Competitive Auction Markets in British Columbia

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0 QUALIFICATIONS OF AUTHORS

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I am the Holbrook Working Professor of Economics at Stanford University, Research Associate at the National Bureau of Economic Research, and Principal of Market Design Inc. I am an expert on auctions, microeconomic theory, and industrial organization. I previously was the Castle Krob Career Development Associate Professor of Economics at the Massachusetts Institute of Technology, and I was a Sloan Foundation Research Fellow, a National Fellow at the Hoover Institution at Stanford University, and a Fellow at the Center for Advanced Study in the Behavioral Sciences at Stanford University. I have received continuous funding from the National Science Foundation since 1996. My curriculum vitae, which includes a list of my publications and other experience, is attached as Exhibit A.

I have written two scholarly articles on the subject of U.S. Forest Service timber auctions. I have also published advances in statistical methods for analyzing data from auctions. In a series of theoretical articles, I have explored the topics of collusion, price-fixing, and market dominance.

Since December 2001, I have advised the British Columbia Ministry of Forests on the design of market reforms.

I have published numerous articles in scholarly journals, including American Economic Review, Econometrica, Review of Economic Studies, Journal of Political Economy, Quarterly Journal of Economics, and the RAND Journal of Economics. I am a Fellow of the Econometric Society. I currently serve as associate editor of Quarterly Journal of Economics and Theoretical Economics, and I am on the Economics Panel of the National Science Foundation. In the past I have served as foreign editor for Review of Economic Studies, co-editor of the Journal of Economics and Management Strategy, and associate editor for the RAND Journal of Economics and the American Economic Review.

Peter Cramton

I am Professor of Economics at the University of Maryland and Chairman of Market Design Inc. I am an expert on auctions, bargaining, and market exchange. Much of my recent work has applied this expertise to market design in many industries. I previously was an Associate Professor at Yale University and a National Fellow at the Hoover Institution at Stanford University. My curriculum vitae, which includes a list of my publications and other experience, is attached as Exhibit A.

I have advised many governments in the design and implementation of auctions, and have also advised firms that bid in high-stakes auctions. My auction practice is worldwide, including recent engagements in the United States, France, Belgium, Germany, the Netherlands, Italy, the United Kingdom, Switzerland, Canada, Australia, Austria, India, Singapore, Mexico, and Taiwan.

I have advised the U.S. Department of Justice and the U.S. Federal Communications Commission on collusion in auctions. Designing competitive auction markets has been a focus of this work.

Since December 2001, I have advised the British Columbia Ministry of Forests on the design of its market reforms.

I have published numerous articles in scholarly journals, including American Economic Review, Econometrica, Review of Economic Studies, Journal of Economic Literature, European Economic Review, International Economic Review, Journal of Regulatory Economics, Journal of Law and Economics, Journal of Labor Economics, Journal of Economics and Management Strategy, Games and Economic Behavior, and Journal of Law, Economics and Organization.

1 INTRODUCTION

We have advised the British Columbia Ministry of Forests from December 2001 to date. Our advice focused on the design of a more transparent and market-oriented environment for selling rights to harvest timber. Since 2001, the regulatory environment has been simplified and streamlined to enhance competition. Key policy changes were implemented as part of the *Forestry Revitalization Plan* and the associated legislative and regulatory changes which came into effect during 2003.[1] In addition, the Market Pricing System (MPS) was brought into effect as the system for pricing timber sold under long-term tenures on the Coast of British Columbia in February 2004. This system will be described in more detail below.

During the Period of Review (POR) (April 1, 2004 to March 31, 2005), BC timber sales:

- Are managed by B.C. Timber Sales (BCTS), a division of the Ministry of Forests with a mandate for commercial timber sales. Revenue maximization and competitiveness of the markets are explicit objectives.
- Are awarded using a first-price, sealed-bid auction, on a price-only basis.
- Are open to all bidders (including U.S. bidders).[2]
- Are open and transparent. Detailed information packages are provided by the Ministry. In addition, interested bidders may visit the license area and conduct their own timber cruises or other assessments. The auction rules are known and enforced.

In addition, the log market is open and transparent:

- The province has established a monthly log price reporting system for the Interior similar to that provided for the Vancouver log market on the Coast.
- The take-back of tenure and the associated increase of timber sold at auction and by other market loggers (e.g. First Nations, woodlots) has increased the volume of logs that are traded on the log market.

The behavior of tenure-holders responds to market conditions:

- Mill closures are not penalized, and employment and capacity are determined by market forces.

[1] These measures include: *Forestry Revitalization Act*; *Forest Revitalization Act (No.2), 2003*; *Forest (Revitalization) Amendment Act, 2003*; *Forest (Revitalization) Amendment Act (No.2), 2003*; *Forest Statutes Amendment Act, 2003*; and the *Advertising, Deposit and Disposition Regulation*. See the following website for regulations: http://www.for.gov.bc.ca/tasb/legsregs/forest/faregs/adder/adder.htm

[2] A small number of auction sales after November 5, 2003 still have restrictions on which bidders may participate, as a legacy from the prior small business program. To keep the discussion simple and transparent, in this report, we exclude those sales from our analysis, and we instead focus on the sales without restrictions on participation.

- There are no minimum cut, processing or appurtenancy regulations in place.
- Tenures may be transferred, except if they raise antitrust concerns by increasing concentration too much, or if the tenure-holder is delinquent in payments to the Crown.

We conclude that during the POR, BCTS timber auctions were competitive, and that the prices paid by winning bidders at BCTS timber auctions for the exercise of timber harvest rights acquired in these sales represented market prices for those rights. We have also examined the performance and implementation of the Market Pricing System on the Coast, and we have found it to be a valid market-based pricing system. We outline our reasoning in the following subsections.

In our subsequent analysis, we focus on a subset of tracts that have been auctioned by BCTS. We are interested in tracts where timber was harvested during the POR. In addition, we restrict attention to tracts where the auction date was after November 5, 2003, when the full set of reforms was in place in BC, and we further put aside the small business sales. The tracts, which we refer to as "unrestricted tracts," thus satisfy the following criteria: (i) timber was harvested during the POR, (ii) harvesting rights were sold via BCTS auctions after November 5, 2003, (iii) the auctions had no restrictions on participation, and (iv) full appraisal data is available for the tracts. It should be noted that ## additional tracts met criteria (i)-(iii) but had incomplete data as of this writing and were thus excluded.

We subdivide the tracts into Interior and Coast tracts. For the Interior there were 285 unrestricted tracts; for the Coast there were 63 unrestricted tracts.

2 THE PERFORMANCE OF THE AUCTION MARKET

We evaluate the BCTS auctions along several dimensions. First, we evaluate the rules and procedures used to select timber for auction and conduct the auctions. Second, we evaluate the outcomes of the auctions, including the degree of participation and the auction prices paid on BCTS sales.

2.1 The Rules and Procedures for the BCTS Auctions Enhance Competition

The BCTS auctions are conducted using rules and procedures that are standard for public and private sellers of standing timber. In particular, the following procedures are used:

- For the tract for which timber harvest rights are to be auctioned, a preliminary appraisal is prepared and made public in advance of the auction.[3]
- The auction is advertised in local newspapers and on a website.
- Potential bidders are offered an opportunity to inspect the tract.
- Sealed bids, expressed in a price per unit of volume (non-negative "bonus bids," which are added to the upset price to obtain a per-unit "total bid"), are solicited with a specified due date.
- An "upset price" is publicly announced.

[3] The precise time periods for advertising and advertisements vary with sale size, as specified in the Advertising, Deposits, Disposition, and Extensions Regulation (posted at http://www.for.gov.bc.ca/tasb/legsregs/forest/faregs/adder/adder.htm). For example, the largest sales require advertising at least once every two weeks for eight weeks.

    - Bids below the upset price are rejected, and the tract is not sold if there are no bids above the upset price.
    - The upset price is determined as a percentage of the predicted winning bid for the tract, using a regression-based statistical model (MPS) based on past auction prices.

- Bids are publicly opened, and the highest bidder is awarded the harvest rights for the tract.
- Bidders typically have between 1 and 3 years to harvest the timber, with an average of about 1 ½ years.
- As timber is harvested, the volume is measured and the winning bidder pays the amount of its bid (upset price plus bonus bid) for each unit of volume harvested (except for dead and dry timber, which is billed at $.25 per cubic meter).
- Regulations and procedures are in place to deter collusion.

All of these procedures are "best practice" in the timber industry and in auction markets more generally, and qualitatively similar procedures are in place in a wide range of public and private auction settings. The procedure for determining the upset price is similar to the procedure used in much of the U.S. Forest Service. The use of sealed bidding is also standard practice (for example, it is used for natural resource auctions and procurement by governments and private firms around the world, including in the United States). Economic theory and our experience in designing and implementing auctions indicate that this practice is revenue-maximizing. Similarly, the use of "scale sales," whereby bidders pay the amount of their bid on each unit actually harvested, is also standard practice, as it reduces the volume-based risk borne by bidders and thus increases the prices that bidders are willing to pay.[4]

The BCTS has several procedures in place to prevent collusion. First, collusion is illegal, and bidders who engage in collusion are at risk for both civil and criminal penalties, punishable by fines up to $500,000 as well as jail time for those involved in collusion. In addition, the Ministry has a "whistleblower" policy, whereby the first person to report collusive activity is immune from prosecution. This type of policy is also referred to as a "leniency" policy. The U.S. Department of Justice argues that leniency policies are extremely effective when criminal penalties are available, particularly the threat of jail time, as is the case here.[5] The policy induces a "race" among employees of colluding firms to be the first to report illegal activity in order to avoid jail time; anticipating this, firms are reluctant to collude. Thus, BCTS has implemented "best practices" in terms of the legal policies surrounding collusion, policies that have proven quite effective in other markets.[6]

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[4] Historically, scale sales have been a commonly-used method for auctioning timber in state and federal auctions in the western United States. The alternative to a "scale sale" is a "lump sum sale," whereby the bidder pays a fixed amount for harvesting rights on a tract, irrespective of the volume that is actually harvested. The disadvantage of the lump sum format is that bidders face uncertainty about the volume of timber that they will actually extract from the tract, and so to account for this uncertainty, the bidders factor a "risk premium" into their bids (Athey and Levin, 2001, p. 381). Note that BCTS auctions require a single bonus bid for all sawlogs, and so the problem of "skewed bidding" does not arise. Thus, the BCTS procedure is broadly consistent with, for example, the recommendations of the United States General Accounting Office (1983), which argued for the elimination of species-specific bids in United States Forest Service scale sales.

[5] See, e.g., Hammond (2004), a speech by Scott Hammond of the U.S. Department of Justice outlining the important elements of a leniency program.

[6] Examples are given in Hammond (2004).

Second, the BCTS has a training program for all personnel involved in administering BCTS auctions that is designed to help detect and deter collusion. The content of the training program is consistent with "best practices" in government procurement and natural resource auctions, as well as with advice we provided to BCTS.

The BCTS procedure for setting the upset price is also consistent with "best practice." Setting the upset involves complex tradeoffs to best meet three objectives: (1) to guarantee substantial revenue in auctions where competition is weak but the upset is met without creating too much inefficiency due to unsold stands, (2) to limit the incentive for—and the impact of—collusive bidding, and (3) to provide useful information to bidders. In our opinion, the approach used by BCTS of setting the upset at 70 percent of predicted value is consistent with revenue maximization. Such an upset strikes the right balance between the benefits of enhanced revenues and the costs of unsold timber stands.

Thus, we believe that the design of the BCTS auctions is fundamentally sound. The auctions are consistent with best practices elsewhere, for settings in which the seller's goal is to maximize revenues.

2.2 The Level of Participation is Sufficiently High to Enhance Competition

Economic theory provides a simple framework for analyzing the participation of bidders at sealed bid auctions.[7] First, bidders become aware of the auctions. Second, bidders must decide whether to evaluate a tract and prepare a bid. Bidders will weigh these costs against the profits they expect from entering the auction.[8] At the time they make their entry decisions, as well as when they bid, bidders face uncertainty about the number and identities of opposing bidders who also enter the auction, and this uncertainty enters their calculations about the profitability of entry as well as their decisions about how aggressively to bid. In particular, what matters to bidders is the probability distribution over potential competition—that is, bidders consider the possibility that many opponents will bid as well as the possibility that only a few will bid. The *risk* of greater participation induces bidders to place bids closer to their true values in *all* sales even though the *actual* number of participants may in *some* sales be smaller than expected (of course, in other sales, the actual number is larger than expected). Thus, even in an auction where only one or two bidders actually submit bids, bidders typically are not aware of this in advance, and so they still bid closer to their willingness to pay than if they had known with certainty that only a few bidders would arrive.

The relationship between the expected number of bidders and the expected profitability from bidding in an auction depends on a number of factors, including the dispersion of costs and values among bidders as well as the extent to which these costs and values are private information to the bidders. Historical data from U.S. Forest Service timber auctions in the 1980s have found participation of an average of 3 to 4 bidders to be typical,[9] although the number varies across the different geographical areas. Although we

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[7] See, e.g., Levin and Smith (1994).

[8] An interesting theoretical result is that if bidders are on average symmetric, in an "independent private values" model of bidders' information, bidders make socially efficient entry decisions. That is, bidders decide to bear the cost of entering the auction exactly when their expected contribution to social surplus (in terms of lower harvesting cost or greater value for the timber) is greater than the entry cost, and so the entry decisions maximize social surplus, given the simultaneous-move structure of the game. This result follows as a direct consequence of the Revenue Equivalence Theorem from auction theory, together with the well-known result that a second-price auction yields efficient allocation by giving each bidder his contribution to social surplus.

[9] There are few statistics available about other timber auction markets. The U.S. Forest Service is one of the world's largest auctioneers of timber. Although the U.S. Forest Service does not publish these summary statistics, the authors calculated that in Region 6 (Oregon and Washington) during the 1980s, there were approximately 750 sealed bid auctions that attracted an average of 3.5 bidders and a median of 3 bidders. In Region 1 (Idaho and Montana)

have not performed a detailed study of this issue in the U.S. Forest Service, on its face the data suggests that in these areas, an average of 3 to 4 bidders at timber auctions creates enough competition that expected profits in the auction are as low as the (fairly small) entry costs.

Now consider how these factors relate to BCTS timber auctions in the time period under consideration. Since in BC, the Ministry widely advertises BCTS auctions, it is inexpensive for participants to maintain awareness of auction opportunities. Furthermore, BCTS provides extensive information, including cruise data, about sales, hence the cost of preparing a bid is fairly low. Thus, we expect entry to occur up to the point where expected profits from entering the auction are equal to these entry costs.

The bidding data in BCTS sales during the POR had substantial participation, and the bidding patterns are consistent with the hypothesis that bidders are not aware of the precise number of opponents when they prepare their bids, but rather bidders consider the expected competition.[10] Specifically, the BCTS auctions attracted more than four bidders per auction, on average: on the coast, the average number of bidders was 5.32, with a median number equal to 5, while on the interior, the average number of bidders was 3.71, with a median of 3, similar to the numbers reported above for U.S. Forest Service auctions.

Note that most of the bidders in the auctions during this time period were *not* the major timber companies or tenure-holders, but rather most bidders were logging firms.[11] This reflects an industry structure characterized by a lack of tight vertical integration. In the case of vertical integration, a single firm carries out multiple steps of a production process, in this case both logging and milling. In contrast, in British Columbia, typically firms with manufacturing capability have only limited logging capability, and they use contractors to do the logging. For example, most long-term tenure holders use independent logging contractors to harvest timber from their tenures. Contracting is used almost exclusively in the Interior, while on the Coast at least 50% of logging work is done by contractors.[12] In general, the use of contractors allows firms to operate more efficiently and to specialize in their "primary business." The logging firms, in turn, specialize as well, keeping costs low and staying fully employed by contracting with multiple manufacturing firms. These firms also develop knowledge and expertise at evaluating tracts and estimating the costs of harvesting timber.

Thus, it appears that the efficient industry structure has specialized logging firms and manufacturing firms. The logging firms place bids in BCTS auctions, and they sell the timber directly to mills, through log markets, or some combination thereof. Mills occasionally participate in auctions directly, but this participation is the exception rather than the rule.

The BCTS auctions during this time period restricted bidders to hold no more than three BCTS timber licenses simultaneously. This restriction was introduced in the small-business timber auction program that was a precursor to BCTS, as a way to prevent speculation and promote a competitive market structure. In our opinion, this restriction should have little impact on bid prices. To understand why, first

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during the 1980s, there were approximately 1420 sealed bid auctions that attracted an average of 3 bidders and a median of 2. See http://www.econ.yale.edu/~pah29/timber/timber.htm for data.

[10] For example, even for the small fraction of tracts for which only one bid was received, the average bonus bid is significantly greater than zero, where zero would be the optimal bonus bid for a bidder that knew it had no competition. This highlights an important advantage of sealed bidding: firms always face some uncertainty about who else has submitted bids.

[11] About 97% of the 63 Coast tracts were won by log brokers or market loggers, while 92% of the 285 Interior tracts were won by log brokers or market loggers.

[12] See the November 22, 2004 BC Questionnaire Response at Pages BC-VI-22 to BC-VI-24.

note that at most 8% of BCTS registrants were subject to the limit during the time period. In addition, if a mill is unable to bid on a tract due to the restriction, the market loggers participating in the BCTS auctions will still take into account the mill's valuation for the logs, since the loggers anticipate being able to sell the harvested logs directly to the mill or through the log market (where log market prices will reflect the valuations of all local mills). Thus, a mill's valuation for the logs is still reflected in the auction prices, even if it does not bid directly. Indeed, in the efficient industry structure, this may be the standard practice. For this reason, the restrictions on participation should not have a significant effect in practice.

Next, we review the auction prices. The patterns of bidding appear competitive. On the 285 tracts from the Interior, the average (weighted by volume) of bonus bids, normalized as a percentage of the upset price, is equal to 49%. This implies that the average total bid (bonus bid plus upset) is greater than the statistical prediction of the MPS equation that forms the basis of the upset price.[13] In addition, over 80% of the tracts had bids greater than 10% above the upset price, and 95% of tracts had bids greater than the upset price. This indicates that the market is competitive enough that the upset price rarely binds. In addition, the MPS equation used for setting the upset price is fairly accurate, in that it very rarely led to upset prices that were so high that no bidders valued the tract at the upset prices. The patterns are qualitatively similar on the Coast, with somewhat higher bonus bids: the (volume-weighted) average of bonus bids as a percentage of the upset is equal to 82%, and over 92% of tracts had bids greater than 10% above the upset price.

3 PRICES PAID IN BCTS AUCTIONS ARE A COMPETITIVELY DETERMINED MEASURE OF THE MARKET VALUE OF THE TIMBER HARVESTING RIGHTS SOLD

It is relatively common to use pricing data from competitive transactions as a benchmark for non-market transactions in the same market. This procedure is commonly used to determine transfer pricing within large organizations. For example, General Motors, as well as other companies, set prices for internal transactions using prices from transactions in local markets, in a process known as tapered integration. Indeed, the most common way for determining prices not set directly through auctions or other competitive mechanisms is to determine the price from comparable market sales. This is the approach proposed for the British Columbia timber industry.

One example of using an auction for a portion of goods or services to create a benchmark price for a non-auctioned portion is seen in electricity restructuring in the United States. For example, in Texas, the former utilities are required to auction off 15 percent of their generating capacity. The auction prices are then used to determine the value of the remaining 85 percent of capacity, which is then used to calculate stranded costs.

In many markets that involve substantial capital investment, the vast majority of transactions are long term; firms enter into forward contracts to ensure a return on their capital investments. In such markets, only a small fraction of transactions occur in the spot market. Despite this structure, spot market prices are valid indicators of the present market price for the good. Depending on the resolution of market uncertainties, spot market prices may be higher or lower than prices in long term contracts. However, those spot market prices provide current information on the supply and demand of marginal participants at that point in time. Wholesale electricity markets around the world provide an important example of this phenomenon. These markets are characterized by large capital investment and reliance on long-term contracts. Typically, only 5 percent to 20 percent of the energy volume is traded in the daily

[13] If the average total bid was equal to the prediction of the MPS equation, then the bonus bid would be equal to 3/7 of the upset, or 43%.

spot market. The remaining 80 percent to 95 percent is traded in long-term contracts. Yet, the spot price remains the price that clears the market by equating supply with demand at a given point in time.

Although markets where only a fraction of trade takes place in the spot market are common, they typically function best when trading is not subject to many restrictions. Thus, it is useful that the BC reforms have broadened participation in log markets and made these markets more transparent.

3.1 Using BCTS Auction Prices to Establish Market Value

We have argued that auction prices reflect market prices for the particular harvesting rights being auctioned. We now consider three related but distinct uses of the auction prices.

1. On the Coast, throughout the POR BC used the Market Pricing System (MPS), whereby data from BCTS auctions to estimate an equation that sets stumpage fees for timber harvested under long term tenures (as a function of observable tract characteristics).

2. The auction prices can be used to create a *benchmark* for the aggregate stumpage fees collected under long-term tenures.

3. Using the MPS equation, it is possible to implement a *quality adjustment* for differences between tracts sold under long-term tenures and those sold under auctions, an adjustment that can be applied to the stumpage fees collected on tracts sold by BCTS auctions in order to derive a more accurate benchmark for the stumpage fees collected on long-term tenures.

Under the MPS system the stumpage fees for timber under long-term tenure will be set using prices derived from the market prices in BCTS auctions. Therefore, where MPS is in place we do not expect to find a significant difference between average stumpage fees paid under long term tenure and those paid for timber harvested from auctions, after adjusting for tract characteristics and tenure obligations.[14] However, it is still potentially useful to construct a benchmark and perform the aggregate comparison, as a check that the system is working as intended.

In addition, when tracts auctioned under BCTS are representative of timber harvested under long-term tenures, the quality adjustment will not be very large in magnitude, although it will typically not be zero due to variation in moderately sized samples.

We now consider a number of issues that arise in using the BCTS auctions for the three purposes described above.

3.1.1 The MPS Statistical Model

Let us first describe the MPS Statistical Model. This model uses data from BCTS auctions to estimate a regression equation. Essentially, the statistical model provides an approximation to the relationship between measured characteristics of a tract—the species composition, the size, and some elements of logging costs—and average auction prices. Using the model, one can take a new tract with given measured characteristics, and predict what the price would be if it were auctioned under the BCTS program. In addition, the model can be used to compare the predicted bids for two tracts with different

[14] As discussed further below, there is another source of differences that arises because one variable that enters the MPS model is a price index that reflects current market conditions, and this is updated every quarter. When timber is harvested under long-term tenures, the current value of the index is included in pricing. In contrast, timber harvested under auction is priced using the original auction prices, so that the price paid is fixed throughout the duration of the contract (typically about 1.5 years).

characteristics, or (as in the quality adjustment) the difference in the average predicted bid for two sets of tracts with different average characteristics.

The accuracy of predictions made using the MPS Statistical Model will depend on a number of factors. First, the predictions will be more accurate when the characteristics of the tracts for which predictions are desired are similar to the characteristics of the tracts that were used to estimate the model. Second, the data set used to estimate the regression model must be a sufficient size to accurately estimate the parameters of the model (such as the parameter that indicates how bids change with estimated volume on the tracts). We believe that these conditions are satisfied for the MPS Statistical Model.

Examples of variables included in the statistical model include variables that indicate what type of logging will be used (standard, helicopter or cable), estimated haul distances, estimates of operating and development costs, density of timber, and total volume. Because so many features of logging, harvesting, and timber values differ between the Coast and the Interior, separate models are estimated for each region. Details of the models used in the Coast and the Interior are provided in the Province's questionnaire response. The statistical models explain a substantial portion of the variation in each region. For example, the model explains 75% of the variation in bid prices on the Coast and on the Interior. In addition, the parameters of the model are precisely estimated. Overall the estimated parameters have signs and magnitudes that are straightforward to interpret.

In Section 4.2.1 below, we provide a more detailed discussion about the assumptions required for the MPS statistical model to provide valid predictions, and we address some potential critiques of the model. We argue that the most important assumption is that the tracts used to estimate the model have similar unmeasured characteristics to the tracts for which a prediction is desired. These assumptions will be satisfied if the tracts selected for auction are representative of the tracts harvested under long-term tenure.

3.1.2 Volume and Number of BCTS Auctions

The 285 Interior unrestricted tracts include a net cruise volume of 4.3 million cubic meters of timber, while the 63 Coast tracts include a net cruise volume of 747,300 cubic meters. Total winning bids for the Interior tracts were $101.9 million, while on the Coast total winning bids were $33.8 million. Thus, these markets incorporate a significant volume of economic activity during the relevant time period.

Consider first the volume required to use the stumpage fees collected under BCTS auctions as a valid benchmark for the stumpage fees collected under long-term tenures. If (as we will argue below) BCTS auctions for timber harvest rights consist of timber that is representative of tracts harvested under long-term tenures, the stumpage paid for timber harvested[15] in the unrestricted BCTS sales can be used to estimate the market price of the timber harvested from the long-term tenures. In particular, the average (appropriately weighted by volume[16]) of the auction prices from the unrestricted BCTS sales should be equal to the average price that would be paid if all of the timber harvested under long-term tenures had been sold at auction. Because BCTS auctions and harvests of long-term tenure are drawn from the same geographic locations, involving the same market participants, logging costs, processing facilities, market

[15] In Section 3.1.3 below, we will discuss the distinction between average auction prices (weighted by cruise volumes) and stumpage paid for harvesting rights in BCTS sales, which weights auction prices using harvest volumes and also includes stumpage for grades 3, 4, 5, 6 and y (referred to as dead and dry timber) weighted by harvest volumes. The qualitative arguments in this section are not sensitive to how we resolve ambiguities arising due to the distinction, and so for simplicity we use (unweighted) auction prices for sawlogs in our illustration.

[16] See footnote 15 and Section 3.1.3 for a discussion of weighting and the inclusion of dead and dry timber. The dead and dry timber price can be thought of as a fixed component that enters into the overall auction price, and so we will sometimes speak of auction prices without specifically referring to dead and dry timber.

conditions, and so on, and because BCTS tracts are representative of tracts harvested under long-term tenures, it is possible to simply compare the average prices from the two sets of tracts.

What is necessary to implement this procedure? To make such a comparison requires sufficient BCTS sales to calculate a representative average of BCTS stumpage paid by species. As an illustration, on the 285 Interior tracts, the average price per cubic meter for is approximately $39, while the standard deviation is approximately $12. Given a population of tracts with a mean value of $39 and a standard deviation of values equal to $12, elementary statistics tells us that the average of 285 random draws from this population has standard deviation of $.71. Thus, if the exercise of drawing 285 tracts from the population was repeated many times, 95% of the time the sample mean will lie between $37.6 and $40.4. Thus, when appropriately weighted as described in Section 3.1.3 below, price data from 285 representative tracts can be used to generate an accurate estimate of the average value of the timber harvested from the long-term tenures.[17]

Now consider the quality adjustment. In practice, due to normal variation that arises in moderately sized samples, there are some minor differences in observable characteristics (such as appraised logging costs or species composition) between the tracts harvested under long-term tenures and the characteristics of tracts where harvesting rights are sold at BCTS auctions. To adjust for those differences,[18] the same regression model (MPS) used in setting auction upset prices can be applied. The MPS is designed to analyze the effects of observable characteristics of tracts on auction prices. This model is used to predict average (volume-weighted) prices as a function of tract characteristics for both the BCTS tracts[19] and the long-term tenure tracts. The difference between the two averages yields a prediction of the quality adjustment, that is, the amount that the average prices would differ across the two sets of tracts if all harvesting rights had been sold using auctions.

Note that the MPS statistical model is well suited for understanding the effects on price of the types of variation in tract characteristics that naturally occurs *within* tracts in the sample. For example, within BCTS sales, some tracts are large and some small, and so it is possible to predict the effect of sale size on price. In contrast, the MPS model would *not* be very useful for adjusting for the type of variation that does *not* occur within the sample; for example, a model estimated solely using data from the Coast would not necessarily do very well at predicting differences in auction prices between the Coast and the Interior. Similarly, quality adjustments based on the MPS model would not necessarily give a very accurate prediction of differences in auction prices between BC and tracts in a different country.

Summarizing the discussion so far, given a set of tracts sold using BCTS auctions that are very similar to tracts harvested under long-term tenures, the stumpage paid in the unrestricted BCTS sales can reasonably be used to estimate the current market values of the timber harvested from the long-term tenures. A statistical model can be used to adjust for any observable differences in tract characteristics. This is appropriate because the BCTS tracts are similar to the tracts harvested under long-term tenures in terms of location, market environment, and tract characteristics. In contrast, any attempt to use prices

[17] With thousands of tracts harvested under long-term tenures, the standard deviation of the average value sold under long-term tenures is negligible compared to that of the auctioned sales.

[18] To avoid any possible confusion, we emphasize that adjusting for differences in observable tract characteristics such as logging costs (a "quality" adjustment) is a distinct concern from the issue of accounting for dead and dry wood using harvest volumes. The latter issue is taken up in Section 3.1.3.

[19] Even though actual prices are available for the BCTS auctions, the quality adjustment does not directly make use of them. The quality adjustment uses the MPS for both sets of tracts (BCTS and long-term tenures) in order to generate a measure that depends solely on tract characteristics. The coefficients of the MPS are estimated using past auction data rather than contemporaneous data, which is reasonable given that the coefficients are fairly stable over time, and given that the same model is applied to both sets of tracts.

from other markets would rely on many more assumptions: such a model would need to predict the effects of differences in the number and type of mills, local labor supply conditions, climate, insect infestations, and so on. Since geographical variation in quantities like the number and type of local mills does not happen randomly, but rather is systematically related to observable and unobservable characteristics of each geographical location, it is especially difficult to draw inferences about the causal effects of variation in these factors on prices. Attempts to draw such inferences and then extrapolate to new environments are typically very sensitive to a number of specific modeling assumptions.

Finally, we pause to revisit the role of volume and quantity in estimating the MPS Statistical Model. In the last subsection, we described the overall fit and predictive power of the MPS model. We argued that the MPS model estimation is working well, and that there is sufficient volume and a sufficient number of distinct BCTS sales to precisely estimate the parameters of the model and obtain predictions using the model that are (on average) accurate.

3.1.3 Representativeness of BCTS Auctions

Table 1 shows information about harvests from three categories of tracts. The first category includes only the 285 unrestricted Interior tracts. The second category includes the harvests from the 285 unrestricted tracts as well as auctions where participation was restricted to small mills or loggers. The third category includes all other Crown harvest during this time period (that is, harvests from long-term tenures).

We are interested in estimating the market value of timber harvested in the POR, and priced using methods other than BCTS auctions. Thus, for the "All Auctions" and the "other Crown" categories, we include data about all timber harvested during the relevant time period. We can compare this timber to timber *sold* through auctions during the relevant time period. Because grade data is not available on the appraisal, but instead is recorded at the time of timber harvest, we use data about the aggregate harvest to date from the 285 tracts.[20]

Inspection of Table 1 indicates that the species composition and the quality composition of the 285 Interior tracts is very similar to the species and quality composition of timber harvested from tracts in the "All Auctions" category, as well as of timber harvested from other types of Crown tenures, which are primarily the long-term tenures. For example, the leading species, Douglas Fir, Lodgepole Pine, and Spruce, comprise 7.5%, 65.7%, and 14.8% of the timber harvested from the 285 tracts, respectively, and 8.9%, 55.5%, and 21.2% of the "other Crown" harvest. Among the other, less valuable grades, the 285 tracts have a higher fraction of dead and dry sawlogs (27.1% Grade 3) versus the other, less valuable grades 4-6 (11.2% Grades 4-6). In contrast, the "other Crown" harvest of Coniferous timber has 15.5% Grade 3 and 9.5% Grades 4-6.

We also observe that there is a slightly smaller fraction of Coniferous green sawlogs in the unrestricted auctions: 60.3% versus 71.3% in the other Crown harvest. Note, however, that this difference can be accounted for by comparing stumpage paid on harvest for the BCTS sales with the stumpage paid on harvest for the long term tenures, as described in Section 3.1.3.

Finally, a closer look at the data underlying Table 1 indicates that there is a large amount of overlap in the distributions of tract characteristics among the different groups. For example, there is a wide range of species composition within the 285 Interior tracts: the percentage of Douglas Fir ranges from zero to 99.7%, the percentage of Lodgepole Pine ranges from zero to 100%, and the percentage of Spruce ranges from 0% to 67.9%. Similarly, the fraction of green sawlogs in the 285 Interior tracts ranges from 0% to

[20] Below, in Section 3.1.3, we discuss this issue further.

99.7%. More generally, for each tract harvested under long-term tenures, there are similar tracts sold at unrestricted BCTS auctions.

Given the information presented in Table 1, we expect that the average value of harvesting rights for timber sold in unrestricted BCTS sales should be similar to the value of timber harvested under long-term tenures. Thus, any "quality adjustments" as described above will likely be relatively small in magnitude, and well within the range of variation that can be accurately predicted using the MPS equation. Indeed, in the POR, the estimate of the quality adjustment is approximately $3.90 per cubic meter.

Table 2 presents the analogous information for the 63 Coast tracts. The findings are qualitatively similar.

We reiterate that the applicability of the statistical model which adjusts for differences in tract characteristics hinges on the fact that a wide variety of factors (notably location, and thus local market conditions) are similar across the different sale procedures. It would be much more difficult to use a statistical model to adjust for those types of factors.

To further emphasize this point, Tables 3 and 4 illustrate the geographic dispersion of the unrestricted BCTS auctions on the Interior and Coast, respectively. Clearly, the 285 Interior tracts and 63 Coast tracts are representative of the non-auctioned timber in terms of geographic location.[21]

3.1.4 Using Harvest Prices or Bid Prices to Estimate the Value of Current Timber Harvests

A complexity arises in evaluating data from "scaled" timber auctions. In BCTS timber auctions, similar to many U.S. Forest Service timber auctions, the successful bidder is awarded a Timber Sale License (TSL) which conveys harvesting rights to the sawlog timber at the winning bid (upset plus bonus bid) price as well as rights to timber of grades 3, 4, 5, 6 and y ("low-grade" or "reject" timber, i.e., "dead and dry timber") at a pre-set rate (currently $.25 per cubic meter). As discussed above, the auctions establish a competitively determined market price for TSLs. However, as timber is harvested, it is scaled, and bidders' payments depend on the actual volume harvested. In particular, the *ex ante* expected payment by the bidders is equal to the product of the total stumpage rate bid for sawlogs and the cruise volume for sawlogs, *plus* the product of the pre-set stumpage rate for dead and dry timber and the expected volume for dead and dry timber.

However, because there is no cruise volume available for dead and dry timber, it is difficult for an analyst to quantify the bidders' expectations about dead and dry timber using only appraisal data. One approach to approximating the expected value that bidders anticipated (at the time of auction) to pay for harvesting rights on the tract is to weight the auction bids for sawlogs and the dead and dry timber rate using the actual harvest volumes that are later realized. This approach incorporates the fact that bidders take into account their expected payment for all harvesting rights on the tract (including dead and dry timber) when they place their bids. The value calculated using this approach is what we have referred to in the paper as the price paid for stumpage by winning bidders.

Timber harvested under long-term tenures is charged the stumpage rate then in effect for green sawlogs, and the same $.25 per cubic meter for dead and dry timber. Like auction bidders, long-term tenure-holders consider the overall stumpage they expect to pay for *both* sawlogs and dead and dry timber when they evaluate tracts for harvest.

[21] One minor exception is that no harvest has yet been reported from unrestricted auctions in the North Coast district, which comprises 2.8% of the Coast "other Crown" volume.

In summary, the presence of dead and dry timber in the BCTS TSLs and in the cutting permits under long-term tenures means that care must be taken when utilizing the auction data to estimate the value of current timber harvests. We have described one approach to accounting for dead and dry timber, using harvest data from the auctioned tracts.

3.2 Evaluating the Performance of the MPS on the Coast

During the POR, the MPS system was used to price timber sold under long-term tenures on the Coast. The Coast MPS timber pricing system has two main components. First, the MPS Statistical model is used to generate predicted prices for each of the tracts harvested under long term tenures, "as if" the timber on those tracts had been auctioned through BCTS. Second, these predicted prices are adjusted to take into account: (a) the costs borne by long-term tenure holders to meet their different tenure obligations; and (b) as discussed above, low grade timber priced at the statutory rate. There are a number of very significant costs associated with harvesting timber that are not incurred by bidders at BCTS auctions, but *are* incurred by tenure-holders. These include costs such as road-building and basic silviculture. To account for this difference, the system applies a "tenure obligation adjustment" or TOA to the predicted tract price in order to calculate the actual stumpage rate charged to long term tenure holders. We have not examined the tenure obligation or low-grade adjustments.

We have examined the MPS system used on the Coast. In the previous section we advised that the MPS model works well, and that there is a sufficient, representative sample (BCTS sales) to precisely estimate the parameters of the model and obtain predictions using the model that are (on average) accurate. This means that the MPS statistical model can be used to predict timber prices on the long-term tenures. Although there will, of course, be prediction errors for individual tracts, when averaging over a large number of tracts, the prediction errors will tend to cancel out and the average prediction error should be quite small.

We have also considered the issue of timing. When timber is harvested under long-term tenures, the currently applicable market indicator from the model (i.e. the quarterly log price) is used in pricing the timber. In contrast, at BCTS auctions, the winning bidder pays the amount of his bid throughout the life of the contract. Since BCTS auctions are harvested over a fairly short period, the bidders bear some risk, but it is not too large. However, if log prices fall throughout a period, we would expect tenure-holders to pay less than bidders from BCTS for harvests at a given point in time. In contrast, if log prices rise throughout a period, tenure-holders will pay more. The magnitude of the difference due to this effect depends on the magnitude of changes in log price indices, and it is attenuated by fact that the associated parameters from the MPS Statistical Model are less than 1. This implies that a $1 change in a log price index leads to less than a $1 change in the predicted auction price. Thus, we typically expect this effect to be fairly small.

In conclusion, assuming that the tenure obligation adjustments employed by the Ministry are calculated correctly, it is our opinion that the MPS system is a valid, market-based approach for timber pricing that will produce valid market prices for the timber harvested under long term tenures.

3.3 Long-Term Tenures do not Undermine Competitiveness of Auction Markets

The analysis above shows that the BCTS auction markets are well-designed and function well. In this subsection, we discuss the issue of how the presence of long-term tenures and the stumpage prices paid on long-term tenures affects the prices in auction markets, in the case where auction markets are used for volumes in the range of 5-15% of the total volume sold by the BC Crown. Below, in Section 4.1, we provide a more detailed analysis of this question, and we compare a number of alternative market institutions. Here, we take a broad look at the question of whether the presence of a segment of the market that is "administered" leads to lower-than-competitive prices in auctions.

For the purposes of this discussion, we will consider the hypothetical case where administered stumpage prices paid on long-term tenures are below average auction prices, adjusted by any potential differences arising due to tenure obligations. Keep in mind, however, that the MPS system is designed to eliminate such a difference.

In short, if private and public owners of timber announce a total quantity *Q* to be sold in a particular year, there is a unique price at which the demand for the timber is equal to the supply, call this the "market price." At any lower price, there is "excess demand," in that buyers wish to purchase more than *Q* units. The market price is the price that will result at auctions for private timber, as well as at auctions for public timber, even if prices for a subset of the total quantity are set using an administered system at a level below the market price. Even if a large majority of the volume is sold using such an administered system, auction prices will adjust to be equal to the market price. If auction prices were lower, more buyers would enter the auctions and bid up the price, since at any lower price, more than *Q* units are demanded—in other words, some potential bidders would value the timber more than the auction prices.

The argument for why the stumpage prices paid on long-term tenures do not influence market prices for the remainder of the market is made clearly in Nordhaus (2004) and Kalt and Reishus (2004). The volume available from long-term tenures is limited by restrictions such as the Allowable Annual Cut (AAC).[22] During the POR, the Interior harvest by long-term tenure holders from their own tenures represented only 65% of their log consumption.[23] Thus, the timber from the long-term tenures is not "marginal." Given that there is insufficient volume in long-term tenures to serve all buyers at the stumpage rate during the POR, the "residual demand" must be served through the private market and through auctions. If the stumpage rate on long-term tenures was below the average auction price, then the level of the stumpage rate is irrelevant to the market price. The stumpage rate could fall in half, or all the way to zero; still, the long-term tenure holders would remain unchanged at the constrained level, and the "residual demand" remaining would be unchanged. Since the market price in the private market and in auctions equates supply and this residual demand, the market price would also remain unchanged.[24]

Furthermore, if all of the public timber were sold at auction rather than some through long-term tenures, with the total quantity sold by the crown held fixed, the auction price would remain exactly the same: just as before, the auction price would be the price at which market demand for timber is equal to the total quantity sold in the public and private sector. (Of course, if the administered stumpage prices were below the auction prices, the switch to 100% auctions would result in higher average prices paid by tenure-holders, despite the fact that the auction prices would be unchanged.)

Although it may seem counterintuitive that the stumpage rates on long-term tenures do not affect auction prices, similar phenomena arise in other contexts too. Consider an analogy to electricity markets.

[22] The total Allowable Annual Cut (AAC) from the public forest is apportioned among different types of tenures, including long-term replaceable tenures generally held by major forest companies, auctioned tenures and a variety of other minor tenure forms such as woodlots. This does not take into account the contribution from private timberland. Note that the rules for AAC allow for some flexibility in reallocating the harvest across years in response to market conditions; as a result, some firms may not choose to harvest as much as they are permitted to in a downturn, qualitatively similar to a private landowner. For simplicity of exposition, we focus on the case of homogeneous stands and relatively stable market conditions, whereby firms tend to smooth their harvests over time with only minor variations around the AAC.

[23] On the Coast, the picture is a little different. As described in the Statement of Bruce McRae and Rebecca Ewing concerning AAC Utilization, some long-term tenure holders are large net sellers of logs, while others are large net buyers. However, the conclusion is the same: the competitive timber and log markets are active, vibrant markets.

[24] See Kalt and Reishus (2004) for a more detailed and nuanced discussion of the arguments supporting the conclusion that below-market stumpage rates do not affect prices in the non-administered sector.

Nuclear generators are typically regulated, and they have much lower marginal costs of producing electricity than other sources. Yet, when an auction is used to price electricity, market prices still emerge, without regard to the bids of regulated nuclear plants. In most cases the nuclear plants cannot serve the full market, and so the auction prices for electricity are determined by the costs (and thus the bids) of the "marginal" electrical generators, not the nuclear plants. Shutting down the nuclear plants would, of course, increase the price of electricity, because their supply would be replaced by that of higher-cost generators; but as long as the plants keep operating, it follows that within a wide band, changing the bids of the nuclear plants would have no effect on the market price. Instead, as is standard in economic models of supply and demand, the market price is determined as the lowest price that induces the marginal electrical generators to serve the residual demand. This argument does not change even if the marginal generators serve only a small fraction of the market.

It is, however, important that enough volume is auctioned so that a sufficient number of potential auction participants find it worthwhile to stay "active" in the market. Above, we showed that the BCTS auctions during the relevant time period had levels of participation that are high enough to meet this requirement.

4 Concerns Raised about the British Columbia Approach to Timber Pricing

In this section, we discuss a number of concerns that have been previously raised about British Columbia's approach to timber pricing.

First, we discuss the relationship between market outcomes under perfect competition, and market outcomes under various alternative systems. We address in particular the concerns that the presence of long-term tenures might lead to auction prices that are *lower* than what one would expect under perfect competition; we argue that only prices that are the same as or *higher* than perfect competition will arise. We argue that the presence of prediction errors in the MPS also leads to auction prices that are, if anything, *higher* than those under perfect competition.

We then turn to address a second issue, that the presence of the Market Pricing System (MPS) might lead to strategic bidding behavior by tenure-holders, and in particular to lower auction prices. Although in principle this could be a concern, we argue that in practice its impact will be minimal. In keeping with specific advice from MDI, the MPS statistical model has been designed to minimize any incentive of long-term tenure-holders to withhold demand.

We address potential concerns about the practice in BCTS timber auctions of restricting participation to bidders with logging experience, as well as about the transferability of long-term tenures. Both of these features enhance competition, and we have advised that BC follow these practices.

Finally we examine the MPS statistical model. We establish that the only assumption required to generate an unbiased prediction of auction prices conditional on tract characteristics is that the auctioned tracts used to estimate the model are representative of the tracts to be priced using the model.

4.1 Auction Prices Represent Market Prices

4.1.1 An Overview of the Market Outcomes from Alternative Market Institutions

In order to understand the market outcomes in the BC timber industry, it will be helpful to review outcomes (particularly prices for harvesting rights and tracts selected for harvest) under alternative institutional environments. We note that some of the material we cover here is presented in more detail in Nordhaus (2004) and Kalt and Reishus (2004). Here, we lay out some of the basic logic so that we can specifically evaluate alleged pitfalls of the institutional environment in BC, in particular the consequences of (i) the presence of long-term tenures in the market, and (ii) prediction errors in the MPS statistical model. We show that assertions that these forces lead to lower-than-competitive auction prices are exactly backwards.

Note that there are several economic outcomes of interest. One is the market price of harvesting rights for timber. A second is the selection of tracts that are harvested. A third is the distribution of any economic profits from the harvest of timber between the BC Ministry and long-term tenure holders.

We consider several alternative institutional environments. The benchmark case is perfect competition, which entails efficient selection of tracts for harvest and competitive prices for harvesting rights. As we will argue, these outcomes may be implemented with private ownership of land by many small owners who sell their timber using auctions. We will compare the alternative institutional environments to this benchmark. A first alternative is government ownership of land, with all harvesting rights sold at auctions ("all auctions"). A second alternative is a "hybrid" system, where a large fraction of land is under long-term tenure agreements, and the remaining fraction has harvesting rights sold at auctions. Within the hybrid alternative, there are several sub-alternatives for how the harvesting rights under long-term tenures are priced; these will be considered below.

We consider two cases when evaluating the institutional environments. In the first case, the only economic costs of harvesting a tract are borne by the holder of harvesting rights. In the second, more realistic case, there may be opportunity costs of harvesting at a given point in time rather than delaying harvest, and further there may be externalities from harvesting (e.g. environmental concerns). The advantages of the hybrid system will be especially apparent when considering the second case.

4.1.1.1 Case I: The Only Economic Costs of Harvesting Timber are Direct Harvesting Costs

In this subsection, we focus on a special case, where the only costs of harvesting timber are the costs borne directly by the holder of harvesting rights.

Private Land: All Auction In a competitive market environment, tract selection is determined in a market equilibrium. For a given price for logs, a tract is harvested if and only if the harvesting costs are below the price of logs. The competitive market price of logs, denoted p^C, is defined as the price at which the total supply of logs harvested equals the demand for logs at that price.[25] Tract selection in this benchmark is such that all tracts are harvested that have harvesting costs less than or equal to p^C.

In this case, the owners of the land receive economic profits on each tract equal to the gap between p^C and logging costs on the tract. (Kalt and Reishus (2004) refer to this as the "market stumpage rate.") If small private owners individually auction harvesting rights, this gap is approximately what they would expect to earn from the auctions.[26]

It is important to emphasize that in this case, tract selection is *efficient*. Any non-market force that leads to fewer tracts being cut would reduce the supply beneath the competitive level, resulting in *higher than competitive* log prices. In order to induce *too many* tracts to be harvested, it would be necessary to pay firms to harvest timber, that is, impose some sort of *negative* stumpage fee. That is because the

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[25] Note that we can choose to frame the analysis in terms of prices for harvesting rights, or prices for the output of timber harvesting, logs. For simplicity, we frame the analysis in terms of log prices.

[26] Note that numerous industry publications in the U.S. advocate the use of sealed bid auctions as the best approach to marketing timber on private land. See, e.g., Blinn, C. and L. Hendricks, "Marketing Timber from the Private Woodland," University of Minnesota Extension, 1997, at http://www.extension.umn.edu/distribution/naturalresources/DD2723.html; and M. Shasby and N. Jennings, "Marketing Your Timber," University of Nebraska, Lincoln, Extension, G77-383A, at http://ianrpubs.unl.edu/forestry/g383.htm.

marginal tracts that are harvested earn approximately *zero* economic profits—the harvesting costs are approximately equal to the output prices. The only tracts that are *not* harvested have harvesting costs greater than the output price. To induce firms to cut on these tracts, one would need to pay the firms to harvest.

This hypothetical world of small private landowners who sell harvesting rights to loggers and mills at auctions provides a useful reference point for assessing other systems. However, as we will argue next, it is not the only way to approximate the competitive outcome.

Public Ownership: All Auctions Consider the case with public ownership of land and where harvesting rights are sold at auctions. First focus on a scenario where all possible tracts are offered for auction with a reserve price (or "upset price") of zero. This approach would mimic the tract selection from a world of private ownership. Tracts will receive positive bids if and only if the cost of logging is below the market price of logs. Thus, the supply of timber is determined exactly as in the private ownership case, and thus market equilibrium is the same, with the same p^C and efficient tract selection.

In this method, the auction prices should be approximately equal to the gap between p^C and logging costs on each tract, just as in the case where land is in the hands of small landowners. Thus, the government would extract the economic profits from harvesting rights.

A positive reserve price does not alter the analysis, so long as the reserve price is set below the market value of the harvesting rights on a tract by tract basis. However, given a reserve price that is set too high for some tracts, these tracts will not be harvested under the auction system when they would have been harvested in the perfectly competitive benchmark. This reduction in supply would lead to prices *above* competitive prices in the log market. (A similar comment applies if private landowners use reserve prices, which they often do.)

Finally, consider two cases where land is owned by the government, and harvesting rights are allocated using a mix of auctions and administered pricing on long-term tenures.

Public Ownership: Auctions and Administered Pricing Suppose that the administered pricing is a flat fee per unit, and that auctions have a zero upset price. Then, on the auctioned tracts, the criteria that determines whether a tract will be harvested (that is, it will receive positive bids) is the same as in the "All Auctions" system. For a given price of logs, a tract receives positive bids and is harvested if and only if the price of logs is greater than the harvesting costs. On long-term tenures, there is some inefficiency in tract selection. In particular, for a given price of logs, certain tracts from the administered portion will not be harvested even though they would be in the competitive benchmark, because the flat stumpage fee makes it unprofitable to harvest the marginal tracts that otherwise would have had very small profits. In this case, *less* timber is harvested, resulting in a higher market price for logs. This in turn leads to *higher* prices on the auctioned tracts. It is crucial to emphasize that these prices are *higher than the competitive prices*, due to inefficient tract harvesting decisions on marginal tracts induced by a flat stumpage fee that is higher than the economic profit that could be earned by harvesting the tract. (In Kalt and Reishus (2004)'s terminology, the stumpage fee is above the market stumpage rate for some tracts.)

If there was a positive upset price on the auctioned tracts, again there would be some inefficiency in tract selection, in that some tracts would not be harvested. This would further reinforce the result of prices above competitive auction prices.

The revenue to the government would differ from the all auctions case. The government will not extract all of the economic profits on the administered tracts that are harvested. In addition, the government will not earn any revenue on the administered tracts that are not harvested due to inefficiently high stumpage fees on marginal tracts.

Public Ownership: Auctions and MPS Suppose second that administered pricing varies with the tract characteristics, as in the MPS system. In particular, auction prices are used to estimate the tract values, and the MPS statistical model is used (in conjunction with tenure obligation adjustments) to set prices for harvesting rights under long-term tenures. If the estimates from the MPS statistical model are precise, then all outcomes will be the same as in the all auctions case. Tracts with high estimated logging costs and low estimated log values will be priced close to zero, and they will be harvested. Tracts with predicted auction prices near or below zero may not be harvested, because these tracts are uneconomical. Other tracts will have high predicted prices and will be harvested.

Now consider non-trivial prediction errors from the MPS statistical model.[27] If the prediction error is positive (that is, the tracts are priced too high), then the tract will not be harvested, when it would have been efficient to do so. If the prediction error is negative, so that the price is lower than the auction price (but still non-negative), the tract will be harvested. As long as the stumpage fee is non-negative, the tract will be harvested only if the price is greater than the logging cost, as in the competitive benchmark.

A subtlety is that the market price may be higher than p^C, because some tracts that would have been efficient to harvest are not being harvested due to high prediction errors in the market pricing system. Thus, it is possible that a tract that would not have been harvested under competitive conditions will be harvested. This will put downward pressure on the market price for logs. However, and this is critical, market prices cannot fall lower than the competitive benchmark, p^C. We can establish this using a proof by contradiction. If the market price fell below p^C, then the set of tracts harvested would be a strict subset of those harvested under competitive conditions: all tracts with positive prediction errors as well as some tracts with negative prediction errors would no longer be economical to harvest. But with a smaller number of tracts harvested, the supply of logs will be below the competitive supply, from which it follows directly that the market price must be greater than p^C. Thus, the contradiction is established.

In short, prediction errors in the market pricing system can, similar to a system with a flat administered fee, lead to some inefficiencies in tract selection and prices above competitive market prices. It cannot, however, lead to below-competitive market prices. The magnitude of any inefficiencies will be small if the prediction errors from the MPS statistical model are small.

The government revenue without prediction errors would be equal to that under 100% auctions. Using the MPS system with prediction errors in the model, revenue would be reduced somewhat due to the inefficient tract selection. The auction system extracts all of the available surplus, and so inefficiencies are also revenue-reducing, even if market prices for logs are higher.

4.1.1.2 Case II: More General Economic Costs of Harvesting

In this section, we focus on the case where the holders of harvesting rights do not internalize all economic costs of harvesting timber. In practice, the most important additional economic costs are likely to be the opportunity cost of cutting now rather than waiting until the next year, and the benefits of leaving timber standing for other uses. Some of those other uses may induce externalities, such as environmental benefits, that would not accrue directly to a private owner of the land.

Let us put aside externalities, since those would be ignored by private landowners in a competitive model. For simplicity of exposition, we refer to the additional costs of harvesting timber (that is, economic costs *other than* the costs borne by holders of short-term harvesting rights and externalities) as "dynamic" costs.

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[27] Any correctly-specified statistical model will still have some prediction error as long as there are some tract characteristics that are difficult to measure. It is also possible that a statistical model can have specification flaws that would induce errors in prediction. Our discussion here applies to any type of error.

If the dynamic costs are constant across stands, then in any government-ownership system, a fixed minimum stumpage charge equal to the dynamic cost could be applied to all auctioned stands (in the form of an upset price).

If the dynamic costs vary across tracts, the analysis is a bit more complex. In the all auction system, it would be necessary to rely on the Ministry to engage in tract selection, since the auctions will not price all of the costs of harvesting.

In the case of government ownership with auctions and either the MPS system or administered pricing, long-term tenure-holders take into account many of the dynamic costs when they select tracts for harvest. In particular, they will have the incentive to harvest the tracts on their long-term tenures at the appropriate times. This is an important advantage of the system. Dynamic tract selection is undertaken by the long-term tenure holders. As in the discussion above, any prediction error in the MPS statistical model have the effect of deterring harvest of tracts that would be harvested under the competitive benchmark. Negative prediction errors or low administered stumpage fees (leading to stumpage fees below the economic profit for the tract) simply lower government revenue without affecting the harvest decision, since in the competitive benchmark companies will harvest all tracts where the market value of the logs exceeds the sum of harvesting costs and dynamic costs.

4.1.1.3 Summary

In the institutional environment in BC, which entails a mix of auctions and the MPS system, we should expect auction prices to be equal to or higher than the prices that would emerge in the competitive benchmark. The volume that will be harvested is equal to or smaller than the competitive benchmark. The long-term tenure system has the advantages of leaving dynamic tract selection to the long-term tenure-holders. At the same time, the hybrid system allows the Ministry to extract a large fraction of the economic profits from harvesting rights (the MPS system extracts almost all of the profit).

Thus, we have shown that the dominant role of timber supply from long-term tenures does not lead to price suppression in the auction market. In addition, prediction errors in the MPS model, if anything, would tend to increase auction prices above competitive levels. Price suppression could only occur if tenure holders had the power to successfully collude to manipulate markets on a large scale. In the next section we show why this is implausible.

4.1.2 The Incentives Created by the Existence of MPS Does Not Lead to Distorted Auction Prices

A potential concern with the MPS approach is that it might give long-term tenure-holders an incentive to behave in a way that reduces the prices for harvesting rights at BCTS auctions. Here, we argue that this is not a significant concern.

First, we pause to observe that it is not obvious exactly how a tenure-holder can commit not to purchase logs derived from BCTS auctions. What matters for prices in the BCTS auctions is the expectations loggers have about the price that they can obtain for the logs in the future, either from log brokers or directly from mills. A long-term tenure-holder might decide not to directly bid in a BCTS auction. But market participants can still form rough estimates of the future value of lumber and the costs of processing logs, and so they can make a prediction of the future price that mills would in principle be willing to pay for the logs. The price that loggers can obtain for harvested logs is determined primarily by the aggregate supply of logs in the geographical area and the aggregate demand by mills. It does not matter much who buys the specific logs harvested from a specific tract. If an individual firm tried to commit to a policy of refusing to buy logs from BCTS auctions in an effort to depress the auction price,[28] but the mill maintained the same production levels, then other firms (who might otherwise have relied on other sources of supply) will then find it profitable to buy the logs. Only if mills somehow *reduce* their overall production substantially would they affect the auction prices. Of course, if mills reduce production substantially, the market supply of finished products (e.g. lumber) decreases, and so market prices of lumber should *rise*.

For efforts to reduce auction prices to be effective, long-term tenure-holders would need to coordinate their behavior. Coordination on commitments not to purchase from BCTS auctions would, however, be difficult to implement, because firms would have the individual incentive to "deviate" from such an agreement and purchase logs that could be profitably processed. In addition, a conspiracy to manipulate auction prices would violate antitrust laws. As discussed earlier, BC has in place a tough set of antitrust provisions, including severe civil and criminal penalties for violations, and a whistle-blower policy to further discourage unlawful coordination.

For the remainder of this subsection, we will for the purposes of the discussion assume that firms *can* somehow commit to withhold demand for logs, for example by destroying some of their capacity.

The market pricing system does not create extra incentives for tenure holders to withhold demand in order to reduce auction prices and thus stumpage fees. A single auction has little impact on stumpage fees, which are based on a large set of auctions. Even manipulation of most or all of the auctions in a local region has only a modest impact on stumpage fees in that local region, since the stumpage fee is based on all the auction sales in either the Coast or Interior. Locational dummy variables are specifically omitted from the Coast MPS statistical model (and will be omitted from the Interior model when the MPS pricing system is implemented) to ensure that this is the case.

Indeed, we have studied the incentive of large tenure holders to manipulate auction outcomes. Even when we made the extreme assumption that all firms within a forest district colluded, the MPS model attenuated the impact on price. Of course, if firms in the district act individually, as seems more likely given the harsh punishments for collusion, then the impact on price would be much less.

What is required for the MPS system to approximate the competitive benchmark is a market structure of long-term tenures and mill capacity on the Coast and in the Interior that is workably competitive. The current market structures are consistent with many other industries that are viewed as competitive.

4.1.3 Restricting Participation to Qualified Bidders Enhances Competition

Another potential concern is that prices in the BCTS auctions may be lower because of the practice of restricting participation to qualified bidders. This is not the case. These restrictions—requiring some minimal level of experience in addition to financial bonding—are intended to increase *meaningful* competition and raise prices. The presence of unqualified bidders increases transaction costs for both the government and the bidders. Sale to unqualified bidders can lead to default, environmental damage, or other damage to the timber resource, such as delayed harvesting of insect-infested timber. Thus, it makes sense to restrict participation to bidders who can demonstrate the ability to responsibly execute the contract.

[28] It is not clear how a firm could make such a commitment, since later, long after the auction is over and prices can no longer be directly affected, the firm loses potential profits by refusing to buy logs from the tract. Thus, the firm cannot *credibly* commit not to buy logs.

Given the minimal level of requirements, there are plenty of small loggers in BC that can enter auctions and earn a profit if the auction prices fall below competitive levels. The restrictions do not serve as an entry barrier, stifling auction competition. Rather, the restrictions create a level playing field and provide a foundation for meaningful competition.

Bidder qualification is a common and important practice. Bidder qualification is seen in all procurement auctions we are aware, both public and private, as well as all high-stake auctions. Bidders typically must satisfy both financial and technical qualification, as is the case in BC.[29]

4.1.4 Transferability of Tenures Is Good for Competitiveness

Another concern is that the transferability of tenures could create market concentration. However, the antitrust policies in place in BC specifically prohibit transfers that create excessive market power.

In most U.S. markets, there are few restrictions on the transfer of ownership rights for assets or even entire firms. Antitrust authorities monitor such transfers in environments where concentration is a concern. Typically this combination—transferability coupled with antitrust oversight—leads to an appropriate balance between concerns about the exercise of market power and concerns that assets should be able to be transferred into the hands of those who can use them most productively. In addition, transferability encourages efficient asset maintenance and investment.

4.2 The Quality Adjustment and the Specification of the MPS Model

We have discussed several nuances that arise in using prices from BCTS auctions for harvesting rights as a comparison for stumpage fees under long-term tenures. The first issue is the role of a *quality adjustment*. The second issue concerns accounting for timber graded in categories other than green sawlogs, timber that we will loosely refer to as "dead and dry timber."

Let us focus on the issue of the quality adjustment. Recall that the MPS statistical model provides, for any set of appraised tract characteristics, a predicted value for auction prices for harvesting rights. The quality adjustment is performed as follows. The MPS model is applied to the tract characteristics of the tracts harvested under log-term tenures, and a predicted value for harvesting rights on the average tract harvested under tenures is obtained. Next, the model is applied to the tracts sold at auction, and a predicted value for harvesting rights on the average auctioned tract is obtained. The difference between these two predictions is the quality adjustment, interpreted as the difference in the average value between the two sets of tracts.

The quality adjustment is likely to play only a small role in practice, because the tracts selected for BCTS auctions are representative of the tracts sold under long-term tenures. Normal statistical variation or other minor factors might lead to small differences among the sets of tracts, and thus a small quality adjustment may be called for.

The next subsection reviews the principles behind simple statistical models for prediction, and then addresses previous critiques about the econometric specification of the MPS model.

4.2.1 Specification of the MPS Statistical Model

On the Coast, the MPS statistical model uses a two-equation system for prediction, while on the Interior, a single-equation system is used. The main arguments about what is required to generate

[29] For example, the U.S Federal Acquisition Regulations provide a long list of standards for bidder qualification, both financial and technical. See http://www.arnet.gov/far/loadmainre.html.

accurate and unbiased predictions are easiest to describe in the context of a single-equation system, and so we will begin with a discussion of such a model.

Consider three sets of tracts. The set S^B is a baseline set of tracts. For these tracts, we observe auction prices, appraisal characteristics, and participation. There are two other sets of tracts, S^A and S^L, for which we observe appraisal characteristics. Our goal is to use the information derived from the baseline set S^B to estimate a statistical model that relates characteristics to auction prices, and then use that statistical model to predict the difference in value between the two sets S^A and S^L. The basis for the prediction are the tract characteristics observed for the sets S^A and S^L.

More formally, for each tract i in S^B there is a list of n appraised characteristics about tracts (such as size, specialized logging required, etc.). Call this list $\mathbf{x}_i=(x_{i,1},\ldots,x_{i,n})$. In addition, the unobserved characteristics of each tract that might affect tract value are summarized in a variable u_i. Let WIN_BID_i denote the winning bid at the auction.

Conceptually, the goal of the quality adjustment is to take two different sets of tracts, S^A and S^L, and obtain a consistent prediction of

$$E[WIN\_BID_i \mid i \in S^A] - E[WIN\_BID_i \mid i \in S^L].$$

This expression is interpreted as the expected value (that is, the average) of winning bids for all tracts in the set S^A less the expected value of winning bids for tracts in S^L, if these tracts were to be sold at auctions.

Let the relationship between winning bids, tracts, and unobservables be given by a function $g(\mathbf{x}_i, u_i)$, as follows:

$$WIN\_BID_i = g(\mathbf{x}_i, u_i).$$

There are two critical assumptions required for developing a statistical model to obtain the desired prediction. First, we require that the relationship described by $g(\mathbf{x}_i, u_i)$ is stable across all of the tracts in sets S^A, S^B and S^L. Second, we require that the distribution of unobservable tract characteristics given knowledge of observable tract characteristics is also stable across sets of tracts. Both of these conditions would be satisfied if, for example, the tracts in S^A and $S^{\boldsymbol{B}}$ are selected as a representative sample from the same population of tracts as S^L, or if any important differences among these tracts can be observed and included in the vector $\mathbf{x}_i$.

Then, it immediately follows that there exists a function

$$h(\mathbf{x}_i) = E[WIN\_BID_i \mid \mathbf{x}_i] = E[g(\mathbf{x}_i, u_i) \mid \mathbf{x}_i]$$

that applies to any tract in S^A, S^B or S^L. In other words, there exists a functional relationship between observed tract characteristics and expected winning bids, and this relationship applies to members of each of the different sets of tracts S.

Given this, it follows that finding a consistent prediction of the quality adjustment boils down to finding a consistent estimate of the function h, call it $\hat{h}$, using a baseline sample of auctions S^B, and then calculating the quality adjustment as

$$E[\hat{h}(\mathbf{x}_i) \mid i \in S^A] - E[\hat{h}(\mathbf{x}_i) \mid i \in S^L].$$

Note that nothing in this approach relies on observation of all relevant tract characteristics. Some important tract characteristics will remain unobserved, so that we can never predict winning bids with perfect accuracy. It is not necessary to observe everything about a tract in order to obtain a consistent prediction of winning bids conditional on tract characteristics. For example, the omission of variables describing road costs does not invalidate the procedure. So long as the relationship between road costs and observable characteristics is stable across the different subset of tracts, the overall procedure is valid. Of course, the more tract characteristics are observed, the more accurate is the prediction. But the approach explicitly accounts for the fact that some characteristics are unobserved.

Another potential concern for the two-equation model used on the Coast is "simultaneous equations bias." We argue that this concern is not relevant for the purposes of prediction. Although the two-equation approach does make use of the intermediate outcome "number of bidders" in estimating the model, the procedure still leads to a prediction about expected winning bids as a function of the covariates. One question that could be raised is whether, in the simultaneous equations framework, the MPS statistical model estimates the *causal* effect of the number of bidders on winning bids. However, it is not necessary to estimate this effect in the context of a prediction model, since we do not observe the number of bidders for tracts harvested under long-term tenures. There are many intermediate outcomes in determining auction prices, such as the number of bidders who seriously read the appraisal, the number who conduct a cruise, the number who submit serious bids, and so on. Some tract characteristics may directly affect stand values, while others may impact winning bids only through their effect on participation. It is not necessary to decompose *why* a tract characteristic affects winning bids in order to make a valid prediction, so long as all tracts are "representative" in the sense described above. Although a two-equation model can be useful for aiding interpretability of the model, since it decomposes the effects of tract characteristics directly on values from the effects of tract characteristics through participation, this decomposition is not important for the overall prediction of auction prices.

In practice, there are many alternative techniques available to construct $\hat{h}$ from a sample of auctions S^B. There are many criteria upon which these techniques can be evaluated, including (i) parsimony, (ii) simplicity, (iii) predictive power, (iv) a functional form that fits data, (v) interpretability of model, and (vi) (in the context of MPS) the extent to which bids in one geographic area have strong effects on predicted values in that area.

Perhaps the simplest approach is the use of Ordinary Least Squares (OLS) regression, which uses linear combinations of the observed tract characteristics to make a prediction. Even within this simple approach, choices must still be made about functional form for how the tract characteristics enter the model. Although different functional forms may lead to different specific predictions on a given sample, there is no reason to believe that any particular functional form will be biased one way or the other when comparing predictions on two representative samples. The robustness of functional forms should be evaluated, and there are diagnostic techniques within econometrics for evaluating a model.

The Coast region in BC uses a system of equations model. This amounts to selecting a somewhat more complex estimation technique and a particular functional form. The goal of adding this complexity is to take advantage of prior knowledge that certain variables are more likely to have indirect effects on prices through participation, rather than direct effects on values. In addition, the parameters of such a model are easy to interpret. However, it should be emphasized that the validity of the overall approach does not hinge on having such prior knowledge or imposing it in the statistical model, and it should not make much difference whether a single equation model or a system of equations model is used.

5 CONCLUSIONS

We have reviewed the rules and procedures for BCTS auctions, as well as auction outcomes, for the unrestricted BCTS sales from April 1, 2004 to March 31, 2005. We believe that the prices paid for stumpage by winning bidders at BCTS auctions represent market prices, determined through competitive behavior by buyers of harvesting rights for standing timber. The BCTS auction markets are transparent, open, and free of restrictions and regulations that might hamper the effectiveness of the markets. The rules and procedures follow industry "best practice." A relatively small volume is required to be auctioned at BCTS auctions in order to establish a valid basis for comparisons with timber harvested under other tenures. Standard economic logic implies that the stumpage fees paid by auction winners should, on average, be equal to the market price at which the total timber sold by public and private sellers is equal to the demand for timber. It is important that BCTS sells enough timber at auctions in order to (a) generate competitive and active participation by potential bidders, and (b) to sell by auction a representative sample of timber sold under long-term tenures. The size of the BCTS program is sufficient for the purpose of estimating the average market price of all harvests from long-term tenures.

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Table 1: Interior Crown Volume, Value and Average Rate Billed - April 1, 2004 to March 31, 2005

		Volume (m3)						Value (C$)			Average Rate (C$/m3)		
	Grade	Unrestricted Auctions*	%	All Auctions**	%	Other Crown***	%	Unrestricted Auctions*	All Auctions**	Other Crown***	Unrestricted Auctions*	All Auctions**	Other Crown***
Coniferous	3	1,156,311	27.1%	1,513,406	23.8%	7,906,304	15.5%	289,077	378,352	1,977,635	0.25	0.25	0.25
	4	259,102	6.1%	411,921	6.5%	3,005,112	5.9%	64,776	102,981	748,391	0.25	0.25	0.25
	5	174,489	4.1%	246,473	3.9%	1,353,996	2.6%	43,623	61,619	338,577	0.25	0.25	0.25
	6	42,292	1.0%	63,806	1.0%	526,400	1.0%	10,573	15,952	131,407	0.25	0.25	0.25
	Green Sawlogs	2,575,070	60.3%	3,851,244	60.6%	36,492,622	71.3%	101,414,957	149,795,838	799,478,083	39.38	38.90	21.91
Coniferous Total		4,207,264	98.6%	6,086,851	95.7%	49,284,435	96.3%	101,823,006	150,354,743	802,674,092	24.20	24.70	16.29
Deciduous	3	505	0.0%	1,076	0.0%	6,679	0.0%	126	269	1,669	0.25	0.25	0.25
	4	20,936	0.5%	72,590	1.1%	592,909	1.2%	5,234	18,148	148,223	0.25	0.25	0.25
	5	206	0.0%	6,935	0.1%	6,653	0.0%	52	1,734	1,663	0.25	0.25	0.25
	6	742	0.0%	2,173	0.0%	17,165	0.0%	185	543	4,291	0.25	0.25	0.25
	Green Sawlogs	37,880	0.9%	189,214	3.0%	1,260,803	2.5%	59,383	533,181	630,630	1.57	2.82	0.50
Deciduous Total		60,269	1.4%	271,988	4.3%	1,884,209	3.7%	64,981	553,875	786,475	1.08	2.04	0.42
Grand Total		4,267,533	100.0%	6,358,838	100.0%	51,168,644	100.0%	101,887,987	150,908,618	803,460,568	23.88	23.73	15.70

		Volume (m3)						Value (C$)			Average Rate (C$/m3)		
	Species	Unrestricted Auctions*	%	All Auctions**	%	Other Crown***	%	Unrestricted Auctions*	All Auctions**	Other Crown***	Unrestricted Auctions*	All Auctions**	Other Crown***
Coniferous	Balsam	201,656	4.7%	332,801	5.2%	2,752,109	5.4%	4,256,938	6,940,740	47,064,234	21.11	20.86	17.10
	Cypress	0	0.0%	5	0.0%	843	0.0%	0	3	992	0.32	0.63	1.18
	Douglas Fir	321,656	7.5%	465,634	7.3%	4,561,959	8.9%	13,109,247	19,691,704	77,917,046	40.76	42.29	17.08
	Hemlock	144,612	3.4%	256,792	4.0%	1,069,595	2.1%	2,433,069	4,390,429	7,061,539	16.82	17.10	6.60
	Larch	34,858	0.8%	48,264	0.8%	513,119	1.0%	1,220,501	1,832,111	6,031,608	35.01	37.96	11.75
	Lodgepole Pine	2,804,965	65.7%	3,795,503	59.7%	28,389,409	55.5%	57,382,753	78,212,285	418,962,052	20.46	20.61	14.76
	Other	0	0.0%	0	0.0%	0	0.0%	0	0	0			
	Red Cedar	61,821	1.4%	106,858	1.7%	1,050,659	2.1%	1,901,265	3,799,002	12,819,293	30.75	35.55	12.20
	Spruce	633,080	14.8%	1,070,117	16.8%	10,864,490	21.2%	21,408,342	35,182,140	231,899,360	33.82	32.88	21.34
	White Pine	3,594	0.1%	6,556	0.1%	59,927	0.1%	70,812	166,123	669,249	19.70	25.34	11.17
	Whitebark Pine	3	0.0%	3	0.0%	1,011	0.0%	89	92	16,159	28.45	28.55	15.98
	Yellow Pine	1,019	0.0%	4,318	0.1%	21,310	0.0%	39,989	140,115	232,559	39.25	32.45	10.91
	Yew		0.0%		0.0%	4	0.0%			1			0.25
Coniferous Total		4,207,264	98.6%	6,086,851	95.7%	49,284,435	96.3%	101,823,006	150,354,743	802,674,092	24.20	24.70	16.29
Deciduous	Alder	81	0.0%	576	0.0%	69	0.0%	137	15,920	261	1.69	27.62	3.81
	Aspen	41,603	1.0%	235,840	3.7%	1,563,146	3.1%	51,094	500,752	644,819	1.23	2.12	0.41
	Birch	10,370	0.2%	18,408	0.3%	75,590	0.1%	4,668	10,259	32,402	0.45	0.56	0.43
	Cottonwood	8,215	0.2%	17,163	0.3%	245,395	0.5%	9,082	26,945	108,990	1.11	1.57	0.44
	Maple		0.0%		0.0%	11	0.0%			3			
Deciduous Total		60,269	1.4%	271,988	4.3%	1,884,209	3.7%	64,981	553,875	786,475	1.08	2.04	0.42
Grand Total		4,267,533	100.0%	6,358,838	100.0%	51,168,644	100.0%	101,887,987	150,908,618	803,460,568	23.88	23.73	15.70

* Interior unrestricted auction sales awarded Nov. 5, 2003 or later.
** All Section 20 Sales.
*** All non-Section 20 provincial crown harvest.
Excludes waste, reject and special forest products.

Table 2: Coast Crown Volume, Value and Average Rate Billed - April 1, 2004 to March 31, 2005

		Volume (m3)						Value (C$)			Average Rate (C$/m3)		
	Grade	Unrestricted Auctions*	%	All Auctions**	%	Other Crown***	%	Unrestricted Auctions*	All Auctions**	Other Crown***	Unrestricted Auctions*	All Auctions**	Other Crown***
Coniferous	B	1,096	0.1%	1,729	0.1%	28,866	0.2%	47,598	67,406	328,448	43.42	38.98	11.38
	C	17,679	2.4%	33,176	1.8%	197,162	1.1%	800,966	1,632,481	2,828,432	45.31	49.21	14.35
	D	6,975	0.9%	18,559	1.0%	386,086	2.2%	313,614	831,159	7,617,366	44.96	44.79	19.73
	E	55	0.0%	348	0.0%	6,945	0.0%	3,876	14,899	34,266	69.97	42.85	4.93
	F	9,956	1.3%	23,187	1.3%	361,113	2.0%	431,505	954,933	6,361,277	43.34	41.18	17.62
	G	103	0.0%	621	0.0%	18,427	0.1%	6,967	24,152	107,761	67.96	38.86	5.85
	H	129,238	17.3%	321,147	17.4%	4,336,276	24.4%	6,038,007	14,832,663	65,915,680	46.72	46.19	15.20
	I	81,589	10.9%	202,461	11.0%	2,440,493	13.7%	4,013,441	9,539,874	35,429,062	49.19	47.12	14.52
	J	334,156	44.7%	824,495	44.7%	5,318,224	29.9%	16,195,070	39,513,507	74,852,947	48.47	47.92	14.07
	K	3,442	0.5%	8,789	0.5%	219,061	1.2%	198,607	436,274	4,489,331	57.70	49.64	20.49
	L	8,992	1.2%	20,579	1.1%	424,846	2.4%	533,827	1,073,540	7,878,984	59.37	52.17	18.55
	M	7,016	0.9%	16,271	0.9%	332,034	1.9%	393,085	821,349	6,061,810	56.03	50.48	18.26
	U	79,210	10.6%	211,196	11.4%	1,845,455	10.4%	3,773,646	9,487,845	27,199,995	47.64	44.92	14.74
	X	25,783	3.4%	68,462	3.7%	1,001,600	5.6%	1,074,411	2,820,327	13,910,270	41.67	41.20	13.89
	Y	37,355	5.0%	85,171	4.6%	730,529	4.1%	10,941	23,418	183,937	0.29	0.27	0.25
Coniferous Total		742,645	99.4%	1,836,192	99.5%	17,647,118	99.1%	33,835,561	82,073,826	253,199,565	45.56	44.70	14.35
Deciduous	U	4,508	0.6%	8,995	0.5%	144,273	0.8%	4,509	8,995	128,442	1.00	1.00	0.89
	Y	247	0.0%	632	0.0%	8,868	0.0%	62	158	2,308	0.25	0.25	0.26
Deciduous Total		4,755	0.6%	9,627	0.5%	153,141	0.9%	4,570	9,154	130,750	0.96	0.95	0.85
Grand Total		747,400	100.0%	1,845,819	100.0%	17,800,259	100.0%	33,840,131	82,082,980	253,330,315	45.28	44.47	14.23

		Volume (m3)						Value (C$)			Average Rate (C$/m3)		
	Species	Unrestricted Auctions*	%	All Auctions**	%	Other Crown***	%	Unrestricted Auctions*	All Auctions**	Other Crown***	Unrestricted Auctions*	All Auctions**	Other Crown***
Coniferous	Balsam	53,980	7.2%	177,112	9.6%	2,404,747	13.5%	1,575,325	5,295,863	31,416,705	29.18	29.90	13.06
	Cypress	16,615	2.2%	61,825	3.3%	696,876	3.9%	653,809	2,377,743	10,077,139	39.35	38.46	14.46
	Douglas Fir	327,909	43.9%	691,476	37.5%	3,133,824	17.6%	16,113,461	34,226,257	44,008,922	49.14	49.50	14.04
	Hemlock	191,600	25.6%	508,603	27.6%	6,048,199	34.0%	7,347,252	20,214,519	78,218,730	38.35	39.75	12.93
	Lodgepole Pine	686	0.1%	4,970	0.3%	37,407	0.2%	34,932	284,543	405,453	50.94	57.26	10.84
	Other		0.0%		0.0%	0	0.0%			0			0.26
	Red Cedar	146,590		360,206		4,946,711		7,834,539	18,635,235	86,957,848	53.45	51.73	17.58
	Spruce	4,726	0.6%	30,221	1.6%	361,165	2.0%	246,971	971,770	1,706,212	52.26	32.16	4.72
	White Pine	538	0.1%	1,508	0.1%	18,150	0.1%	29,272	64,203	408,547	54.38	42.59	22.51
	Whitebark Pine		0.0%		0.0%	-2	0.0%			0			0.25
	Yellow Pine		0.0%	272	0.0%	0	0.0%		3,694	0		13.60	0.25
	Yew	0	0.0%	0	0.0%	39	0.0%	0	0	10	0.25	0.25	0.25
Coniferous Total		742,645	99.4%	1,836,192	99.5%	17,647,118	99.1%	33,835,561	82,073,826	253,199,565	45.56	44.70	14.35
Deciduous	Alder	3,175	0.4%	7,268	0.4%	140,906	0.8%	3,035	6,885	120,239	0.96	0.95	0.85
	Arbutus		0.0%	1	0.0%	0	0.0%		1	0		0.79	0.00
	Aspen		0.0%		0.0%	126	0.0%			120			0.95
	Birch	295	0.0%	388	0.0%	2,528	0.0%	285	373	2,093	0.97	0.96	0.83
	Cottonwood	734	0.1%	840	0.0%	3,590	0.0%	725	826	3,263	0.99	0.98	0.91
	Maple	551	0.1%	1,130	0.1%	5,991	0.0%	526	1,067	5,034	0.95	0.94	0.84
Deciduous Total		4,755	0.6%	9,627	0.5%	153,141	0.9%	4,570	9,154	130,750	0.96	0.95	0.85
Grand Total		747,400	100.0%	1,845,819	100.0%	17,800,259	100.0%	33,840,131	82,082,980	253,330,315	45.28	44.47	14.23

* Coast unrestricted auction sales awarded Nov. 5, 2003 or later.
** All Section 20 Sales.
*** All non-Section 20 provincial crown harvest.
Excludes waste, reject and special forest products.

Table 3: Interior Crown Volume Billed by District - April 1, 2004 to March 31, 2005

Region	District	Unrestricted Auctions*	%	All Auctions**	%	Other Crown***	%
Northern Interior	Fort Nelson	38,655	0.9%	219,272	3.4%	1,828,688	3.6%
	Fort St. James	380,566	8.9%	534,143	8.4%	2,781,633	5.4%
	Kalum	162,074	3.8%	259,758	4.1%	553,890	1.1%
	Mackenzie	119,903	2.8%	180,145	2.8%	2,214,650	4.3%
	Nadina	194,110	4.5%	297,474	4.7%	4,611,207	9.0%
	Peace	64,820	1.5%	304,207	4.8%	2,487,384	4.9%
	Prince George	986,042	23.1%	1,066,485	16.8%	6,335,538	12.4%
	Skeena Stikine	55,028	1.3%	117,337	1.8%	466,038	0.9%
	Vanderhoof	377,510	8.8%	581,324	9.1%	4,139,393	8.1%
Northern Interior Total		2,378,707	55.7%	3,560,146	56.0%	25,418,420	49.7%
Southern Interior	100 Mile House	73,494	1.7%	127,215	2.0%	1,593,410	3.1%
	Arrow Boundary	126,364	3.0%	213,493	3.4%	2,226,913	4.4%
	Cascades	83,518	2.0%	157,454	2.5%	2,046,614	4.0%
	Central Cariboo	190,136	4.5%	191,000	3.0%	3,128,638	6.1%
	Chilcotin	11,545	0.3%	116,788	1.8%	819,109	1.6%
	Columbia	19,682	0.5%	118,730	1.9%	758,493	1.5%
	Headwaters	67,085	1.6%	116,856	1.8%	1,197,191	2.3%
	Kamloops	317,780	7.4%	417,894	6.6%	3,106,626	6.1%
	Kootenay Lake	42,869	1.0%	60,378	0.9%	758,819	1.5%
	Okanagan Shuswap	394,371	9.2%	542,367	8.5%	3,655,672	7.1%
	Quesnel	333,919	7.8%	450,313	7.1%	4,470,932	8.7%
	Rocky Mountain	228,063	5.3%	286,205	4.5%	1,987,805	3.9%
Southern Interior Total		1,888,826	44.3%	2,798,693	44.0%	25,750,224	50.3%
Interior		4,267,533	100.0%	6,358,838	100.0%	51,168,644	100.0%

* Interior unrestricted auction sales awarded Nov. 5, 2003 or later.
** All Section 20 Sales.
*** All non-Section 20 provincial crown harvest.
Excludes waste, reject and special forest products.

Table 4: Coast Crown Volume Billed by District - April 1, 2004 to March 31, 2005

District	Unrestricted Auctions*	%	All Auctions**	%	Other Crown***	%
Campbell River	213,225	28.5%	487,261	26.4%	4,372,004	24.6%
Chilliwack	171,995	23.0%	390,735	21.2%	1,188,297	6.7%
North Coast		0.0%	78,623	4.3%	505,932	2.8%
North Island - Central Coast	112,806	15.1%	180,416	9.8%	5,228,290	29.4%
QCI	13,272	1.8%	60,636	3.3%	862,522	4.8%
South Island	130,603	17.5%	275,967	15.0%	3,083,251	17.3%
Squamish	46,890	6.3%	84,760	4.6%	637,615	3.6%
Sunshine Coast	58,609	7.8%	287,420	15.6%	1,922,349	10.8%
Coast Total	747,400	100.0%	1,845,819	100.0%	17,800,259	100.0%

* Coast unrestricted auction sales awarded Nov. 5, 2003 or later.
** All Section 20 Sales.
*** All non-Section 20 provincial crown harvest.
Excludes waste, reject and special forest products.

EXHIBIT A: Curriculum Vita for Susan Athey and Peter Cramton