Auctioning Timber to Maximize Revenues in British Columbia

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SUMMARY

British Columbia is proposing substantial market reforms to improve its pricing of timber. A key element of the reforms is using the outcome of timber auctions to price timber for non-auctioned long-term tenures. Using market transactions to price timber on long-term tenures has the advantage of setting market-based prices for all of B.C.'s timber, while retaining the benefits of long-term tenures. In our paper, "Auction-Based Timber Pricing and Complementary Market Reforms in British Columbia," we demonstrate that this market-based approach enables efficient cutting of timber, encourages efficient investment in developing timber lands, and minimizes the impact of government decisions on timber pricing. Here we examine how the approach affects the revenues that British Columbia can receive from its timber resource.

We find that the proposed approach—auctioning a representative fraction of the timber lands and then using the auction sales to price timber harvested under long-term tenures—maximizes the revenues that the government can receive for the timber resource. This result is due to the fact that auctioning a small fraction of the timber minimizes the incentive and ability of the firms to collude. As a result, the timber auctions are more competitive, and the timber revenues from both the auctioned and non-auctioned timber are maximized.

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1 INTRODUCTION

We have been asked by the British Columbia Ministry of Forests to answer the question: "How should British Columbia price its timber to maximize revenues from its timber resource?" We find that the approach under consideration, in which a representative portion of timber is auctioned and then the auction prices are used to determine the prices for timber harvested under long-term tenures, yields higher revenue than an alternative where 100% of the volume is auctioned.

The approach we recommend uses two important instruments to limit the collusive bidding that can undermine revenues. The first instrument is the upset price.[2] Bids below the upset price are not accepted. Upset prices are set at a substantial fraction of estimated market value. This greatly limits the maximum gain that can be obtained through collusion, and hence limits the incentive for collusive bidding. Moreover, the upset guarantees substantial revenue even when competition is weak, so long as the upset is met. The second instrument is the volume of auctioned timber. By auctioning a small fraction of the timber, companies have a reduced incentive to collude and reduce auction prices. The reason is that collusion in the local auctions has a small impact on the companies' payments when a small fraction of timber is auctioned. Although the collusion can reduce the payments for the auctioned timber, it has little impact on what the companies pay for the non-auctioned timber. Hence, the incentive to collude is reduced, the auctions are more competitive, and revenues are increased.

We begin by demonstrating a revenue equivalence result. Absence any possibility of collusive bidding, the timber revenues are invariant to the volume of auctioned timber. We then enrich the model to recognize the possibility of collusion. In particular, it is assumed that companies will collude if the gains from collusion more than outweigh the costs. We find that by auctioning a small fraction of the total timber volume, the incentive to collude in the auction is reduced. Hence, the auctions are more competitive and achieve higher revenues than if all of the timber were auctioned.

Throughout this paper, we ignore any effect that the volume of auctioned timber might have on the aggregate output of British Columbia. In our paper "Auction-Based Timber Pricing and Complementary Market Reforms in British Columbia," we argued that if the Crown does not respond optimally to market conditions, there is a risk that British Columbia may impact the world price. For example, British Columbia might sell too much timber in a downturn, depressing world prices; similarly, in an upturn, B.C. might auction too little volume, inflating world prices. In this paper, we abstract from this consideration, in order to focus on the effects of the volume auctioned on the extent to which firms can exercise market power and reduce revenue to the Crown.

2 ABSENT COLLUSION, REVENUES ARE INVARIANT TO THE VOLUME OF AUCTIONED TIMBER

In the absence of collusion, if the pricing model is well-specified, an individual firm's affect on its own future stumpage rates is minimal. At a given point in time, a tenure-holder chooses whether to attend a given auction, or to harvest more timber from its long-term tenure. The tenure-holder evaluates the expected economic costs and benefits of extracting its own timber over the next few years. In addition to expected stumpage rates, the tenure-holder considers the opportunity cost of extracting the timber now instead of in the future. If auction prices are, on average, below the economic cost of extracting the timber from its tenure, the tenure-holder will attend the auction, in the hopes of winning at a price below its stumpage rates, and thus obtaining a cheaper source of timber. If auction prices are, on average, above the cost of extracting from the long-term tenure, the tenure-holder will cut from its long-term tenure, reducing

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[2] Our paper, "Setting the Upset Price in British Columbia Timber Auctions," examines how to set the upset price to maximize revenues.

demand at the auction. Thus, in equilibrium, the auction prices equal the cost of extracting from the long-term tenure, and this is invariant to the fraction of volume auctioned.

To analyze the effects of market power on Crown revenue, we will introduce a simple model of firm objectives. As a benchmark case, we formalize the logic just described in the context of this model.

We begin with the simplest case in which both the lumber market and timber auctions are competitive. In this case, mills are price takers in the lumber market. Similarly, the mills are price takers in the timber auctions. They mill a quantity q_C such that the price of lumber is equal to the marginal cost of producing lumber, $P = MC_M + MC_T$, where MC_M is the marginal milling cost and MC_T is the marginal timber cost. Since the timber auctions are competitive, the mill is a price taker in the auctions, and so will not distort quantity to impact the price of timber. Changing the quantity of timber that is auctioned has no effect on the mill's decision making. The mill continues to purchase timber at the same competitive price MC_T, whether the timber is auctioned or from long-term tenures. Hence, the government's revenues are invariant to the fraction of timber that is auctioned.

3   RECOGNIZING THE POSSIBILITY OF COLLUSIVE BIDDING, REVENUES ARE ENHANCED BY AUCTIONING A SMALL FRACTION OF THE TOTAL TIMBER VOLUME

In this section, we continue with the model introduced in Section 2, and analyze the effect of the volume auctioned on revenue. We show that when there are fixed costs to colluding, or when the effectiveness of collusion increases with the frequency of interaction, revenue can be increased by decreasing the volume auctioned.

As in Section 2, suppose that the lumber market is competitive and the auction market is competitive absent collusion, but that the local mills can collude to reduce the timber auction price to the upset price. However, colluding is illegal and if the collusion is detected, the colluding mills will face a penalty based on the harm caused (the reduction in government revenues). Our claim is that the incentive to collude decreases when a smaller fraction of timber is auctioned. There are several reasons for this.

First, consider the effect of the volume of auctioned timber on collusion, in the absence of anti-competitive enforcement. When collusion requires firms to bid lower than competitive levels, or to refrain from bidding, firms often have an incentive to deviate at a particular auction. The threat of future punishment deters such a deviation. Sometimes, the punishment takes the form of a bidding war in future auctions. In that case, the number and frequency of auctions changes the extent to which the threat of future bidding wars is an effective threat. If auctions occur infrequently, and are not too important for overall firm profits, then the threat of a future bidding war cannot deter a deviation today, and this type of collusion will not be sustainable. On the other hand, if auctions are frequent and are a critical source of supply for each firm, then the threat of a future bidding war can deter deviations, and collusion will be easier to sustain. This is an example of a general principle in the theory of collusion: the more frequently the firms interact, and the higher the gap between the collusive and competitive outcome, the easier it is to sustain collusion.

Now, consider the effect of the volume auctioned in the presence of anti-competitive enforcement. Collusion, or coordinated efforts to exercise market power, typically entails some costs for the firms involved. These costs can take a variety of forms, depending on how collusion is organized and enforced. Some of these costs must be incurred on an auction-by-auction basis. Other costs are fixed, independent of the number of auctions. A major cost is the risk of detection and resulting penalties. Some penalties and consequences of detection are independent of the magnitude of collusion. For example, the policy in British Columbia is that colluding firms will be excluded from future purchases of timber from the Crown. There may be other fixed costs, such as damage to a firm's reputation and the legal costs associated with mounting a defense. Other penalties are related to the harm caused. We assume here,

consistent with the law, that the there are some penalties independent of the scale of the collusive scheme, and other penalties are based on the harm caused.[3]

Let us focus for a moment on a hypothetical scenario where all penalties from detection are fixed, and independent of the scale of collusion, where collusion is assumed to involve most or all firms in a given district or region, but not all firms in the entire province (since such an all-encompassing scheme would be very difficult to conceal). In this scenario, we argue that the incentive of firms to collude is highest when 100% of the volume is auctioned. To see why, note that with 100% auctioned, a successful collusive scheme lowers the prices for all timber a company buys. On the other hand, with a moderate fraction auctioned, the benefits from successful collusion are smaller. Collusion lowers prices on the fraction sold at auction. It also lowers stumpage fees on timber cut from long-term tenures. But, a reduction in auction prices in a given district or region does not lower a given firm's stumpage fees one-for-one. Instead, results from local auctions are averaged in with auctions from other regions. For this reason, the benefit from collusion is lower with less than 100% volume auctioned. If the costs are independent of the scale of collusion, then the incentive to collude is lower as well.

Now, we turn to incorporate penalties that are proportional to the economic harm from collusion. We argue that with such penalties, the incentive to collude is lower when less than 100% of volume is auctioned. To see why, observe that if 100% of timber is auctioned, then a collusive scheme in a given region only affects prices in that region, and the harm caused (and thus the penalties) are exactly proportional to the benefits to the colluding firms. On the other hand, if 20% of volume is auctioned, then the benefit to collusion from the perspective of the firms is the price reduction on the auctioned volume in the region, together with the less-than-proportional reduction in stumpage fees. On the other hand, the economic harm includes not only these amounts, but further, it includes the reduction in stumpage fees that the collusion caused in other regions. In other words, the colluding firms provided benefits to firms in other regions by lowering the other firms' stumpage fees. That is, the colluding firms caused a public good from the perspective of other firms, or a public bad from the perspective of the government. If penalties are proportional to the harm caused, then the penalties relative the benefit to a particular firm increase when the fraction of volume auctioned decreases. As a result, incentives for collusion are reduced, and the timber market is more likely competitive.

In the analysis above, we have assumed that the timber auctions are competitive absent collusion. Certainly, there are districts where because of large transportation costs the largest mills are able to exercise local market power in the timber auctions. Our main result—that reducing the volume auctioned reduces the incentive to adopt collusive bidding strategies—still holds true for the same reasons as given above.[4] Although the dominant mills have a greater *ability* to exercise local market as the volume is reduced, their *incentive* to do so is reduced with the volume, since the lower auction prices have a decreasing impact on the mills' total timber costs. Hence, even when local market power is a problem, auctioning a smaller fraction of the timber reduces the incentive for collusive bidding, and thus increases the competitiveness of timber auctions.

The underlying intuition for this result is seen in the theory of optimal auctions. Bidders are able to capture profits in auctions as a result of the private information they bring to the auctions. Profits increase when there is greater uncertainty in values and less competition. The proposed market reforms do two things to limit companies' profits. First, the upset price is conditioned on pricing information from other

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[3] The British Columbia Forest Act (Part 12, Division 4, Section 164) and the Federal Competition Act (Sections 45 and 47) state that collusion in bidding is illegal, punishable by fine (not more than $10 million) and/or imprisonment (not more than 5 years). In addition, parties found guilty of collusion in prior auctions may be disqualified from participating in future auctions (see the registration rules in the Small Business Forest Enterprise Regulation).

[4] This is demonstrated in the appendix.

districts, making the upset price a better predictor of values. Second, for non-auctioned timber, the price of timber is the expected auction price taking into account representative information from all districts.

4 CONCLUSION

British Columbia has proposed market reforms to improve its pricing of timber. The market-based approach enables efficient cutting of timber, efficient investment in developing timber lands, and minimizes the impact of government decisions on timber pricing. The package of reforms eliminates trade distortions, allows for efficient entry and exit, and promotes efficient specialization. Companies see the correct price signals and have the flexibility to respond with efficient operating and investment decisions.

A critical issue is how much volume should be auctioned. To reduce the government's impact on timber prices, it is important not to auction too much. In our earlier paper, we identified three factors—statistical precision, market thickness, and absence of strategic bidding—that place a limit on the minimum auction volume that achieves reliable market-based prices for all timber. We found that most gains in statistical precision are obtained with moderate auction volume of between 15 and 25 percent, and the gains in terms of precision from auctioning more than 15 to 25 percent diminish rapidly. In terms of market thickness, volumes in this range should be sufficient to generate competitive auctions, so long as the small loggers do not exit the market. Finally, we found that the primary issue in terms of strategic bidding was model specification, not volume, and our analysis suggested that with an appropriately specified model, strategic bidding should not be a major concern.

Our analysis here further supports the conclusion that auctioning a small fraction of timber volume does not create problems as a result of strategic bidding. Indeed, we find that auctioning a small fraction of volume actually reduces the incentive for companies to engage in collusive bidding. As a result, auctioning a small fraction of volume increases competition in the auction, and raises timber revenues.

Thus, we believe that any potential problems with statistical precision, market thickness, and strategic bidding can be addressed by auctioning a volume of between 15 and 25 percent, and we see little reason to believe that there will be substantial improvement in the functioning of the markets at greater levels of volume. Rather, the higher auctioned volume would serve to increase the government's impact on the market, and thereby increase the force of politics rather than economics in determining timber prices. The auctioned volume should be kept low enough to ensure that the long-term tenure holder's dynamic cutting decisions determine prices, not the short-term supply decisions of the Crown.

APPENDIX
ANALYSIS WHEN DOMINANT MILLS HAVE LOCAL MARKET POWER

In the main text, we assumed that the timber auctions are competitive absent collusion. In practice, there are districts where because of large transportation costs the largest mills are able to exercise local market power in the timber auctions. This appendix shows that our main result—that reducing the volume auctioned reduces the incentive to adopt collusive bidding strategies—likely holds true for the same reasons as given in the main text.

We suppose that the world lumber market is competitive, but that some mills can exercise local market power in the timber auctions. A mill's production depends on the quantity of logs it purchases at auction, q_a, and the quantity it acquires from long-term tenures, q_t. The mill recognizes that its long-term tenure marginal cost, $c_t(q_t)$, depends on q_t. In particular, $c_t(q_t)$ is increasing in q_t, since the mill harvests the most economical timber first. Similarly, the mill with market power recognizes that the quantity, q_a, it purchases at auction impacts the price of timber at auction, $p_a(q_a)$, but not the cost from long-term tenure. In particular, $p_a(q_a)$ is increasing in q_a. Hence, we are assuming that the mill does affect the local auction price, but the mill is not sufficiently large to have a significant impact on the price of long-term tenures.

The mill selects quantities q_a and q_t to maximize its profits:

(1)
$$\max_{q_t, q_a} p_l(q_a + q_t) - p_a(q_a)q_a - \int_0^{q_t} c_t(x)dx - \int_0^{q_a+q_t} c_m(x)dx,$$

where p_l, the world price of lumber, is taken as given.

Assuming that the mill has not reached its maximum allowable cut on its long-term tenures, then the problem is unconstrained. The first-order conditions that determine the optimal choices of q_a and q_t are:

(2)
$$p_l = c_t(q_t) + c_m(q_a + q_t),$$
$$p_l = c_a(q_a) + c_m(q_a + q_t), \text{ where } c_a(q_a) = p_a(q_a) + p_a'(q_a)q_a.$$

Examination of the first-order conditions provides much of the intuition for this simple model. The optimal q_a and q_t are such that the marginal cost of acquiring and milling logs is exactly equal to the price of lumber. The marginal cost of acquiring logs from auctions, $c_a(q_a)$, is the auction price, $p_a(q_a)$, plus the term that reflects the mill's market power. In a competitive market, the mill's choice of auction quantity does not affect the auction price, $p_a'(q_a) = 0$. However, when the mill has market power, $p_a'(q_a) > 0$, and the mill has an incentive to reduce its auction quantity as a result of the higher marginal cost of acquiring logs at auction. The size of this distortion from the competitive market depends on two factors: (1) the steepness of the residual supply curve, $p_a'(q_a)$, and (2) the quantity that the mill is purchasing at auction.

The last point provides some intuition for why auctioning a larger volume of timber is unlikely to make the auction market more competitive. Other things being equal, the larger quantity that the mill acquires at auction, the greater is the mill's incentive to reduce the auction price by reducing its acquisition of auctioned timber. Of course, other things are probably not equal as the auction volume increases. For example, it is plausible that the slope of the residual supply curve will be flatter ($p_a'(q_a)$ closer to zero) as the volume increases, since the auction market will be thicker. As the auction volume increases it is likely that more bidders will need to participate in the auction market to satisfy their needs. Still equation (2) shows that the incentive to reduce the auction price grows linearly with the auction

quantity. There needs to be a strong countervailing force, such as a much flatter residual supply curve with larger volume, for market power to be less of a problem as the auction market expands.

The model above assumes that the mill is able to commit to its optimal choice of auction quantity. In practice, mills may have a hard time making such commitments.[5] After the auction has occurred, mills that exercise market power have an incentive to buy additional logs in subsequent markets, since the auction price (and presumably the log market price) is below the mill's marginal cost of acquiring logs from long-term tenures. The mill only has market power to the extent that it can commit to *not* buying additional logs in subsequent markets. Without this commitment, market power is not an issue, and the results from the main text apply.

In sum, although the dominant mills may have a greater *ability* to exercise local market as the volume is reduced, their *incentive* to do so is reduced with the volume, since the lower auction prices have a decreasing impact on the mills' total timber costs. Hence, even when local market power is a problem, it is likely that auctioning a smaller fraction of the timber reduces the incentive for collusive bidding, and thus increases the competitiveness of timber auctions.

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[5] See Ronald H. Coase, "Durability and Monopoly," *Journal of Law and Economics*, 15, 143-149, 1972.