Reserve Prices, Stumpage Fees, and Efficiency

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In this memo, we consider the two goals of the econometric analysis of auction data in British Columbia: setting reserve prices and setting stumpage fees for tenured tracts. We outline the efficiency consequences of accurate reserve prices and stumpage fees. We discuss some of the different considerations that arise in each type of exercise, and the extent to which the goals are in conflict. Then, we analyze more carefully the efficiency objective and how inaccurate stumpage fees can lead to inefficient tract selection. We consider an alternative, where stumpage fees are based on selling prices of forest products derived from long-term tenures, but show that such a system would distort tract selection and thus harm efficiency. We close with recommendations for policy.

1 THE TWO USES OF PREDICTED MARKET PRICES

BC is considering using the data from auctions of timber to predict what market prices should be if a new tract is put up for auction. These predicted prices are used for two distinct purposes. First, if a tract is designated for auction, then the predicted price is used as a benchmark for the reserve price. Second, the predicted price is used to set stumpage fees on timber sold through the tenure system.

1.1 Setting Reserve Prices

Why does it matter if these predicted prices are unbiased and/or precise estimates? Let us start by considering the case where the predicted prices are used to set reserve prices. In other papers, we have laid out a number of costs and benefits of setting reserve prices accurately on a given tract, *assuming that this is an efficient tract to harvest at a given point in time*. In short, prices that are too low can make it more attractive to engage in anticompetitive behavior and they can reduce revenue (by inducing bidders to bid less aggressively). Reserve prices that are too high can lead to tracts that go unsold, potentially because the reserve price failed to factor in aspects of the sale that bidders can see would make it particularly costly to harvest. Too many unsold tracts also can raise issues of upward bias in future estimation of market prices.

However, this discussion does not really focus on the following two questions: (1) is this a better tract to harvest than others, and (2) should this tract be harvested now rather than later. Each tract has a potential economic benefit, through the final product, as well as a production cost, which includes the timber extraction cost. Let S_j be the average selling price of forest products from tract j, and let C_j be the cost of extracting and processing the timber. Then the

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economic benefit to the winner of the auction is $S_j - C_j - B_j$, where B_j is the bid of the winner. Tracts also differ in how fast the timber grows, how productive replanting would be, and other environmental and consumption benefits of leaving the timber standing or removing it (including leisure as well as fire risk). Let F_j be the opportunity cost of harvesting the timber now versus the relatively near future, and let E_j represent the sum of the other factors, where each is ordered so that higher values correspond to higher costs of cutting now. The efficient thing to do is to harvest tracts with the highest net economic gain, including all of those factors. That is, tracts should be harvested that have the highest value of $S_j - C_j - E_j - F_j$. The price at an auction for timber B_j will be proportional to $S_j - C_j$, the benefits through the sale of product less production costs, but will ignore E_j and F_j.

Note first that the more timber is sold at auction, the more responsibility the Ministry takes (as opposed to market participants) for tract selection. This might be good for efficiency, if tracts vary widely in their costs and benefits outside of what is captured in the auction price, and if such costs and benefits are important. On the other hand, it might be bad for efficiency if market participants have, in aggregate, better information about the value of timber and the costs of extraction. Under the tenure system, the timber industry bears more responsibility for tract selection, although the Ministry provides guidance and can still factor in things like environmental concerns. Presumably tenure-holders are concerned about at least some environmental factors, such as risk of fire or insect damage.

Once a set of tracts has been put up for auction, the market has little role in selecting which tracts are harvested. Private firms decide the exact timing of harvest, but only within a narrow window of a couple of years. Only the reserve price serves to allocate tracts; if no bidders are willing to bid more than the reserve price, then the tract goes unsold.

This logic suggests that perhaps reserve prices are an important policy tool for allocating which tracts should be harvested. In other words, the Ministry might auction off more tracts than it expects to sell, and set a reserve price high enough so that a reasonable number of tracts go unsold. The reserve price would incorporate the value $S - C - E$ for a "typical" or even an "advantageous" tract to auction, rather than just the expected value of a particular tract. Only if this tract had a value higher than some cutoff would it be harvested.

However, there are many limitations on using the reserve price in this way. First, because it is expensive to prepare a tract for sale, that cost should be taken into account when comparing the benefit of harvesting a particular tract against another tract that has not yet been prepared. Put another way, there is significant waste in preparing many more tracts for auction than will be harvested. Second, when reserve prices are high enough that a bidder expects a substantial probability of not wishing to win at the reserve, bidders will not be induced to examine tracts, and participation at auctions will fall. This will undermine the competitiveness of auctions. Since expected profits from each auction will fall relative to participation costs, such a system will create incentives for bidders to signal their intentions to make costly investments in bid preparation, to deter opponents.

Now, let us consider the considerations that should enter into the choice of estimation approach when the goal is to find a predicted value that will be used to set the reserve price. For this purpose, predicted values do not have to be precisely accurate, since they are unlikely to determine the final market price. There may, however, be some benefit to calculating the conditional variance of the prediction, that is, determining which sale characteristics lead to relatively precise or imprecise predictions. When the prediction variance is low, the reserve price could be set higher, while when it is high, the reserve price could be set lower. The idea is that the reserve price should balance the risk of an inefficient no-sale (due to an overestimate of the

market value of the tract) against other benefits of a high reserve price. However, such fine-tuning may not be tractable in practice, because of the complexity and "unfairness" of the system.

1.2 Pricing Stumpage on Long-Term Tenures

The issues surrounding pricing stumpage on long-term tenures are similar, but somewhat distinct, from the issues surrounding setting reserve prices. Since the stumpage fees are actual transaction fees, it is more important that stumpage fees be accurate. Further, it is especially important that the stumpage fees are set in a transparent way and are unbiased in aggregate, from the perspective of trade negotiations.

Why is the accuracy of stumpage fees important for efficiency (rather than just for the profits of tenure holders)? Because stumpage fees influence the choices tenure-holders make about which tracts to harvest, and when. The tenure-holders will wish to harvest the tracts within their tenure that maximize the $S_j - C_j - \lambda E_j - F_j - P_j$ (and in particular, where this quantity is positive). That is, tenure-holders will consider the value of the final product less the production/extraction costs, the opportunity cost of cutting the trees in the relatively near future, and P_j, the stumpage fee. The tenure-holders will also consider some environmental concerns, but not all of the externalities and very long-term effects of a cutting decision, which accounts for the parameter λ.

What stumpage fee maximizes efficiency, then? Presumably some administrative adjustments can be made for certain environmental concerns, as an attempt to incorporate E_j (note that could be a subsidy for cutting disease-infected or fire-prone trees, or an environmentally-motivated tax). If E_j is small, then the efficiency-maximizing stumpage fee would be proportional to $S_j - C_j - F_j$. Recall that auction prices are proportional to $S_j - C_j$. Thus, if both F_j and F_j are small, then a stumpage fee proportional to $S_j - C_j$ induces efficient selection among tracts. Note that it is not important that the stumpage fee be equal to $S_j - C_j$ for this purpose, just that it is proportional, so that the highest value of $S_j - C_j - P_j$ corresponds to the highest value of $S_j - C_j$. But, we argued above that auction prices should indeed be proportional to $S_j - C_j$.

If F_j is not small, then stumpage fees based on auction prices may cause some distortion to optimal cutting rules. However, any other stumpage fee that did not incorporate the opportunity cost of waiting a few years to cut the timber would also distort optimal cutting rules. And, relative to a system where the government auctions a larger number of tracts with relatively high reserve prices, there is no additional distortion here, since reserve prices (themselves based on past auction prices) would also ignore F_j. Thus, some other solution (such as administrative adjustments to pricing) would be necessary to fully account for F_j in either a system with 100% of volume auctioned, or a market-based pricing system like the one proposed. The market-based pricing system does better than the 100% auction system, but is still not perfect.

A similar logic follows for incoroporating other externalities E_j, except that the tenure-holders likely put less weight on E_j than on F_j.

To summarize the discussion so far, the market-based pricing system leads tenure-holders to make efficient choices among different tracts, if: (i) the stumpage prices are an accurate measure of the price that would have been paid by the highest bidder in an auction of each tract, (ii) environmental concerns and relative benefits of harvesting certain tracts now versus later do not vary greatly across tracts within a tenure-holders area.

However, note that efficiency requires that the forecast of what the auction price would have been for a given tract. As we have demonstrated elsewhere, the market-based pricing system incorporates prediction errors. If some tracts are over-priced and others under-priced using the

market-based pricing system, then a tenure-holder may no longer select the most efficient tracts for harvest. The magnitude of any distortions depends on the precision of prediction error, and the extent to which that is large relative to efficiency differences among tracts.

Given this discussion, what are the most important considerations for the design of an estimation approach? First, the predicted values should be as precise as possible, but estimates of the variance of the prediction should not affect stumpage rates. All we need to know is the predicted market price. Second, as we have discussed elsewhere, the specification of the pricing equation should be chosen to minimize possibilities for manipulation of stumpage fees through bidding at auctions. Third, it may be important to think more carefully about the specification, functional forms, and out-of-sample predictions, since tenure-holders (and the allocation of tracts) will be directly affected by the predictions. It may be more important as well to have interpretable coefficients, since industry may object to pricing rules that are difficult to understand.

However, the goals of getting the most accurate prediction and having interpretable coefficients may be in conflict. Richer specifications including nonlinear functions of variables and those that involve interaction effects are more difficult to interpret, yet improve predictive power.

2 ALTERNATIVE APPROACHES TO SETTING STUMPAGE FEES

Are there any other possible ways of pricing stumpage using market transactions, besides the use of results from auction data? There are few "market" indicators of the variables C_i, E_i, and F_i. Probably the best way to determine the costs of harvesting a particular tract would be to hold a procurement auction! The idea that environmental benefits may be difficult to price is a very old one. And, the most natural way to learn about the intertemporal costs and benefits of cutting is assign long-term property rights, and then allow them to be priced in a market (e.g. allow trade). If one agent had long-term rights to a tract (which the tenure system accomplishes partially but not fully), then even if the rights were not tradeable, the agent would take F_i into account, as well as many aspects of E_i (but not all externalities).

However, there are potentially other market indicators of S_i. For example, the selling price of the final products that are produced is an *ex post* measure of the value of the timber. Thus, it would in principle be possible to implement a scheme that tied stumpage fees to the selling price of the forest products. This could be implemented like a special tax on products produced from long-term tenures. Of course, such a scheme would entail costly monitoring to ensure compliance, but in principle it would be possible.

What are the disadvantages of such a scheme? Consider the incentives of the tenure-holder in selecting among tracts. If the tenure-holders have expectations about future market values that are unbiased, under this scheme the tenure-holders would choose tracts that maximize

$$(1\text{-}t)S_j - C_j - \lambda E_j - F_j.$$

Compare this to the incentive with the proposed auction-based market pricing system, where they would choose tracts that maximize approximately

$$S_j - C_j - \alpha(S_j - C_j + \varepsilon_j) - \lambda E_j - F_j = (1- \alpha)(S_j - C_j) - \alpha \varepsilon_j - \lambda E_j - F_j.$$

In this expression, we use the approximation that the selling price at auctions is equal to $\alpha(S_j - C_j)$, where $0< \alpha <1$, and ε_j is the prediction error from the pricing equation. Which system more closely approximates the social objective, which is to choose tracts that maximize

$$S_j - C_j - \lambda E_j - F_j ?$$

The tax-based scheme might perform reasonably well if the tax t were very small. That is, if the government doesn't charge *any* tax, so stumpage is free, then the tenure-holder's choices of tracts will not be distorted, except to the extent that the tenure-holder ignores externalities or long-term consequences of cutting. However, the higher is the forest products tax t, the more distorted are the decisions. In particular, the firms will overweight the cost of extraction relative to the value of the products when making tract selection decisions.

On the other hand, the auction-based market pricing system does fairly well when the prediction errors are small, or when α is small (that is, when auction prices are a smaller fraction of profit). In other words, the lower are stumpage fees, the lower is the distortion due to mispricing. However, when the pricing system is fairly accurate, this system creates balanced incentives for cutting, in terms of how selling values and production costs are weighed. Furthermore, the incentives are correct on average; that is, we do not expect to see systematic over- or under-weighting of production costs in tract selection, as would be the case with the tax-based system.

Finally, we observe that in both schemes, if E_j is large and positive across all tracts and if $0<\lambda<1$, then in addition to the negative effects to distortion already discussed, there is an effect where larger stumpage fees help align the social incentive to cut with the tenure-holders, since they bring the magnitude of $S_j - C_j$ more into proportion with λE_j.

3 CONCLUSION

This paper has discussed the dual uses of predicted prices from auction data, namely (i) setting reserve prices and (ii) setting stumpage fees. We found that the considerations arising from these two objectives are similar, but there are a few differences. Accuracy is more important for setting stumpage fees, but at the same time, political forces may favor more interpretable regression coefficients. Thus, the tradeoff between these considerations should be carefully managed. Next, we discussed in greater detail the reasons that accuracy is important from an efficiency perspective.

Finally, we compare the auction-based pricing system for stumpage with an alternative, where stumpage fees are replaced with a tax on forest products from long-term tenures. The latter proposal would eliminate the need for a large auction volume, but has several important disadvantages. First, it would require careful monitoring, and separation of final products according to the source of timber supply. Second, if extraction and processing costs vary widely by tract, which we believe they do, then the tax-based system will lead to inefficient tract selection. Only if the prediction errors from the auction-based system are very large relative to the variation in extraction costs across tracts could the tax-based system be preferred.