forest managers who do not own or operate manufacturing facilities.

Now consider the implications of British Columbia's market-based pricing system for setting stumpage fees for licensees with long-term tenures on public forestland. The DOC demands that Canadian-administered fees replicate the values determined in an open competitive market. As we suggested earlier, the predicted conditional high bid best represents what one would observe in the marketplace. This means reserve prices in auctions have a potential impact on administered prices, but the seller's reserve price is largely there to protect against collusion. In an administered setting, if one can model a competitive result free of bid shading, no conditions should be placed on the sale; therefore, the predicted competitive high bid $E(V)$ would be the market value. This predicted value addresses concerns over validating lack of competition in an administered stumpage system using TEA. It can be argued that, despite a competitive market, conditions could still be placed on the sale to ensure costs to the seller are recovered.

In British Columbia, however, most of the costs related to forest management and reforestation are the responsibility of the licensee. The public authority still incurs some administrative, compliance, enforcement, and opportunity costs, but these can be recovered by setting appropriate minimum administered stumpage fees. The stumpage rate charged to nonauctioned cutting authorities would therefore be the maximum of the predicted competitive high bid less appraised allowances for forest management planning and silviculture, or the net opportunity cost incurred by the province as a result of harvesting [11]. The use of the competitive high bid would go a long way in showing that adequate resource rents are collected. Additionally, an appropriate minimum stumpage fee would ensure harvesting is within the extensive margin, and therefore domestic and international prices are not artificially deflated (Nordhaus 1992).

Conclusions

In British Columbia increased reliance on timber auctions to allocate harvesting rights and set stumpage fees will not come without challenges. A central challenge in the setting of reservation and administered prices based on transaction evidence appraisal is dealing with varying competition levels throughout the province. While this issue is sure to be contentious, failure to address it would significantly impede the success of an auction-based system. In this article we show that competition levels in British Columbia's Northern Interior reduce bids for standing timber. A TEA system that does not address this phenomenon will be susceptible to criticism from both domestic and US sources.

Within British Columbia, the distribution of rents that stem from an auction system that does not account for (lack of) competition will evoke concerns from the public as resource owner, because they lose of a portion of the revenue that could fund valuable services such as health and education. Furthermore, equity issues could potentially be a concern as tenure holders in noncompetitive regions would have an unfair advantage. This has implications for competitors within the province and outside. In particular, lack of competition and seemingly obscure setting of stumpage charges are a source of contention with the United States, enabling the Coalition to continue lobbying the Department of Commerce for countervail action against softwood lumber from Canada.

To meet these challenges we recommend a relaxation of log export restraints and further separation of forest management functions from manufacturing and processing of wood. Both policies are likely to be politically controversial and unlikely to be implemented without concomitant assurances of access to US lumber markets. The current research provides an enabling mechanism for encouraging steps toward the resolution of the softwood lumber dispute, namely a means to estimate the true stumpage value of timber in regions where there is lack of competition, thereby making transaction evidence appraisal information more palatable to US interests. The approach presented in this article can form the basis for an appropriate reservation pricing policy and an operational administered stumpage system in British Columbia.

Endnotes

[1] For a discussion of the tenure system, see van Kooten and Folmer (2004, p. 389–393). Companies with long-term cutting licenses also have forest management responsibilities and until recently (2003) were often subject to appurtenancy clauses that tied timber from the license to a manufacturing facility.

[2] For more details see van Kooten and Folmer (2004, p. 58–64).

[3] Brannman et al. (1987) found that the dummy variable became statistically insignificant at five bidders for sealed-bid auctions and nine bidders for oral-bid auctions. We found a similar result using data described in the third section, except that the dummy variables became statistically insignificant when there were eight or more bidders.

[4] In the first stage, the expected bid, E(B), and number of bidders, E(n_A), are estimated using the reduced-form equations. The bid equation is estimated by limited dependent-variable techniques and number of bidders by OLS. The second stage involves re-estimating both equations using the predicted values estimated in the first stage (see Nelson and Olsen 1978).

[5] The upset price does in fact enter the model, albeit in a nonlinear fashion as the truncation point in the inverse mills ratio. Technically, the upset price would be an acceptable bid; therefore the truncation point was set at the upset price less one cent, which is termed the truncated upset price in Table 1.

[6] The zones are Far North, consisting of the Peace, Mackenzie, and Fort St. James Districts; Central North, consisting of the Prince George, Vanderhoof, and Nadina Districts; North-West, consisting of the Kalum, Kispiox, and Bulkley-Cassiar Districts; and the Fort Nelson Forest District. The dummy variables on the Cariboo and Nelson subregions were not significantly different from the Kamloops region, which was included in the constant term. Collectively, these three regions make up what is termed the Southern Interior.

[7] Based on 2002 mill data, this region has a Herfindahl Index ($= \Sigma_{i=1}^{N} s_i^2$, where N is number of firms and s_i is the share of firm i measured in %) less than 1,000.

[8] The calculation is 380 km at 100 km/hr = 3.8 hr × 2 = 7.6 hr cycle time. Given the structural coefficient for the cycle is 1.96, the transportation cost is 7.6 × 1.96 = \$14.90/m^3.

[9] The censored model used by Carter and Newman (1998) is a restricted version of the Heckman model (see Amemiya 1984).

[10] We might add that the same competition benefits would also accrue to US Forest Service timber sales by adopting similar policies, as mills in southern British Columbia would increase competition in US stumpage markets. The caveat is that trade barriers in lumber are removed.

[11] These include recreational and wilderness benefits foregone, which could be estimated by nonmarket valuation techniques such as benefits transfer. The challenge will be to estimate the value of these nonpriced goods at the margin. Further complicating matters, harvesting potentially has external benefits as well.

Literature Cited

AMEMIYA, T. 1984. Tobit models: A survey. J. Econometrics 24:3–61.

BC MINISTRY OF FORESTS. 1999. The market pricing system (Coast)/the market pricing system (Interior). Revenue Branch Report. Government of British Columbia, Victoria, Canada, January 25.

BC MINISTRY OF FORESTS. 2003. The forestry revitalization plan. Government of British Columbia, Victoria, Canada.

BOLTZ, F., D.R. CARTER, AND M.G. JACOBSON. 2002. Shadow pricing diversity in U.S. National Forests. J. For. Econ. 8:185–197.

BRANNMAN, L.E. 1996. Potential competition and possible collusion in Forest Service timber auctions. Econ. Inq. 34:730–745.

BRANNMAN, L.E., J.D. KLEIN, AND L. WEISS. 1987. The price effects of increased competition in auction markets. Rev. Econ. Stat. 69:24–32.

BULOW, J., AND P. KLEMPERER. 2002. Prices and the winner's curse. Rand J. Econ. 33:1–21.

BULOW, J., AND J. ROBERTS. 1989. The simple economics of optimal auctions. J. Pol. Econ. 97(5):1060–1090.

CARTER, D.R., AND D.H. NEWMAN. 1998. The impact of reserve prices in sealed bid federal timber sale auctions. For. Sci. 44:485–495.

FOX, I.K. 1991. Politics of Canada-U.S. trade. *In* Canada-U.S. trade in forest products, R.S. Uhler (ed). University of British Columbia Press, Vancouver, Canada.

GRAFTON, R.Q., R.W. LYNCH, AND H.W. NELSON. 1998. British Columbia's stumpage system: Economic and trade policy implications. Can. Public Policy 24:S41–S50.

HAILE, P. 2001. Auctions with resale markets: An application to U.S. Forest Service timber sales. Am. Econ. Rev. 92:399–427.

HANSEN, R.G. 1985. Empirical testing of auction theory. Am. Econ. Rev. 75(May):156–159.

HUANG, F.M., AND J. BUONGIORNO. 1986. Market value of timber when some offerings are not sold: Implications for appraisal and demand analysis. For. Sci. 32(4):845–854.

JOHNSON, R.N. 1977. Competitive bidding for federally owned timber. Ph.D. dissertation, Univ. of Washington, Seattle, WA.

JOHNSON, R.N. 1979. Oral auction versus sealed bids: An empirical investigation. Nat. Res. J. 19:315–335.

KENNEDY, P. 1992. A guide to econometrics, 3rd ed. MIT Press, Cambridge, MA.

MACMILLAN BLOEDEL. 1998. A white paper for discussion: Stumpage and tenure reform in BC. Vancouver, Canada.

MARGOLICK, M., AND R.S. UHLER. 1992. The economic impact on British Columbia of removing log export restrictions. *In* Emerging issues in forest policy, P.N. Nemetz (ed.). UBC Press, Vancouver, Canada.

MCAFEE, R.P., AND J. MCMILLAN. 1987. Auctions and bidding. J. Econ. Lit. 25:699–738.

MEAD, W.J., M. SCHNIEPP, AND R. WATSON. 1983. Competitive bidding for Forest Service timber in the Pacific Northwest 1963–83. USFS Contract No. 53-3187-2-59, Washington, DC.

NELSON, F., AND L. OLSON. 1978. Specification and estimation of simultaneous-equation model with limited dependent variables. Internat. Econ. Rev. 19:695–709.

NELSON, H., A. KRCMAR, K. NIQUIDET, G.C. VAN KOOTEN, AND I. VERTINSKY. 2003. Evaluating the socio-economic impacts from expanding the use of auction systems for timber in BC. Report prepared for the Forestry Innovative Investment Forest Research Program. FEPA Research Unit, Univ. of British Columbia, Vancouver.

NORDHAUS, W.D. 1992. The impact of stumpage charges on prices and trade flows in forest products, Appendix A to memorandum concerning alleged subsidies and preferentiality in the matter of certain softwood lumber products from Canada. INV. C-122-816. International Trade Administration, US Department of Commerce, Washington, DC.

PEARSE, P.H. 1976. Timber rights and forest policy in British Columbia. Report of the Royal Commission on Forest Resources. Queen's Printer, Victoria, Canada.

PEEL, S. 1991. The future of our forests. Forest Resources Commission Report, Victoria, Canada.

PRESTEMON, J.P., J.M. PYE, AND T.P. HOLMES. 2001. Timber economics of natural catastrophes. *In* Proc. of the 2000 Southern forest economics workshop, March 26–28, Pelkki, M. (ed.). Lexington, KY.

RILEY, J.G., AND W.F. SAMUELSON. 1981. Optimal auctions. Am. Econ. Rev. 71:381–392.

SCHUSTER, E.G., AND M.J. NICCOLUCCI. 1990. Comparative accuracy of six timber appraisal methods. Appraisal J. 58:96–108.

SCHWINDT, R. 1992. Report of the Commission of Inquiry into Compensation for the Taking of Resource Interests. Government of BC Printing Office, Victoria, Canada.

SCOTT, A. 1976. The cost of compulsory log trading. *In* Timber policy issues in British Columbia, McKillop, W., and W.J. Mead (eds.). University of British Columbia Press, Vancouver, Canada.

SENDAK, P.E. 1991. Timber sale value as a function of sale characteristics and number of bidders. Research Paper NE-657. USDA For. Serv., Northeastern Forest Exp. Stn., Radnor, PA.

US DEPARTMENT OF COMMERCE. 2003. Proposed analytical framework for softwood lumber from Canada: Discussion Draft. Washington, DC.

VAN KOOTEN, G.C. 2002. Economic analysis of the Canada-United States softwood lumber dispute: Playing the quota game. For. Sci. 48(6):712–721.

VAN KOOTEN, G.C., AND H. FOLMER. 2004. Land and forest economics. Edward Elgar, Cheltenham, United Kingdom. 533 p.

YIN, R., D.H. NEWMAN, AND J. SIRY. 2002. Testing for market integration among southern pine regions. J. For. Econ. 8:151–166.