Testing for Anti-Competitive Bidding in Auction Markets

Memo from Market Design Inc. and Criterion Auctions to the British Columbia Ministry of Forests
13 March 2002

1   INTRODUCTION

The British Columbian Ministry of Forests proposed an auction design to achieve fair market prices for its standing timber. Because the Crown owns almost all the standing timber in British Columbia, the Ministry proposed to auction a portion of that timber, and use the auction prices to set stumpage rates for timber under long-term tenure. In this manner, the private industry, and not the Crown, will set the supply and equilibrium price of timber in British Columbia. Once implemented, we believe that this market will function properly. However, the Ministry must pay careful attention to bidder's actions at auction to ensure that competition is strong. In particular, because auction prices are used to price tenured stands, a tenure holder may have incentive to alter auction prices, and thus modify the equation that determines stumpage rates for tenured timber in its favor. Thus, the Ministry must monitor carefully the auction market for cheating or collusion. Testing for the effects of collusion in auctions often proves difficult even when *a-priori* knowledge of cheating is available. Still, certain general methods are available to test for the most common form of collusion in auctions.

2   TYPES OF ANTI-COMPETITIVE BIDDING

Collusion between bidders[1] is the most common form of cheating in auction markets.[2] Under this form of collusion, bidders conspire to withhold bids at auction, or submit non-competitive, or "phantom" bids. Historically, collusion in auctions has taken one of several forms. We define these schemes and their payment methods below.

- "Identical Bids": All firms submit identical bids, typically at the upset price or just above it. This is perhaps the most obvious type of collusion. After the U.S. Federal Trade Commission prosecuted numerous cases of identical bidding in the mid-twentieth century, this scheme is less common in the U.S., especially in markets where scrutiny is high.

- "Bid Rotation Schemes": Here, two or more firms decide not to bid against each other. In the simplest version of this scheme, ring members simply take turns, in order, being the sole ring member to bid. More sophisticated versions use some other feature of the auction to determine which member gets to bid. A famous U.S. case involved four firms coordinating on the "phases of the moon," where the phase of the moon at the time of the auction determined whose turn it was to bid.

- "Sophisticated Bid Rotation": Firms communicate with each other about tracts they would particularly like to bid on, and tally how many sales each firm has won, making sure that they "balance out" over time. This type of scheme is more efficient than simple bid rotation

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[1] Often referred to as the formation of "bidding rings" or "cartels."

[2] The other form of cheating, which is far less prevalent, is cheating between a bidder and the auctioneer. For example, an auctioneer may introduce a fake bid at favorable terms for a dishonest bidder in exchange for a kickback. This form of cheating appears to be impossible in the British Columbian auctions, however, because the Ministry already uses numerous auctioneers in each individual auction, and each auctioneer records the bids at a public bidding procedure. This form of monitoring should eliminates the possibility that bidder-auctioneer cheating could occur undetected.

schemes, but requires more coordination and communication, increasing the likelihood that collusion is discovered.

- "Kickbacks": This technique can be used in combination with sophisticated bid rotation schemes. A firm that indicates special interest in a particular auction pays bribes or kickbacks to other firms to keep them from bidding aggressively.

- "Knockout Auctions": This type of scheme can be even more complicated and efficient than sophisticated bid rotation with kickbacks. A group of bidders select one "serious" bidder by holding an auction among the cartel for the right to be the serious bidder. The winner pays the losers, and then goes to the auction as the only active bidder from the group. This scheme has been identified in real estate auctions in the U.S., for example.

- "Phantom Bidding": This technique can be used in combination with the schemes outlined above. In order to avoid detection, bidders coordinate on the amount of the "serious" bid, and then "non-serious" bidders place lower bids. This technique requires more communication and explicit discussion of prices, but makes collusion more difficult to detect statistically.

- "Threat of Bidding Wars": This technique can be used to support the schemes outlined above. In order to deter bidders from "deviating" from a collusive agreement, there must be some punishment for deviant bidders. The most natural punishment is that collusion temporarily breaks down, and a "bidding war" ensues, whereby the collusive scheme is broken, and all firms pay high prices.

Because the above scenarios are complicated at first reading, an example might clarify the basic points. Suppose two firms, Firm A and Firm B, are interested in bidding for a stand. In an honest auction with an upset price of $20, Firm A would submit a bid as high as $30. Firm B values the stand at more than $30, but does not want to compete against Firm A. Firm B suggests that Firm A simply not bid on the stand, and Firm B will submit an uncontested bid of $20. Firm B then will either allow Firm A to win a stand uncontested in the future (bid rotation), or make a kickback to Firm A. Alternatively, Firm A could submit a bid of $20, and Firm B could submit a bid of $21 (phantom bidding). The main point of this example is clear. Bidding rings artificially reduce auction prices, and can therefore undermine the timber pricing mechanism that British Columbia proposed.

3   LESSONS FROM U.S. ANTI-TRUST ENFORCEMENT

In the U.S., the majority of successfully prosecuted price-fixing and bid-rigging cases rely on some sort of "paper trail." That is, authorities become aware of a cartel, and further investigation turns up evidence that firms were meeting and/or explicitly communicating about prices (this practice is explicitly illegal in the United States). The more sophisticated types of collusion provide more profits to dishonest firms, but are also more likely to leave a "paper trail," because increased coordination is required.

In the 1990s, the U.S. Department of Justice instituted a "leniency" program that was credited with the eventual prosecution of a number of major price-fixing cases. In this program, the *first* member of a cartel to "fink" to the Justice department and provide evidence of price-fixing, received leniency. All other members of the cartel were prosecuted, even if they offered to cooperate with authorities. This type of program has a number of attractive features. Firms would hesitate before engaging in sophisticated collusion that leaves a paper trail, requires ongoing communication, or leaves other evidence, for fear of being "turned in" to a leniency program.

In the B.C. timber auctions, there are many potential participants in local markets. Involving all participants in a bidding ring would likely leave some trail. Some of these participants are small logging firms. For the loggers, one auction is relatively large compared to the firm size, and some firms may not anticipate staying in the market for very long horizons. The threat of using the leniency program could lead to instability within the bidding ring. At any time, a disgruntled logger could bring down the whole cartel. If there are threats of criminal penalties to cartel participants, bidding-rings may be even less likely to form.

A final lesson we can take from U.S. enforcement of anti-competitive laws, regards statistical tests for collusion. In the United States, such statistical tests have typically been implemented *after* authorities uncover, through other means, knowledge of a conspiracy. Statistical methods have also been used to calculate damages from a known conspiracy, and, of course, statistical tests serve a useful role in flagging potential cases of collusion. However, we would expect that the most successful anti-collusion program would use a combination of statistical tests and other types of investigative activity to police the market.

Having substantial penalties for collusion—including criminal penalties—and making the bidders aware of the penalties can play an important role in discouraging collusive behavior. Penalties are especially effective in discouraging collusion at large companies, since the employees of the large companies rarely would benefit sufficiently from the collusion to risk such penalties. Penalties are less effective with tiny logging companies, and indeed such companies have been known to rely on violence to enforce collusive arrangements and prevent honest loggers from turning state's evidence.

4   AN OVERVIEW OF STATISTICAL TESTS FOR COLLUSION

An overall approach to testing for collusion builds on the following principles. First, collusive behavior in a particular area[3] should lead to differences in auction performance between different areas at a point in time. Put differently, if a cartel colludes over a wider area, auctions where these firms participate should appear different in some ways. Second, if a market starts out competitive, but eventually falls into a state of collusion, we should see changes over time in auction performance within the area where the colluding firms participate, *relative to* changes over time in the competitive areas.

What aspects of auction performance are most important? As suggested above, collusive behavior should lead to changes in participation (simple and sophisticated bid rotation, kickbacks, and knockout auctions), or to changes in the distribution of bids (phantom bidding). We might see many sales going for just above the reserve price, yet never see auctions void of bids. If the bidders' true valuations are distributed in the neighborhood of the reserve price, we would expect some auctions to go unsold. In some schemes (e.g. simple bid rotation), collusion may lead to unusual patterns in terms of the sequence of bidders that win successive auctions.

These principles suggest a number of potential tests, where some aspect of auction performance (number of bidders, ratio of selling price to reserve price, dispersion of bids, etc) is compared either across geographic areas (or across auctions with different major licensees bidding), or over time. Before proceeding, we raise a few issues that arise in either making comparisons among auctions at a point in time, or in looking for changes over time.

But the researcher should pay careful attention to stand characteristics, so as not to wrongfully conclude that collusion exists. To clarify, when making comparisons among auctions at a point in time, it is difficult to refute the hypothesis that some geographical areas just have different characteristics than

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[3] "Area" simply indicates a group of auctions that share a commonality. It could indicate all stands in a forest region, or it could indicate a series of timber stands, not necessarily in the same region, where two tenure holders operate in close proximity.

others. Geography may cause differences in the distribution of values, or the degree of specialization of the mills. We expect competition to be stronger in some areas than others. Thus, before drawing conclusions based on such comparisons, some qualitative evidence will probably be necessary. (The better-specified the pricing equation, the easier this will be. In the best case, after controlling for variables included in the equation, auction performance will look similar in different Forest Regions.)

Second, when analyzing changes in auction performance over time, it is important to account for the fact that market changes that have nothing to do with collusion may also occur. One way to account for market conditions is to look at changes over time in a "suspect" region or for a "suspect" firm, and compare those changes to some "control" region or "control" set of firms that are closely linked with the "suspect" entity. However, it might also make sense to choose a narrow control group that has more attributes in common with the "suspect" region or firm. Indeed, when an authority suspects collusion, it generally suspects at least one bidder or region from the outset. Thus, it may make sense to start with a limiting control, and then "branch out" as more information is unearthed.

These principles can be applied to any measure of auction performance. Below, we suggest some specific tests to uncover particular types of cartel behavior. However, we note that statistical anomalies always occur in auction markets. Hence, statistical results cannot alone serve as evidence of collusion. Rather, they should be used as a guide to better police anti-competitive bidding in the auctions.

5   A SIMPLE TEST FOR BID WITHHOLDING

Suppose we have suspicion of a bid rotation scheme, and suspect that at least one tenured firm is "withholding" its bids at auction. To test for bid withholding, we might first consider the decision of the suspect, firm, call it Firm Y, to submit a bid for a timber stand. First, Firm Y might bid if the timber stand was located near one of its integrated mills. Second, the firm may bid if current auction prices are below the expected stumpage rate for that firm's tenured stands in the future.[4] Other characteristics unrelated to collusion may also affect a tenure holder's propensity to bid at auction. If Firm Y was withholding it's bid at auction because it was part of a bidding ring, then competition from another firm would also explain Firm Y's decision to bid. In particular, did another firm, call it Firm X, submit a bid in the auction? If we find that Firm Y was less likely to bid in auctions where Firm X bid, then we have found preliminary evidence that Firm Y is withholding its bids against Firm X.

Formally, we might estimate equation 1 using either a Probit or Logit technique:

(1) $prob_i(bid_l) = a_0 + a_1 p_l^a + a_2 p_l^t + Zk + u_l$

In equation (1), l is an index for the particular auction stand. Thus, we are attempting to estimate the probability that bidder i submits a bid in auction lot l. Let p_l^a denote recent auction prices of stands similar to stand l, and let p_l^t denote the forward-looking price of tenured timber with similar characteristics as stand l. Z is a $1 \times j$ row vector of indicator variables that identify all bidders that i might compete against at auction, and k is a $j \times 1$ column vector of coefficients. Finally, u_l is a disturbance term drawn from a random sample. Upon estimating equation (1) we might find that a coefficient on one of the competitor dummy variables is highly negative and statistically significant. This would indicate that bidder i was significantly less likely to compete in auctions against this competitor. Thus, we have found *preliminary* evidence of bid withholding.

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[4] Note, that auctioned timber will be cut in the future, whereas tenured stands may be cut now. Thus, the tenure holder is more likely to bid at auction if current auction prices are below its expected price for tenured timber in the same time period as when the auctioned timber can be cut.

In interpreting the results of such a test, several caveats apply. First, Firms X and Y may specialize in different types of tracts, or on different locations. This could account for the negative correlation in their participation. On the other hand, if Firms X and Y are similar, then we would expect them to bid against one another in auctions where they are both within reasonable proximity. Thus, we expect to see a positive coefficient on Firm X's dummy variable if the market is competitive. Our point is that the "null hypothesis" of what behavior should look like in the absence of collusion depends on the relationships among the firms.

6   TESTING FOR PHANTOM BIDDING

The method described above will not effectively uncover phantom bidding, because firms involved in the bidding ring are clever enough to place fake bids that paint the façade of a competitive auction. Thus, a different test is required. Typically, researchers have attempted to test for a structural change in the bidding function or the bid distribution to determine if such cheating has occurred.[5] These tests can be quite involved, but simple examples do exist.

Consider the stumpage equation that the ministry currently uses to set upset prices in the Small Business Forest Enterprises Program (SBFEP). That equation estimates the value of a timber stand, at auction, based on a series of cost and value variables. One could reasonably posit that the relationship between those explanatory variables and the stumpage rate would be distorted under collusion. The relationship that would most obviously be distorted is that between the number of bidders at auction, and the stumpage rate. In particular, the coefficient on the number of bidders variable should be smaller (less positive) if cheating occurs, because increasing the number of bidders does not increase competition to the same degree as in an honest auction.

Thus, if the Ministry suspects Firm X, Firm Y, and Firm Z of participating in a bidding ring, it can create an indicator variable that equals one when all of those firms bid at auction.[6] Interacting this dummy variable with the number of bidders variable, and perhaps other explanatory variables, is one possible way to test for a bidding ring. If the coefficient on the interaction between the Firms X, Y, Z indicator variable and the number of bidders variable is negative and statistically significant, then *preliminary* evidence of a bidding ring may exist.

7   OTHER GUIDELINES FOR SCRUTINY

The statistical tests outlined above can be used to identify geographic areas or groups of firms that merit further scrutiny. Our research on strategic bidding also suggests another way to select areas or firms for scrutiny. In particular, special attention should be paid to areas where local market power may be a problem, as measured by Herfindahl indices. In addition, our analysis of the incentives for strategic bidding identifies certain districts where local auction prices have a larger-than-average effect on local stumpage fees under long-term tenures. Thus, those districts should also receive special monitoring.

8   CHANGES IN MARKET STRUCTURE

An important component of deterring or limiting collusion is the participation of small loggers. Thus, the Ministry should closely monitor the entry, exit, and participation of these firms. If the loggers begin to

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[5] Porter and Zona, *Journal of Political Economy*, 101(3), 518, follow this general method to test for cheating in auctions for New York State highway construction contracts.

[6] Another idea would be to create an indicator variable that equals one when the stand is near tenured tracts for all three bidders. This indicates that all three bidders are potential bidders in the auction, even if not all three firms submit bids.

exit the industry, or complain about the major licensees manipulating log prices, scrutiny should be applied. One solution would be to maintain some small-business set-aside sales. This would promote the economic activity of the loggers who would, presumably, continue to bid in auctions against the tenure holders.

9   DATA COLLECTION

Currently, the Ministry does an excellent job of maintaining its database for the SBFEP auctions. However, additional variables should be compiled on a going forward basis, because certain tests require information that the Ministry does not currently maintain. In particular, the entire distribution of bids, and the identities of all bidders[7] should be maintained in the database. To the extent that it is feasible, the ministry may also want to construct a measure of "potential bidders,"—that is the bidders it believes might have immediate interest in the stand. For certain stands this information may be obvious, but more elusive for other auctions. Still, when this information is readily available, it should be recorded. In addition, the date that the auction occurs, and the effective date of the stand should be recorded (if they are not already), because certain collusive schemes may revolve around either or both of these dates. Finally, the Ministry, having the most internal knowledge of this market, might attempt to predict a possible collusive scheme, and determine if certain data would be needed to monitor such corruption.

10   FINAL NOTES

Tests for bid rigging are most useful when *a-priori* knowledge of cheating exists. Then, the tests are generally used to estimate the damages incurred because of collusion. Above, we propose methods to detect bid rigging. If these methods lead the researcher to conclude that evidence of bid rigging exists, then formal actions should be taken to obtain hard evidence of anti-competitive practices. In general, statistical results do not offer irrefutable evidence that bid rigging occurred, because statistical anomalies always exist, at least in probability. However, statistical tests can be used to raise "flags" that certain areas or firms might deserve further scrutiny, and passing such statistical tests can provide some confidence that the auction market is performing well.

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[7] The easiest way to maintain bidder identities is with a unique identification number, as the ministry currently does with loggers in the SBFEP auctions.