An Analysis of Auction Volume and Market Competition for the Coastal Forest Regions in British Columbia

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The B.C. Ministry of Forests is considering the implementation of a package of complementary reforms to improve market performance and competition in the British Columbian timber industry. The key feature of these reforms is that a portion of Crown owned timber will be sold at auction, and those auction prices shall be used to determine stumpage rates for tenured timber. This process is known as the Transaction Evidence Pricing System (TEPS). The TEPS system will be *loosely* based on the current Small Business Forest Enterprises Program (SBFEP), where loggers compete for auctioned timber comprising approximately 6.5 percent of the volume in British Columbia.

British Columbia is divided, geographically, into a coastal area and an interior area by a series of mountain ranges. This creates two distinct timber markets—the Coast and the Interior. Steep slopes and high quality timber dominate the Coast, while the Interior is characterized by more shallow terrain and timber that varies substantially in quality. Timber extraction on the coast can be costly upfront because extraction on a mountainside requires “cable yarding” or even helicopter removal. But log transportation in the Coast is often cheap, because logs can be barged if they are close enough to a major waterway. In the Interior, ground skidder extraction is frequent, and is much cheaper than cable or helicopter removal. Thus, upfront extraction in the Coast is, on average, more expensive than in the Interior. Almost all logs in the Interior, however, must be hauled their entire travel distance from the field to the mill, increasing the transportation costs in the Interior relative to those in the Coast. Also, an active log market exists in the Coast, whereas almost all logs in the Interior move directly from the field to a lumber or pulp mill. Therefore, the market in the Coast is vastly different from the market in the Interior.

Because of the differences between the Coast and the Interior, careful attention must be paid to how these differences will affect the implementation of TEPS. In particular, the volume of auctioned timber that is required to ensure a precise average stumpage rate in the one area may differ from that which is necessary in the other area. Also, competition in one area may differ from competition in the other area. If competition in the Coast is much lower than competition in the Interior, then the regression specification used in the Coast could have different effects on the ability of certain firms to exercise market power than it would in the Interior.

We addressed necessary auction volume and district level competition for the Interior in our paper, “Auction-Based Timber Pricing and Complementary Market Reforms in British

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Columbia." Here, we address those same issues for the Coast. We begin by reviewing the Coast regression specification as it exists currently in the SBFEP system. We then analyze the auction volume that is necessary to produce statistically accurate average timber prices on the Coast. An analysis of local competition and its role in regression specification follows the auction volume analysis, and we conclude with a summary of our findings.

1 REGRESSION SPECIFICATION

Currently, the Ministry uses a three-step method to estimate the value of a timber stand that is to be let at auction. The first step is to predict the market price of timber using an ordinary least squares (OLS) regression, but substituting the average number of bidders in the regression sample rather than the actual number of bidders in the auction. This estimated market price is then used to predict the *ex-ante* number of bidders that was expected to enter the auction. In the third step, the expected number of bidders is used to predict the market price using the regression equation from the first step.

The Ministry uses this three-step process to correct a perceived under-prediction of the true stumpage rate at auction that it found when using a one-step OLS model. This is worthy of note, because in future trade negotiations with the United States, the U.S. Industry's biggest justifiable concern with timber pricing in British Columbia is that a pricing system might lead to stumpage rates that are biased downward. However, the bias that the Ministry found was more likely the result of the regression specification choice and the representativeness of the auction sample. A simpler one-step method may be less prone to bias when those problems are corrected.

It will be important to show that a timber pricing system accurately predicts the average price of future auctioned stands, so that the average price of B.C. timber exported to the United States reflects market prices. If the sample of auctioned tracts is representative, then a one-step regression cannot lead to bias in the average predicted price. Of course, given a particular sample, the estimated regression line may be different from the "true" regression line. The larger the sample, the more precise is the estimate of the true relationship between sale characteristics and market prices.

The Ministry's current Coast specification uses a sample of far fewer observations than the Interior specification. Simply increasing the sample size (i.e. increasing the auction volume from 6.5 percent), and paying close attention that the sample is representative of the population of stands, might improve the predictive power of a simple one-step OLS regression. Also, careful attention should be paid to possible outlier stands that exist in the current dataset. When expanding auction volume, the extent that "extreme" tracts (say, high-volume tracts) are present in the auction sample should reflect their prevalence in the tracts that will be extracted from long-term tenures.

The current Coast specification with the current sample size leads to "noisy" results. Increasing the regression sample with historical data does not improve upon those results. When one includes sales dating back to 1992 (without changing the specification), the standard deviation of the residuals increases. The move to the Market Pricing System in 1999 surely contributes to this result, and in the future, outcomes are more likely to be comparable across years. Nevertheless, because including the historical data does not improve the estimation, one can conclude that, at least initially, larger auction volume in a given year in the Coast is required.

Before proceeding with an analysis of how increasing the auction volume can improve precision, we first illustrate how outliers and specification choice can produce misleading results in a given sample. Under the current specification, in both the stumpage equation and the number of bidders equation, volume enters, either directly or indirectly, through the variables

$volume/1000$ and $(volume/1000)^2$, where *volume* is the total coniferous cruise volume. The *volume* variable, however, contains one large outlier relative to the rest of the sample. The maximum value of $volume/1000$ is 140.8, while the second largest value is only 58.3. If a researcher were to estimate a one-step regression with $volume/1000$ and $(volume/1000)^2$ on the right-hand-side, she would find that this one outlier drives the coefficient on $(volume/1000)^2$.

To see this effect most clearly, recall that the effect of $(volume/1000)^2$ on bids, conditional on other covariates, can be calculated in two ways. One way is to run a regression of bids on $(volume/1000)^2$ and other covariates, and examine the estimated coefficient on $(volume/1000)^2$. An equivalent way to evaluate this effect, but one that is easier to depict graphically, requires a series of three regressions. First, bids are regressed on other covariates, and the residuals are obtained. Second, $(volume/1000)^2$ is regressed on other covariates, and the residuals are obtained. Third, we regress the residuals from the first regression on the residuals from the second regression. The latter regression tells us how the part of bids unexplained by other covariates depends on the part of $(volume/1000)^2$ unexplained by other covariates. This regression is easier to depict graphically, because it boils down to the relationship between two sets of residuals, rather than including all other covariates. Figure 1 illustrates exactly this relationship using an "added variable plot"—that is, a scatter-plot of the two sets of residuals graphed with the corresponding regression line.

With either of these two methods, we can then examine the costs and benefits of including the additional variable in the regression, as well as evaluate our chosen functional form.

Figure 1. Added Variable Plot

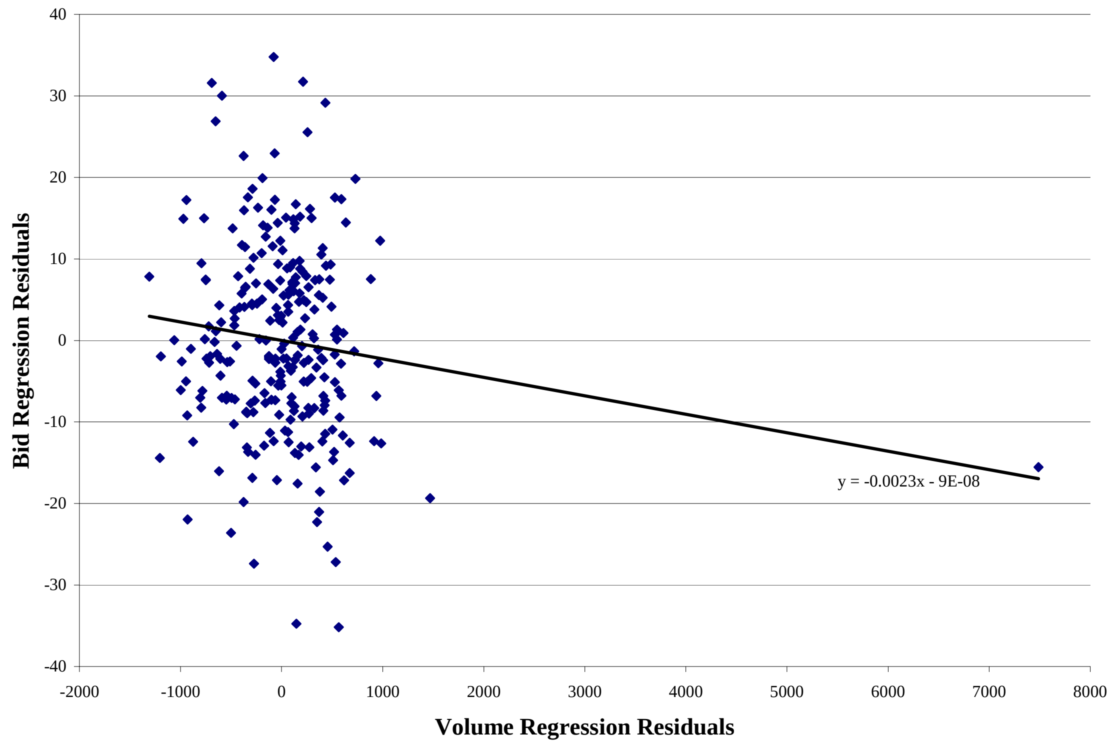

Figure 1 illustrates graphically that a single data point can drive the estimated relationship between two variables. This does not mean that the estimated coefficient on $(volume/1000)^2$ is inaccurate, but it does cause reason for concern. Large timber stands *should be* in the regression because those stands must be priced on tenured lots, and these stands convey valuable pricing information. However, large stands should only affect the average timber price to the extent that the frequency with which they are sampled coincides with their existence in the population.

Furthermore, when there are large gaps in the distribution of a variable like volume, the chosen functional form will dramatically affect predictions. As the figure illustrates, fitting a single line through these observations will affect predictions dramatically for both the low-volume and high-volume tracts. If the true relationship between $(volume/1000)^2$ and bids is linear, then there is still the problem that the estimated slope of the line is highly sensitive to one datapoint. (Anticipating this, firms could have an incentive to manipulate bids in outlier sales.) Perhaps an even more serious problem is that there is no reason to believe that the relationship is linear. The predicted bid for volumes in a middle range (where there is no data) is determined entirely by extrapolation. Fitting a parabola or a cubic to these points would yield drastically different predictions for volumes in the middle range. Thus, if predictions will be required in that range, functional forms in such a case should be chosen based on some prior information.

Overall, it is much more desirable to select a sample that is representative, so that there are observations of auctioned sales throughout the range where predictions are needed. One must therefore ensure that the sample is representative of the population, and that a small group of stands is neither over-represented nor under-represented in the sample. In this scenario, two solutions exist. First, if the regression will be used to price but few stands with characteristics similar to those of the outlier, then the outlier should be omitted. However, if many high-volume stands are to be priced, then more stands need to be auctioned in that range. The set of auctioned stands will then be representative. In the latter case, if there are two “clusters” of volume, low and high volume, one should not attempt to fit a single line through both clusters. A more flexible functional form would be superior. However, the implications of that functional form for out-of-sample predictions should be carefully examined. For example, if observations are clustered into groups, we should probably estimate a separate relationship for each cluster, implemented by including dummy variables for ranges of volume and interacting the volume variable with a dummy variable for the range. With this approach, the analyst is forced to choose how to extrapolate in regions with little data. Using prior information, the “moderate” volume sales must be grouped either with low or high-volume stands, and the functional form should be examined to be sure those (rare) sales would be predicted in a sensible way.

2 AUCTION VOLUME

To determine the minimum auction volume that will produce an accurate average timber price with a reasonable level of statistical confidence, we perform a Monte Carlo study of selection from a population of timber stands. We assume a true stumpage equation, and then vary the sample volume to determine the incremental benefit in statistical precision that comes from more auctioned timber. For variables that look as though they are normally distributed, we use the joint distribution of those variables in the Coast SBFEP dataset to generate our population. For variables such as helicopter extraction volume or cable yard volume, where an assumption of normality is not justified, we apply a frequency table of the slope variable to different categorical values of the relevant extraction method. Finally, we use a two-equation model to depict the true workings of the market. In particular, we assume that stumpage rates are determined by relevant value and cost variables, but that the level of competition is also determined value specific variables and a random cost of entering the auction. Thus, we posit the following model:

$$\begin{aligned} &\log(Bidders_i) = a_0 + a_1 changeVLM_i + a_2 HemlockBalsam_i + a_3 Slope_i + a_4 Heli_i \\ &+ a_5 Cable_i + a_6 Haul_i + \varepsilon_i \end{aligned} \tag{1}$$

$$\begin{aligned} &Bid_i = b_0 + b_1 Price_i + b_2 OperCost_i + b_3 DevCost_i + b_4 VolPerHect_i \\ &+ b_5 \log(Bidders_i) + b_6 Volume_i + u_i \end{aligned} \tag{2}$$

A reduced form for the stumpage equation can then be calculated by substituting the number of bidders variable from equation 1 into equation 2.

We now describe the process by which we generate the random dataset. For variables data that appear to be roughly normal (i.e. mound shaped), or where transformations of those variables appear normal, we generate data from a joint normal distribution using the appropriate empirical correlation matix. Table 1 contains this matrix.

TABLE 1. CORRELATION MATRIX FOR NORMALLY DISTRIBUTED VARIABLES

	Price	*Change VLM*	*Hem-Balsam*	*Slope*	*log(Dev Cost)*	*log(Op Cost)*	*Vol per Hectare*	*log (Haul)*	*log (Vol)*
Price	1.0								
Change VLM	-0.07	1.0							

Hem-Balsam	-0.188	0.012	1.0						
Slope	0.287	0.004	0.235	1.0					
log(Dev Cost)	-0.002	-0.066	-0.025	-0.054	1.0				
log(Op Cost)	-0.188	-0.04	-0.135	0.08	-0.058	1.0			
Vol per Hectare	0.345	-0.009	0.306	0.233	-0.006	-.572	1.0		
log (Haul)	-0.22	-0.1	0.086	0.079	-0.032	.353	-0.169	1.0	
log (Vol)	0.129	-0.026	0.139	0.277	-0.126	-.283	0.379	-0.197	1.0

After generating a series of joint-randomly distributed variables with the above correlation matrix and zero mean and variance of one, we then adjust each variable for its mean and variance in our dataset.

We then generate the heli-extraction and cable-yard variables based on their frequency distributions with varying degrees of slope. We break the slope into quadrants, and then plot the frequencies with which cable-yarding accounts for 0 percent, 100 percent, or some intermediate percent of total extraction. We do the same for heli-extraction. We then create 0/1 variables for heli and cable extraction based on the frequencies seen in the regression sample for the 0/1 extraction proportions. When our probability rule tells us that one of the extraction methods should have an intermediate value (between 0 and 100 extraction by that method), we sample from a truncated normal distribution centered at 0.5. We perform this procedure based on frequencies over the four slope quadrants: 0 to 24 percent grade, 25 to 49 percent grade, 50 to 74 percent grade, and 75 to 100 percent grade. This process maintains the relationship between slope and extraction method (steeper slopes require more specialized means of extraction) while taking into consideration the unique characteristics of the heli and cable-extraction variables.

To generate our population dataset, we assume approximately 1000 stands per year, with an average stand volume of about 14 thousand. We find an average bid of about $53, and an average log(bidders) of approximately 1.5.

We generate the error terms for equations 1 and 2 respectively from predicted errors in regressions run on the coast regression dataset. In particular, we applied the specification in equation 1 to the coast data, and then obtained the residuals. These disturbances had mean of approximately zero, and standard deviation of .634. We therefore assume that the ε_i errors are a random sample from a normal distribution with zero mean and standard deviation of .634. We then estimated the reduced form equation found by substituting equation 1 into equation 2. Running this specification on the coast data yields predicted disturbances with mean zero and standard deviation of 11.58. Assuming that ε_i and u_i are statistically independent, it is possible to solve for the standard deviation of u_i accordingly.[2] Although this helps us describe the data-

2. Denote the disturbances in the reduced form equation as υ_i (as in equation 3). Given our estimation, the standard deviation of the υ_i disturbances is 11.58. Assuming statistical independence between the

generating process intuitively, it is unnecessary to assume independence or solve for the properties of u_i, because we can randomly generate bids based on the properties of the predicted disturbances we found in the reduced form estimation. Thus, we generate bids according to the reduced form equation (equation 3 below), assuming that υ_i are distributed normally with zero mean and a standard deviation of 11.58.

$$\begin{aligned} &Bid_i = c_0 + c_1 Price_i + c_2 OperCost_i + c_3 DevCost_i + c_4 VolPerHect_i \\ &+c_5 Volume_i + c_6 changeVLM_i + c_7 HemlockBalsam_i + c_8 Slope_i \\ &+c_9 Heli_i + c_{10} Cable_i + c_{11} Haul_i + \upsilon_i \end{aligned} \tag{3}$$

We sample 200 times (in 5 percent increments from 10 percent to 50 percent) the representative stands in our model, and then apply a one-equation regression to the reduced form equation defined by equation 3.

We then compute the R^2 for the regression as well as the confidence intervals around the estimated regression line. Thus, we can see how the “fit” of the regression, and the size of the confidence intervals that contain the “true” regression line with 95% probability, are improved by increasing the sample volume. Table 2 below contains these results.

TABLE 2. RESULTS FROM 200 MONTE CARLO SIMULATIONS

Volume (%)	***Mean R^2***	***Average 95% Conf. Int. Size***	***Incremental Improvement***	***Incremental Improvement (%)***
10	.805	14.839		
15	.796	11.863	2.976	20.055
20	.795	10.185	1.678	14.145
25	.794	9.038	1.147	11.262
30	.790	8.224	0.814	9.006
35	.791	7.579	0.645	7.843
40	.789	7.07	0.509	6.716
45	.790	6.633	0.437	6.181
50	.790	6.310	0.323	4.870

Table 2 indicates that the statistical precision of the estimation increases with additional volume. The size of the 95 percent confidence interval around the predicted bids decreases with an increase in sample volume. Thus, the accuracy of the estimated regression line with respect to the true regression line improves as more timber is auctioned off. The last two columns of Table 2 show the incremental improvement in the precision of the estimated equation with each 5 percent increase in volume. The last column gives the improvement as a percentage of the average bid. The largest increase in the precision of the estimate occurs when we move from a sample of 10 percent to a sample of 15 percent. Here, the 95 percent confidence interval decreases by $2.98, a significant improvement in precision. Each further increase in volume results in a smaller improvement of our estimated regressions likely resemblance to the true stumpage equation. For

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disturbances in equation 1 and equation 2, we can write the following: $Var(\upsilon_i) = 11.58^2 = b_5^2 Var(\varepsilon_i) + Var(u_i)$. Above, we estimated $Var(\varepsilon_i) = .634^2 = .402$. Estimating equation 2 using OLS, we obtain 13.96 as an unbiased estimate of b_5. Solving the above equation yields $Var(u_i) = 11.58^2 - 13.96^2 * .402 = 55.75$. Thus, the standard deviation of the u_i disturbances is 7.467.

example, moving from 45 to 50 percent results in an improvement of only $0.32, or about one-tenth the improvement from increasing volume from 10 to 15 percent.

Results in Table 2 indicate that prediction errors, at the 95 percent level, will not fall to below plus or minus 50 cents until the auction volume exceeds 25 percent. The benefits in statistical precision in moving beyond 35 percent volume are very small. In particular precision at the 95 percent level increases to only plus or minus 15 cents in moving from 35 percent to 50 percent volume. Thus, it appears that an auction volume of between 25 and 35 percent would ensure sufficient statistical accuracy, and increasing volume beyond 35 percent offers little incremental benefit.

2.1 Auction volume over time

The above analysis focused on the incremental improvement in statistical precision from auctioning a larger volume *in a given year*. Timber sales occur over time, however, and eventually multiple years of data will be available for analysis. Therefore, it may be possible to decrease the auction volume in future years, and still maintain a reasonable level of accuracy. Below, we test this hypothesis by doubling the population size (simulating two years of data), and noting the changes in statistical precision as we increase the sample size. Table 3 contains these results. We then compare these results to our findings in Table 2 above that assumed only one year's worth of data.

TABLE 3. RESULTS FROM 200 MONTE CARLO SIMULATIONS WITH TWO YEARS OF DATA

Volume (%)	***Mean R^2***	***Average 95% Conf. Int. Size***	***Incremental Improvement***
10	.803	10.579	
15	.805	8.495	2.084
20	.801	7.352	1.143
25	.802	6.529	0.823
30	.801	5.948	0.581
35	.80	5.517	0.431
40	.803	5.099	0.418
45	.801	4.820	0.279
50	.801	4.585	0.235

In Table 3, we see that auctioning 20 percent volume over a two-year period offers similar statistical precision to auctioning 35 percent volume in a one-year period. In particular the 95 percent confidence interval for the predicted regression line is plus or minus $3.68, on average, when 20 percent of the cumulative two-year volume is auctioned. Auctioning 35 percent volume during a one-year period yields an average 95 percent confidence interval of plus or minus $3.79, which is very similar to results obtained when 20 percent volume over two years is auctioned. The importance of this result is that as observations build over time, auction volume in the subsequent year may be decreased.

Caution should be used in a decision to decrease auction volume in a subsequent year, however. If the market is in a stage of rapid fluctuation, then, over time, stumpage rates on tenured timber will either decrease or increase in response to the prices of auctioned timber. But if fewer stands are auctioned in time t relative to those in the regression sample for time t-1, then the adjustment of tenure prices could be hindered. This problem is likely mitigated by the simple inclusion of a time trend in the regression analysis. A disadvantage to this approach is that it might be difficult to implement quickly certain specifications that would be necessary. Thus, the changes should be planned in advance. An alternative solution might be to choose a time frame (two years, three years, etc) over which to sample data. The sample volume would be naturally higher in the first year in which the reforms are implemented, but would decline in the second year, and stay constant into the future. The higher volume in the first year would be necessary to ensure statistical accuracy in the *only* year when little auction data is available. Alternatively, the Ministry could auction the same volume in each year, and simply accept less accurate estimates in the first year.

3 COMPETITION WITHIN DISTRICTS

To analyze the current state of competition within logging areas, we proceed along two lines. First, we measure the level of concentration in particular combinations of Coast Districts where common loggers operate. Second, we measure the benefits, by district, that might be experienced through a coordinated effort to decrease stumpage on auctioned timber. Together, these two analyses allow us to target districts where local market power is mostly likely to exist (if it exists at all). This analysis is similar to one we performed on the Interior.

3.1 District Area Concentration

We begin our analysis of competition in the Coast by determining mill concentration at the district level. In our paper "Auction-Based Timber Pricing and Complementary Market Reforms," we found that the Coast as a whole was "moderately concentrated", as defined in the U.S. Department of Justice and Federal Trade Commission Horizontal Merger Guidelines.[3] The majority of the mill capacity in the Coast is controlled by three firms, each with between 15 and 22 percent market share. Analyzing the concentration of mill capacity within the Coast as a whole is reasonable, because the Coast has an active log market. If prices of timber in Squamish exceed the prices in Chilliwack, then, through purchases on the log market, mills in Squamish will purchase timber from Chilliwack and the prices will realign. Therefore, the ability of a group of mills in a particular district to influence prices in that district will be effected by the overall level of competition between mills in the Coast Region.

If the log market in the Coast were to disappear (an unlikely scenario) then mill competition would be determined by the ability of loggers to move between districts and bargain over prices. Thus, we also perform a mill concentration analysis by district groupings that would likely drive competition in the event that the Coast log market were to decline. Table 4 lists those groupings.

TABLE 4. LOGGER BIDDING AREAS IN THE COAST

Area	Districts
1	North Coast, Queen Charlotte, Mid Coast, Port McNeill, Campbell River
2	Port McNeill, Campbell River, South Island, Sunshine Coast, Squamish
3	Chilliwack, Squamish

To measure the effect of Coast concentration if the Coast's log market were to decline in scale, we again use the Herfindahl-Hirschman Index (HHI), which sums the squared market

3. We determined that the HHI in the Vancouver Forest Region is 1315.5. *See*, Susan Athey, Peter Cramton, & Allan Ingraham, *Auction-Based Timber Pricing and Complementary Market Reforms in British Columbia*, 13 (BRITISH COLUMBIA MINISTRY OF FORESTS, Working Paper 2002).

shares of firms in the particular area of question. An HHI of zero indicates perfect competition, and an HHI of 10,000 indicates total monopoly power. Table 5 lists HHIs for the Coast's bidding Areas.

TABLE 5. DISTRICT LEVEL CONCENTRATION IN THE COAST

Area	HHI	Concentration Level
1	1,953	High
2	2,447	High
3	1,378	Moderate

Above, we see that mill concentration is high in two of the three bidding Areas. However, the concentration levels in Table 5 would occur only in a worst-case scenario—namely, if the log market in the Coast were to disappear. Therefore, the importance of the log market on competition in the Coast is evident. Changes in mill capacity in the Coast should be monitored along with the relative importance of the log market on timber prices in the Coast. Table 6 lists mill capacity in each of the Coast Areas.

TABLE 6. MILL CAPACITY BY BIDDING AREA IN THE COAST

District	Annual Capacity (MBF)
1	456
2	1,930
3	2,446
Total Capacity	**4,831**

The data in Table 6 shows that the combined mill capacity in Area 1 is only 9 percent of total mill capacity in the Coast. Mill capacity in Area 2 is 40 percent of total mill capacity in the Coast. Thus, if the log market in the Coast were to disappear, any changes in the level of Competition in the Coast would most likely appear within the Coast Districts that comprise Area 2.

3.2 District Competition

To gauge the potential ability of firms in the Coast to undermine the integrity of the auction market, we perform an analysis similar to our Interior analysis. We suppose that bidders in a single district are able to decrease auction prices by 10 percent, and then investigate how predicted prices for non-auctioned timber would respond. We then consider the price effect on District A's non-auctioned timber if firms in another district (chosen randomly) were able to force a 10 percent price decrease. We present the results from this analysis in Table 7 below.

TABLE 7. TENURE PRICE EFFECTS FROM AUCTION PRICE REDUCTION

District Name	*Percent Reduction in Own District Tenure Price from 10 percent Decrease in own Auction Prices*	*Predicted Average Percent Reduction in Tenure Prices as a Result of Reduction in Auction Prices in Other Districts*
Campbell River	3.72	-0.27
Chilliwack	5.19	0.40
Duncan	2.92	0.15
Mid Coast	2.76	3.48
North Coast	2.62	-3.75
Port McNeill	6.44	0.50
Queen Charlotte	8.38	-0.71
Squamish	7.53	-0.42
Sunshine Coast	1.21	-0.36

The first column in Table 6 shows the percent reduction in tenure prices if firms in that district successfully decrease auction prices by 10 percent. The largest effect occurs in Queen Charlotte, an effect that might be compounded by the "Isolated" variable that includes the entire Queen Charlotte district. Thus, it might be prudent, going forward, to consider the omission of this variable, particularly considering that it is not statistically significant in the market price equation.

The districts of Chilliwack, Port McNeill, and Squamish would also experience rather high price decreases from a coordinated decline in auctioned stumpage. Other districts have predicted declines in tenured timber rates of between 1 and 4 percent. These results are more problematic than those found in the Interior analysis, but there are fewer districts in the Coast than in the Interior. Thus, any auctioned timber in the Coast represents a larger portion of total the sample than it did in the Interior. The active Coast log market, however, will likely reduce the predicted effects in Table 5. In particular, if firms in Port McNeill successfully engage in tactics that significantly reduce stumpage prices at auction, then firms in, say, Cambell River will likely enter the Port McNeill auction market to purchase cheap timber, and then float those logs to mills they are accustomed to processing at in Cambell River. Of course, careful attention must still be paid to any friction that might inhibit the proper functioning of such market forces. For example, if certain areas may only be logged via helicopter, and an expensive upfront cost is necessary to develop such extraction in that area, then barriers to entry may preclude such competition for some time into the future.

The second column in Table 6 indicates average price reduction on tenured timber in a particular district that might occur if another district, chosen randomly, was able to sustain a 10 percent decrease in the price of its auctioned timber. Contrary to results for the Interior, we find that certain districts will experience a price *rise* on their tenured timber if another district systematically decreases its prices on auctioned timber by 10 percent. Only one district, the Mid-Coast, would experience a significant decline in tenured stumpage if another district decreased its auction prices. These results reduce some of the worries that column one in Table 6 showed, although the ability of one district to affect is owned tenured stumpage prices by reducing prices on its own auctioned timber should still be of concern given the current specification and data.

4 CONCLUSION

We found that the auction volume necessary to ensure statistical accuracy using TEPS is higher in the Coast than it was in the interior. An auction volume of between 25 and 35 percent would ensure accurate out of sample pricing in the Coast if only a single year's worth of data was used to estimate the TEPS equation. However, if multiple years of data are pooled to form the regression sample, volume could be decreased to approximately 20 percent. Time trends, or further structural changes to the specification could be used to account for major market fluctuations between years. Such specification changes would facilitate the inclusion of multiple years of data in the regression sample, and would therefore lower the auction volume that would be necessary to ensure statistically accurate stumpage rates. Regarding local market power, we found that mill concentration could be problematic only in the most remote areas of the Coast, which represent a miniscule percent of the total market. We did, however, find that, given the current data and specification, certain districts would benefit significantly from a coordinated effort to lower auction prices. Thus, careful attention should be paid to reduce these incentives as the Ministry moves closer toward applying the reforms.