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Bidder Collusion and Antitrust Law: Refining the Analysis of Price Fixing to Account for the Special Features of Auction Markets

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BIDDER COLLUSION AND ANTITRUST LAW: REFINING THE ANALYSIS OF PRICE FIXING TO ACCOUNT FOR THE SPECIAL FEATURES OF AUCTION MARKETS

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I. INTRODUCTION

Courts and commentators have painstakingly analyzed antitrust policy toward horizontal price fixing, but surprisingly, one of the most common forms of price fixing—bidder collusion—has escaped the sustained attention of antitrust lawyers.[1] We attribute this inattention to the mistaken belief that the economics of bidder collusion is essentially equivalent to the economics of price fixing in posted-price markets. However, there are significant differences regarding the economics of collusion in auction and procurement markets as compared to posted-price markets, and we derive antitrust policy recommendations that apply specifically to bidder collusion in this article.[2]

The law governing bidder collusion was settled long ago. It falls within the ambit of the per se condemnation of agreements by horizontal

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[1] For example, Hovenkamp's extensive discussion of cheating in cartels covers posted-price and negotiated-price markets but makes only brief mention of auctions. HERBERT HOVENKAMP, FEDERAL ANTITRUST POLICY: THE LAW OF COMPETITION AND ITS PRACTICE 147–53 (2d ed. 1999).

[2] Auctions have become increasingly popular in recent years. *See* Robert C. Marshall & Michael J. Meurer, *The Economics of Auctions and Bidder Collusion, in* GAME THEORY AND BUSINESS APPLICATIONS 339, 339 (Kalyan Chatterjee & William F. Samuelson eds., 2001); Paul Klemperer, *What Really Matters in Auction Design*, 16 J. ECON. PERSP., Winter 2002, at 169, 169.

competitors to fix prices.[3] Horizontal price fixing was first condemned in *United States v. Trans-Missouri Freight Association.*[4] The defendants were competing railroads that established an association that set freight rates for its members. The collusive agreement in this posted-price market matches the canonical example of price fixing in antitrust treatises.[5] In posted-price markets, sellers[6] specify a price or price list at which they sell their products, and the buyers understand that the posted prices are not negotiable. The ban against horizontal price fixing was extended to auction and procurement markets in *Addyston Pipe & Steel Co. v. United States.*[7] The Supreme Court found bid rigging violated the Sherman Act on a theory that evolved into the per se rule.[8] The affected market in that case was iron sewer pipe procured by local governments in sealed-bid auctions. The defendants colluded by allocating territories and rigging bids.

We look back to these cases because they shed some light on an anomalous feature of antitrust theory. Antitrust commentators see *Addyston Pipe* as equivalent to *Trans-Missouri* in terms of anticompetitive effect. They also see *Addyston Pipe* as the prototypical case of bidder collusion.[9] Many auction and procurement markets are not very much like the market in *Addyston Pipe.* And the reasoning that guides antitrust

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[3] Addyston Pipe & Steel Co. v. United States, 175 U.S. 211, 237 (1899). The per se rule and rule of reason seem to be melding together to form a continuous standard in horizontal restraint cases, but even under this modern treatment bid rigging is subject to "virtually summary disposition." *See* William E. Kovacic, *Illegal Agreements with Competitors,* 57 ANTITRUST L.J. 517, 528 (1988). The following activities are considered bid rigging: joint bidding, bid rotation, inspecting competitors' bids before the auction, territorial and customer allocation. *See id.* at 530–31. Judge Posner notes that 90% of the prison sentences for violation of antitrust law arise in bid-rigging cases. RICHARD A. POSNER, ANTITRUST LAW 44 n.29 (2d ed. 2001).

[4] 166 U.S. 290 (1897).

[5] *See, e.g.,* HOVENKAMP, *supra* note 1, at 144–53.

[6] Posted-price markets less commonly involve buyers posting a price and facing a large number of sellers. The best examples are labor markets.

[7] 175 U.S. 211 (1899). The ring first agreed on a sales price and then conducted a private procurement exclusively among ring members, known as a knockout, to see who would be the winner and active bidder for the ring at the auction.

[8] The per se rule against price fixing was fashioned later in *United States v. Trenton Potteries Co.,* 273 U.S. 392 (1927), and *United States v. Socony-Vacuum Oil Co.,* 310 U.S. 150 (1940). *See* KEITH N. HYLTON, ANTITRUST LAW: ECONOMIC THEORY AND COMMON LAW EVOLUTION 98–112 (2003).

[9] *See, e.g.,* James L. Langenfeld & Louis Silvia, *Federal Trade Commission Horizontal Restraint Cases: An Economic Perspective,* 61 ANTITRUST L.J. 653, 659 (1993) ("*Addyston Pipe* can be considered the archetypical traditional collusion theory case."); POSNER, *supra* note 3, at 78, 87 (discussion of bid rigging in sealed-bid procurements but no discussion of ascending bid auctions); Robert C. Marshall & Leslie M. Marx, Inefficiency of Collusion at English Auctions (2004), *available at* http://faculty.fuqua.duke.edu/~marx/bio/papers.html (Antitrust enforcers heavily emphasize the threat of collusion at sealed-bid procurements but

policy toward price fixing in cases like *Trans-Missouri* should not be applied without reflection to bidder collusion cases. We address four main points.

First, two of the most commonly employed auction schemes differ greatly in terms of their susceptibility to collusion.[10] A *first-price* auction is a sealed-bid auction in which the high bidder wins and pays the amount of his bid. The sealed-bid procurements in *Addyston Pipe* were first-price procurements. The other auction is the oral ascending bid auction, which is also known as the English auction. First-price sealed-bid auctions[11] share many of the properties of posted-price markets in terms of their vulnerability to collusion—it can occur, and often does, but not without considerable cost and effort by the cartel members. By contrast, oral ascending bid auctions are much more vulnerable to collusion. We recommend that enforcement authorities carefully scrutinize oral ascending bid auctions for signs of collusion.[12]

Several related factors make collusion harder at first-price sealed-bid auctions than oral ascending bid auctions. A key to understanding the difference between auction formats is the presence or absence of *shading* by the bidder representing the bidding ring. At a first-price sealed-bid auction the payoff from winning equals the gap between a bidder's valuation of winning and his bid. The bidder gets no profit unless he shades his bid below his valuation. A bidding ring, unconcerned about defection, achieves greater profit for ring members by shading the ring bids below their noncooperative level. But, this increased shading makes the bid of the highest valuation ring member vulnerable to defection by another ring member. In contrast, the bidder selected to win for a ring at an oral ascending bid auction remains willing to bid up to his valuation, leaving no room for profitable defection by another ring member.[13]

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virtually ignore collusion at ascending bid auctions. One explanation is that sealed-bid auctions leave more evidence in the form of bids by every bidder.)

[10] *See* Marc S. Robinson, *Collusion and the Choice of Auction*, 16 RAND J. ECON. 141 (1985) (conjecturing that collusion is easier to sustain at second-price than first-price auctions); *see also* Robert C. Marshall & Leslie M. Marx, Bidder Collusion, Proposition 1, at 15 (rev. 2004), *available at* http://faculty.fuqua.duke.edu/~marx/bio/papers.html. In a second-price sealed-bid auction the bidder submitting the highest bid wins and pays the amount of the second highest bid. For simplicity, second-price sealed-bid auctions are only discussed in footnotes.

[11] Hereafter, for brevity, we usually omit the term procurement, but our comments apply to both auctions and procurements unless we note otherwise.

[12] On-line descending bid procurements (sometimes called reverse auctions) are strategically equivalent to the oral ascending bid auction and share its susceptibility to collusion.

[13] *See* Robert C. Marshall & Daniel A. Graham, *Collusive Bidder Behavior at Single Object Second-Price and English Auctions*, 95 J. POL. ECON. 1217 (1987) (demonstrating collusion

The need to shade the winning bid at a first-price auction makes it more difficult for a ring to detect and punish defectors. As noted by Stigler, the inability to detect deviant pricing by cartel members is the fundamental challenge to cartel stability.[14] When there are many bidders at an auction, some inside the ring and some outside, the ring at a first-price sealed-bid auction has trouble detecting whether they lost at an auction because they were genuinely outbid by a non-cartel bidder, or alternatively, because a ring member cheated, for example, by using a surrogate bidder at the auction.[15] The absence of shading makes a ring at an oral ascending bid auction less vulnerable to surrogate bids.[16] The greater vulnerability of rings at first-price auctions means they are similar to posted-price markets in that collusion requires significant coordination and often leaves a substantial paper trail or other evidence of collusion, making it easier for the antitrust enforcement agencies to detect and punish colluding bidders.

Second, the economics of bidder collusion differs from the economics of collusion in posted-price markets because these pricing institutions endogenously arise from different economic environments. Posted prices are usually found in markets with relatively simple products and numerous, anonymous, and low-volume buyers who passively take the price as given. The market in *Trans-Missouri* fits this description; the railroads posted prices for farmers and other low-volume customers who had simple, standardized shipping needs. Although the market in *Addyston Pipe* had similar characteristics (i.e., a large number of local governments conducted small-volume procurement of relatively standardized sewer pipe), many auctions and procurements take place in markets with informationally complex products. Examples include oil tract leases, used machinery, electromagnetic spectrum, antiques, weapon systems, timber, and art. Buyers and sellers need to gather and use specialized information to evaluate the products subject to transaction. When two equally well-informed bidders confront each other noncooperatively at an auction they will bid out the full value of the information they have acquired. This diminishes the incentive for noncooperative bidders to gather information. Thus, the inherent trade-off: Collusion preserves the informa-

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at second-price and English auctions is profitable without repeated play); Marshall & Marx, *supra* note 10 (presenting a formal comparison of collusion between second-price and first-price auctions that shows the relative vulnerability of the former to bidder collusion).

[14] *See* George J. Stigler, *A Theory of Oligopoly*, 72 J. POL. ECON. 44 (1964).

[15] Depending on the context, a defector might disguise his bid by using a "shill" bidder at the auction or by secretly contracting with an outside bidder.

[16] The possibility that a ring member can cheat by using a shill (disguised) bid makes collusion especially difficult at sealed-bid auctions but does not affect collusion at English auctions. *See* Marshall & Marx, *supra* note 10.

tional rent and preserves the incentive to gather information, but once "competitors" conspire to suppress rivalry, socially undesirable effects follow. This trade-off should be kept in mind by courts and the antitrust enforcement agencies as they seek to characterize the social impact of joint bidding.[17] In environments where there is no opportunity to pursue a legally sanctioned joint venture, it is reasonable for the courts to evaluate the merits of this trade-off.[18]

Third, private enforcement provides a socially valuable complement to public enforcement. However, an important class of potential plaintiffs, non-colluding competing bidders, possibly face a standing barrier that retards private enforcement. Antitrust law tends to disfavor suits by competitors out of fear that a competitor's incentive to bring a suit is not closely aligned with social incentives to bring a suit.[19] Suits that are inconsistent with antitrust policy goals are blocked by standing rules, especially the antitrust injury doctrine. This doctrine, developed in the context of posted-price markets, should be relaxed in certain auction markets because non-colluding bidders sometimes have incentives to sue that match social incentives.

Non-colluding bidders may be harmed by bidder collusion in two ways. First, auctioneers and procurers often combat cartels by being more aggressive in their use of reserve prices. A higher reserve price in an auction may result in non-cartel bidders being denied an item that they would have won in the absence of the cartel. Second, when the commodity is informationally complex, bidder collusion may create a better-informed bidder relative to the non-colluding bidders. Non-colluding bidders will realize that winning against better-informed colluding bidders is "bad news." Consequently, timid bidding by non-cartel bidders implies they will lose items that they would have won in the absence of collusion.

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[17] Auctioneers should also consider the impact of joint bidding on the incentive to gather information.

[18] Surprisingly, bidder collusion potentially creates two social benefits. First, it may be a source of countervailing power at auctions run by a monopoly seller or procurements run by a monopsony buyer. Second, it may provide necessary incentives for socially valuable investment in information production. *See* Marshall & Meurer, *supra* note 2, at 360–61.

[19] *See generally* Roger D. Blair & Jeffrey L. Harrison, *Rethinking Antitrust Injury*, 42 VAND. L. REV. 1539 (1989). This danger is great when the defendants allegedly engage in a horizontal restraint. *See* Joseph F. Brodley, *Antitrust Standing in Private Merger Cases: Reconciling Private Incentives and Public Enforcement Goals*, 94 MICH. L. REV. 1, 50 (1995) ("[W]e normally assume that competitors will benefit from collusion in their market . . . ."). Nevertheless, there are circumstances in which competitors do meet the standing requirements to bring a suit challenging a horizontal restraint. *See id.* at 46, 49–50 (competitors may face exclusionary tactics from new firms created by a merger, and thus may be suitable antitrust plaintiffs).

Finally, recognizing that optimal antitrust enforcement cannot deter all bidder collusion, auctioneers should account for the risk of collusion when designing an auction. Focusing on government timber and mobile phone spectrum auctions, we identify factors that should guide government agencies when they choose an auction or procurement method. We explain that auction design calls for difficult trade-offs: although ascending bid auctions create a greater risk of collusion, they have social welfare advantages over sealed-bid auctions that might offset the risk.

II. COMPARISON OF COLLUSION IN POSTED-PRICE, FIRST-PRICE SEALED-BID AUCTION, AND ENGLISH AUCTION MARKETS

In this section we explain why oral ascending bid auctions tend to be more susceptible to collusion than first-price sealed-bid auctions or posted-price markets. There are two issues antitrust economists recognize as relevant to an analysis of bidder collusion. First, collusion might be easier to sustain in auction markets because prices and quantities are easily observed. This transparency encourages collusion because it makes cheating more difficult.[20] Second, collusion at an oral ascending bid auction is facilitated by the opportunity for the ring to respond to deviant behavior while the auction is still in progress. Instead, we emphasize a different issue—oral ascending bid auctions are more susceptible to collusion than first-price sealed-bid auctions because of the differences in the payment rule for each.[21]

A. COLLUSION IN POSTED-PRICE MARKETS

Besides the hazard of antitrust litigation, firms face other obstacles to collusion in posted-price markets. They may have trouble agreeing on a collusive price or how to divide a market. However, the most difficult obstacle arises because cartel members are tempted to cheat on cartel rules by exceeding their output quota and undercutting the collusive

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[20] For example, Hovenkamp notes the transparency in typical auction markets and concludes: "Cheating is most difficult (and cartels therefore most successful) in auction markets . . . ." HOVENKAMP, *supra* note 1, at 150.

[21] There is little difference between the first-price sealed-bid and the second-price sealed-bid auctions (defined *supra* note 10) in terms of transparency and the opportunity to respond to deviant behavior in real time. Nevertheless, the second-price sealed-bid auction shares essentially the same susceptibility to collusion as the oral ascending bid auction. Note that the price paid at an oral ascending bid auction is the amount at which the second-highest valuing bidder drops out, and that this is the same as the price paid at the second-price auction (up to a bid increment). These comparisons highlight the importance of the payment rule as opposed to transparency and real-time response capability for the susceptibility of an auction scheme to collusive bidding.

price.[22] A cheater hopes to gain the benefit from the high cartel price by drawing customers away from other cartel members by offering discounts to buyers. In markets that last a single period or have a brief duration, the temptation to cheat is inexorable: cheating is the most profitable strategy for each firm regardless of what rival firms do. Repeated interaction is usually necessary to overcome the temptation to cheat because repetition encourages cartel members to trust each other to obey cartel rules and gives members a chance to punish any cheaters.[23] Of course, cheaters can only be punished after cheating is detected.[24] Even for cartels operating in multiple periods for long durations, the possibility of secret price concessions makes collusion precarious.[25]

B. COLLUSION AT ENGLISH (ASCENDING BID) AUCTIONS

Ex ante, collusion is successful if the ring's expected payment for an item is reduced compared to non-collusive bidding. At an English auction the ring's expected payment is depressed by suppressing the bids of all ring members except the one with highest valuation. The ring member with highest valuation continues to bid as he did noncooperatively. This leaves no room for cheating by ring members without the highest valuation, and implies that English auctions are especially vulnerable to collusion. In contrast, bidding rings at first-price sealed-bid auctions face a risk of cheating similar to the risk faced by cartels in posted-price markets.[26]

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[22] *See* Stigler, *supra* note 14.

[23] Punishment strategies used to enforce cartel prices are described in Ian Ayres, *How Cartels Punish: A Structural Theory of Self-Enforcing Collusion*, 87 COLUM. L. REV. 295 (1987). A famous result in game theory known as the Folk Theorem establishes the link between repetition and collusion. The Folk Theorem (so named because it was known to many economists before it was formally stated), when applied to the environment considered herein, holds that if bidders at an auction are sufficiently patient, if auctions are repeated indefinitely, and if enough information is revealed to bidders at the end of each auction, then collusion is an equilibrium. The value of repetition is that it discourages cheating. A potential cheater can earn a short-run gain from cheating until his cheating is detected. Detection leads to punishment by the cartel and the loss of the long-term benefits from collusion. For a sufficiently patient bidder the long-term gains of collusion will outweigh the short-term gains from cheating, and cheating is deterred.

[24] Actually, cartels can ward off secret output expansion by responding to a decline in the market price with a generalized punishment phase consisting of competitive pricing. *See* Edward J. Green & Robert H. Porter, *Noncooperative Collusion Under Imperfect Price Information*, 52 ECONOMETRICA 87 (1984).

[25] One more condition usually necessary for collusion is that firms are sufficiently patient. A firm can be deterred from cheating today by the threat of future punishment, but that threat is not typically effective against an impatient firm that heavily discounts future profit compared to current profit.

[26] *See* Marshall & Marx, *supra* note 10 (formal comparison of collusion between second- and first-price auctions); Robinson, *supra* note 10 (collusion easier to sustain at second-price than first-price auctions).

To build some intuition about collusion at auctions we start with a simple example. Suppose there are three bidders, *X*, *Y*, and *Z*, ready to participate in an English (oral ascending bid) auction. Bidder *X* has a valuation of 5, bidder *Y* has a valuation of 4, and bidder *Z* has a valuation of 3, the bidders know each other's valuation,[27] but the auctioneer only knows the distributions from which the bidders draw their valuations. If the bidders do not collude, then *X* will win the auction and pay 4. Bidders *Y* and *X* remain active in the English auction until the bidding reaches 4, at which time bidder *Y* drops out and bidder *X* wins.

Now consider what happens if various sets of bidders collude. First, suppose the pair *X* and *Z*, or the pair *Y* and *Z*, collude; neither of these collusive rings has an effect on the auction outcome. In either case, bidder *X* wins and pays a price of 4. An effective ring must contain the two high valuation bidders, *X* and *Y*. If *X* and *Y* form a ring but *Z* is excluded, then *X* will win the item for a bid of 3. The auctioneer's revenue falls from 4 to 3, and there is a collusive gain of 1. *X* has to beat non-colluding bidder *Z* and persuade bidder *Y* not to bid, or at least bid nothing above 3. Any split of the collusive gain makes both *X* and *Y* better off, because *Y* gets nothing in the absence of the bidding ring.[28]

Finally, consider a collusive agreement that involves all three bidders.[29] *X* would win the item at a cost of zero, leaving nothing for the auctioneer and a collusive gain of 4 for the ring. Any division of the collusive gain between the three bidders gives them each an incentive to participate.[30] As before, no one has an incentive to cheat because no one can profitably win against *X* at the auction.[31]

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[27] Our main results carry through to the case in which valuations are private information.

[28] Outside the ring, *Y* cannot profitably compete against *X* because *X* would always be willing to bid higher than *Y*.

[29] Bidding rings sometimes succeed despite exclusion of potential members. *See infra* text accompanying notes 95–100.

[30] This choice is arbitrary; any division of the collusive gain that provides a positive payoff to each (beyond non-collusive payoffs) is consistent with individual rationality on the part of the bidders.

[31] In the last example, it seems implausible that the all-inclusive ring could really acquire an item at a price of zero from the auctioneer. More plausibly, an auctioneer would set a reserve price before the auction, or simply reserve the right to refuse to award the item. A reserve price is a preannounced minimum acceptable bid. An auctioneer selects a reserve based on his knowledge of the bidders' distributions and on his knowledge about the probability of collusion.

C. COLLUSION AT SEALED-BID AUCTIONS

Incentives to cheat at a first-price sealed-bid auction are more similar to the incentives present in posted-price markets.[32] Continuing our example, non-collusive bidding at the sealed-bid auction yields the same outcome as at the English auction: *X* would submit a bid of 4 and win the auction. Suppose instead that *X* and *Y* collude. The maximum collusive gain occurs if *X* submits a bid of 3. The winning bid would fall from 4 to 3, and the ring would realize a collusive gain of 1. But unlike the English auction, *Y* has a strong incentive to cheat in the sealed-bid auction. *Y* could submit a bid just above 3, and capture a payoff just below 1. A side payment to *Y* must be as least as large as the gain from deviant behavior in order to dissuade deviant behavior—but then *X* would be paying *Y* almost the entirety of the gain from collusive behavior. If there are costs to collusion, then *X* would not find collusion profitable. *X* is vulnerable to cheating because she must shade her bid below her valuation in order to capture surplus from the auction. At an oral ascending bid auction the highest valuation cartel member does not need to shade her bid; in fact, she bids exactly as she would had no cartel ever formed.

Collusion at a one-shot sealed-bid auction is difficult to sustain; usually repeated play is required to achieve collusion.[33] The requirements for successful collusion are about the same as those for collusion in posted-price markets. Bidders should be patient, they should plan to participate in the cartel for some time into the future, and they should believe that the auction will be repeated regularly. It is also important that cheating is detectable. If a cheating bidder uses a shill bidder to avoid detection, the cartel might not be able to identify the cheater or even know that

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[32] For a discussion of bidder collusion at sealed-bid highway construction procurement auctions, see *JTC Petroleum Co. v. Piasa Motor Fuels, Inc.*, 190 F.3d 775, 777 (7th Cir. 1999) (standardized service, defection from collusion is easy to detect and punish). The Dutch auction, the open outcry equivalent of a first-price auction, is used in Holland and other countries to sell agricultural products. At a Dutch auction the price declines from a high initial price until a bidder stops and wins the auction and pays the amount indicated on the dial. The discriminatory auction is a version of a first-price auction when multiple items are sold simultaneously. An article by Vickrey (cited by the Nobel Prize committee) shows that the Dutch and first-price sealed-bid auction are strategically equivalent. *See* William Vickrey, *Counterspeculation, Auctions, and Competitive Sealed Tenders*, 16 J. FIN. 8, 20 (1961). Thus, the issues discussed in this section pertain to the Dutch auction as well.

[33] *See* Klemperer, *supra* note 2, at 172 (frequently repeated auctions are more vulnerable to collusion). Collusion can be sustained at a one-shot sealed-bid auction if a cartel member can use the threat of litigation to induce side-payments. *See* Robert C. Marshall, Michael J. Meurer & Jean-François Richard, *Litigation Settlement and Collusion*, 109 Q.J. ECON. 213 (1994).

cheating has occurred.[34] Furthermore, the cartel should have stable membership. If participants come and go, they will not have the long-term stake in collusion that is required to deter cheating. At the English auction these factors are less relevant because collusion can be sustained even though some bidders are short-term and impatient. Cheating is difficult to hide. As we described in the one-shot setting, the cartel will remain active up to the highest valuation of any member—this offers protection against cheating whether the auction is repeated or not.[35]

D. ENTRY

A standard lesson in microeconomics is that supranormal profit, in the absence of barriers, attracts entry to the market. In addition to stopping cheating, successful cartels will have an incentive to block entry. Without entry barriers, firms will enter the collusive market seeking a share of the supranormal profit. Entry barriers might arise from increasing returns, governmental action (e.g., a patent grant), or as the result of actions by cartel members that deter entry.[36] Exclusionary conduct that deters entry is much easier at English auctions than at sealed-bid auctions. A simple example shows why.[37]

Suppose that bidders *X*, *Y*, and *Z* share the same valuation of 6 for an item available at an English auction. Suppose that *X* and *Y* invest a sunk cost to enter the auction and then form a bidding ring. Suppose that *Z* is considering entry into the auction and must sink a payment of 2.5 to enter. If *Z* does not enter, then *X* and *Y* will earn a collusive profit of 6. If *Z* enters the market, joins the ring, and receives an equal share of the collusive gain, the payoff of 2 would not be sufficient to cover the cost of entry. Nor could *Z* enter the market and bid against the ring. Competition between *Z* and the ring would drive the bid up to 6 and all profit would disappear.

Colluding bidders at a sealed-bid auction face more pressure from a potential entrant. Continuing the example, *Z* can compete effectively with the ring at a sealed-bid auction. Suppose that *X* and *Y* cannot observe whether *Z* makes the investment required for entry, so they must guard against competition from *Z*. The ring can deter entry if they

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[34] *See* Marshall & Marx, *supra* note 10 (the impact of shill bidders on viability of collusion is examined for both second-price and first-price auctions).

[35] A threat to bidder collusion at English auctions comes from the strategic response of the auctioneer. We will discuss auctioneer responses in detail *infra* Part IV.

[36] For an example of alleged exclusionary conduct by colluding bidders at a sealed-bid auction, see *JTC Petroleum*, 190 F.3d at 777–79.

[37] This example is drawn from Marshall & Meurer, *supra* note 2, at 347–48.

commit to bid 3.5, but this reduces their collusive gain to 2.5. If the ring bids 0 in an attempt to collect the entire collusive gain, then Z can submit an arbitrarily small positive bid, win the item, and more than cover the cost of entry. The equilibrium strategy for the ring balances these two objectives and implements a mixed strategy with bids ranging from 0 to 3.5. Bidder Z will stay out of the auction with some probability and with the complementary probability Z will enter the market and submit a bid over the same range. The details of the equilibrium are not important.[38] What matters is that the expected profit of the ring falls because of the threat of entry. Since the ring must shade its bid to earn a profit, it becomes vulnerable to entry in much the same way it is vulnerable to cheating.

The above analysis presumes that the potential entrant knows of the ring. It also presumes that the ring can continue to function without detection by enforcement authorities. How reasonable are these presumptions? We advance two arguments in support of them. First, the members of any industry know the production process, costs, and demand better than a government enforcement agent. Potential entrants usually do not emerge from the ranks of the completely uninformed but produce related products and are well aware of what might be involved with entry. Second, when the threat of entry looms it would not be unreasonable for members of a cartel to approach the entrant to buy them out, dissuade them from entry, or invite them into the cartel, depending on circumstances. In other words, intra-industry communication might plausibly occur that could be hidden from an enforcement agency.

III. BIDDER COLLUSION AND PRIVATE INFORMATION

The nature and feasibility of collusion and its welfare effects depend, among other things, on the private information held by cartel members.[39] If cartel members truthfully reveal their private information to each other, this greatly aids the cartel's ability to maximize the gains from collusion. But the desire of cartel members to maximize their individual profit discourages truthful revelation. Self-interest motivates cartel mem-

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[38] The ring's equilibrium strategy has a mass point at 0. Z's equilibrium calls for Z to stay out with a probability equal to the ratio of the sunk cost to the value of the item. If Z enters, then she draws her bid from a distribution with no mass points over the interval from 0 to 3.5. The entrant gets zero expected profit. The ring gets an expected profit of 2.5. *See id.* at n.23.

[39] *See generally* Susan Athey & Kyle Bagwell, *Optimal Collusion with Private Information*, 32 RAND J. ECON. 428 (2001).

bers to distort information disclosure and causes cartels to make inefficient output decisions.[40]

Private information presents similar efficiency challenges for colluding bidders.[41] An efficient bidding ring typically extracts private information from ring members to assure that the winning bidder has the highest value for an auctioned item, or the lowest production cost in a procurement setting.[42] Also, a ring uses the information to bid effectively against non-colluding bidders,[43] and in some contexts the information can be used to guide investment decisions related to efficient exploitation of an auctioned item.[44]

Economists typically distinguish two private information auction environments: common values and independent private values.[45] In a common values environment bidders share a common but unknown true value for the auctioned item—they receive different private signals about the value. Similarly situated oil exploration companies would share a common value for rights to explore for oil on a particular tract, but they would receive disparate private signals about the value of the tract from their geologists. In contrast, art collectors are apt to hold independent valuations for a work of art; the valuations arise from introspection and, thus, are private. In practice, most auctions mix the features of the common values and independent private values environments; for example, the possibility of resale introduces a common values element into art auctions, and variation in drilling costs introduces an independent private values element into oil tract auctions.

Ideally, we would offer policy advice strongly linked to the distinction between common and independent private values.[46] Life would be easier

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[40] *See* Susan Athey, Kyle Bagwell & Chris Sanchirico, *Collusion and Price Rigidity*, 71 REV. ECON. STUD. 317 (2004) (firms do not adjust cartel prices efficiently in response to privately observed fluctuations in firms' costs).

[41] *See* Ken Hendricks, Robert Porter & Guofu Tan, Bidding Rings and the Winner's Curse: The Case of Federal Offshore Oil and Gas Lease Auctions, (June 19, 2003) (unpublished manuscript, *available at* http://www.papers.nber.org/papers/W9836) (Information revelation necessary for efficient collusion is harder to achieve in common value settings than in private value settings. Bidders who have received a good signal are reluctant to participate in a ring because the cost of making payments to fellow ring members outweighs the benefit of a smaller payment to the auctioneer.); R. Preston McAfee & John McMillan, *Bidding Rings*, 82 AM. ECON. REV. 579 (1992) (designing a mechanism that supports information disclosure within an all-inclusive ring).

[42] *See* McAfee & McMillan, *supra* note 41 at 583–84.

[43] *See* Hendricks et al., *supra* note 41, at 23.

[44] *See id.* at 3.

[45] *See, e.g.*, Marshall & Meurer, *supra* note 2, at 343.

[46] Economists continue to develop econometric techniques to distinguish common values from independent private-value auctions. *See, e.g.*, Philip A. Haile, Han Hong & Matthew

for example, if we could assert that collusion is more likely in one of the two environments, or if the social welfare costs of collusion were more severe in one of the environments. Unfortunately, neither theoretical nor empirical research on bidder collusion points to strong distinctions, though much work needs to be done. Nevertheless, we can present some useful insights into the nature of bidder collusion that hinge on the distinction between common and independent private values.

The existence of the "winner's curse" in common values auctions is a notable strategic difference between the two informational environments.[47] The label "winner's curse" arose because unsophisticated bidders were cursed by winning a common values auction if they failed to adjust their bid downward to account for the "bad news" of winning. Winning is bad news in the sense that the winning bidder has received the most favorable signal about the value of the auctioned item. A sophisticated bidder avoids the winner's curse by recognizing that winning means all other bidders received less favorable signals, so she should adjust her expected valuation and bid accordingly. In contrast, winning does not reveal information in the independent private values environment because valuations are independent; therefore, there is no winner's curse.

Collusion by a subset of bidders can strengthen or weaken the effect of the winner's curse. The winner's curse affects poorly informed bidders more severely than well-informed bidders. It is possible the winner's curse is so severe that poorly informed bidders get zero expected profit, and they are discouraged from participating in the auction. Joint bidding helps poorly informed bidders and encourages entry if they can pool their information to mitigate the winner's curse.[48] At the other extreme, a well-informed bidder may be reluctant to share her advantage by

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Shum, Nonparametric Tests for Common Values at First-Price Sealed-Bid Auctions, National Bureau of Economic Research, Working Paper No. w10105 (Nov. 2003), *available at* http://www.nber.org/papers/w10105 (identifying common values at first-price auctions by detecting the presence of a winner's curse).

[47] *See* Paul R. Milgrom & Robert J. Weber, *The Value of Information in a Sealed-Bid Auction*, 10 J. MATH. ECON. 105 (1982); Paul R. Milgrom, *Rational Expectations, Information Acquisition, and Competitive Bidding*, 49 ECONOMETRICA 921 (1981).

[48] Hendricks, Porter, and Tan study certain federal off-shore oil tract lease auctions that have a strong common values component. Their data are drawn from a time when bidders were allowed to bid jointly. They found relatively little joint bidding, and most joint bidding was by pairs of bidders even though there were twelve major bidders. *See* Hendricks et al., *supra* note 41, at 25 (almost 90% of the joint bids involved pairs and the remaining joint bids involved triplets). The joint bids were negotiated after firms acquired their private information. The authors infer that joint bidders drew relatively discouraging signals about the value of the tract. *See id.* at 8.

colluding with a poorly informed bidder,[49] but may be eager to collude with another well-informed bidder.[50] In particular, two fully informed bidders will dissipate all of their informational rents if they bid against each other at a common values auction; they can potentially preserve their rents by colluding.[51]

Problems created by private information present a nontrivial challenge for bidding rings, but the success of a bidding ring that was prosecuted in *United States v. Seville Industrial Machinery Corp.* shows colluding bidders can overcome these problems.[52] Machinery dealers operated a bidding ring for many years at used machinery auctions in the New York City metropolitan area.[53] Dealers of used machinery possess significant expertise. They know demand conditions, and they make extensive investments in understanding who has what kinds of machines for sale and at what price. In addition, by inspecting a used machine tool they can determine its remaining productive life. This information allows a machinery dealer to resell a machine tool to a firm that values it highly.

The core membership of the ring, a group consisting of the seven or eight wealthiest and most knowledgeable dealers in the area, was in place prior to the announcement of any auction. Upon announcement of an auction, the ring would expand to include other dealers. If dealers came to the auction from out of town they would immediately be invited to join the ring. Dealers were heterogeneous in terms of their knowledge of machine tools and their wealth. The least knowledgeable and poorest

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[49] *See* Hendricks et al., *supra* note 41, at 25 ("Shell had a reputation as being better informed than other major bidders"; they rarely participated in joint bids.) Hendricks, Porter, and Tan show that an all-inclusive ring is not feasible in a common values setting when the tract is not too valuable, information gathering cost is high, and the number of bidders is small. *See id.* at 22.

[50] Treasury auctions are more appropriately modeled in a common values framework. The dealers are mainly intermediaries, and they resell most of the securities they acquire at the auction. *See* V.V. Chari & Robert J. Weber, *How the U.S. Treasury Should Auction Its Debt*, Q. REV. FED. RES. BANK OF MINNEAPOLIS 10 (1992). Since dealers' valuations ultimately depend in large part on the demand of the same buyers, their valuations are correlated; valuations differ because dealers hold different orders, and they differ in their interpretation of publicly observable economic data. Bidders are asymmetric, the most effective bidders are better informed about future securities prices, and the less-informed bidders face an aggravated winner's curse. Empirical evidence confirms that bidders earn informational rents at Treasury auctions. *See* Elizabeth B. Cammack, *Evidence on Bidding Strategies and the Information in Treasury Bill Auctions*, 99 J. POL. ECON. 100, 113 (1991).

[51] *See infra* text accompanying notes 95–100.

[52] 696 F. Supp. 986, 993 (D.N.J. 1988).

[53] Much of this discussion is based upon the descriptive sections of Daniel A. Graham & Robert C. Marshall, Bidder Collusion at Auctions (Duke Univ. Dep't of Econ. Working Paper, 1984). *See generally* United States v. Seville Indus. Mach. Corp., 696 F. Supp. 986 (D.N.J. 1988).

of the dealers in the coalition were known as "schleppers" and were treated differently within the ring.

Before an auction, dealers would individually inspect the machines for sale at a preview. The issues of how to share information within the ring and how to bid at the auction were resolved differently before and after 1970.

Pre-1970. There was one machinery dealer who dominated the coalition. This individual, Sam (name changed), would have a meeting of ring members before the auction to review each item being sold at the auction. At this meeting ring members were asked to report whether or not they were interested in an item. An expression of interest was all that was required. No ring member was asked to state how much they would be willing to pay, or provide any other similar information. At the auction no ring member would bid except Sam. Sam would only bid on items that were of interest to members of the ring. All items won by Sam were the property of the ring. Individual ownership and distribution of the collusive gain occurred via an auction conducted by the coalition after the main auction. This secondary auction was called a "knockout."

Post-1970. Sam left the machinery business and there was no one of sufficient dominance to replace him. Consequently, the coalition adopted new operating rules. Absolutely no information was shared ahead of time by members of the coalition, not even statements of interest. Instead, ring members would just bid on items at the main auction. Only one rule had to be followed: If a fellow ring member was actively bidding, then no other ring member could bid against him. If the active ring bidder dropped out of the bidding, then any ring member could enter the bidding. Any item won by a member of the ring was property of the ring and had to be brought up for sale at the knockout.[54]

After the main auction, all items purchased by members of the coalition were offered for sale, by means of an oral ascending bid auction, to members of the coalition.[55] At the knockout, bids would be submitted

[54] An interesting feature of the post-1970 bidding mechanism is the way it respects the privacy of members' bidding intentions. The rules did not require anyone to reveal information before the auction. The ring's active bidder at the main auction only revealed what he would have revealed by bidding noncooperatively. It might seem that by bidding at the main auction the ring member has conveyed information to other ring members that will be used against him at the knockout. However, if that same bidder had let another ring member win the item for the coalition at the main auction, the moment he bids at the knockout he would convey at least as much about his willingness to pay as by winning the item for the coalition at the main auction. The emphasis on keeping one's information private reflects the fact that the ring members want to preserve the rents to the investments in attaining their specific expertise.

[55] *Seville Indus. Mach.*, 696 F. Supp. at 993.

as a "bonus" above the price paid for the item at the main auction.[56] The ring member with the largest bonus bid would win the item. His bonus bid would be recorded by the ring accountant. To understand payments at the knockout, suppose the ring purchased only one item at the main auction. Then the winner of the knockout would pay the purchase price from the main auction to whoever initially bought the item. In addition, the knockout winner would put his bonus bid "in the hat." The hat money would then be equally distributed among all ring members, including the winner of the knockout.[57] If the ring purchased more than one item, then the process would continue until all items were sold at the knockout. The ring's accountant would notify each bidder what they owed net to the hat or would receive net from the hat.

Some rings were a mix of wealthy, knowledgeable dealers, and poorer, less-informed dealers. In such cases the wealthy expert dealers would form a ring within the ring.[58] Members of the inner ring would not bid against one another at the first knockout. All other aspects of the first knockout, the bidding and distribution of "hat" money, would be just as described above. After the first knockout was completed, any items won by the inner ring would then be sold amongst themselves via another knockout. By not bidding against one another at the first knockout, the inner ring preserved a large portion of its informational rents. Remarkably, there were cases in which a sequence of more than two knockouts occurred (called "nested knockouts").[59] One ring bidder recalled an auction where there were seven levels of nesting of rings (requiring seven knockouts).[60]

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[56] In the pre-1970 era Sam occasionally paid too much for an item. Then there would be no bonus bids. Instead, there would be loss bidding. The winner's contribution to the hat would be negative by the amount of the winning loss bid. In the post-1970 era loss bidding did not occur because if there were no bonus bids the item would be awarded to the ring member who had won the item for the coalition at the main auction.

[57] So if his bonus bid were X and there were k members of the coalition he would end up paying out only X (k-1)/k. Of course, the actual payout would be accounted for by all bidders in determination of their bidding strategies.

[58] The mechanism used by the dealers' ring to accomplish successful collusion has an elegant feature. The nested knockout rewards ring bidders according to the marginal contribution that they make to the ring, averaged over all the possible ways that they could have joined the coalition. Amazingly, this means that the collusive rents were apportioned to ring members in accordance with their Shapley value, their average marginal contribution to the cartel. *See* Daniel A. Graham, Robert C. Marshall & Jean-François Richard, *Differential Payments within a Bidder Coalition and the Shapley Value*, 80 AM. ECON. REV. 493 (1990).

[59] Frequently, there were several levels of nested knockouts. *Seville Indus. Mach.*, 696 F. Supp. at 993.

[60] Actually, there were only six. At the start of the first knockout, which was attended by all 300+ of the colluding bidders, Sam announced that all "schleppers" should come forward, collect their $50, and leave. Approximately 50 individuals complied.

The description of the used-machinery bidding ring nicely illustrates the differences between collusion in typical posted-price markets and collusion in an auction market featuring heterogeneous bidders and informationally complex goods. The ring displayed amazing durability despite changing membership, constant competition from outside the ring, and countermeasures by suspicious auctioneers. We see this as testament to the powerful pro-collusion incentives created by the English auction. The structure of the ring with its nested knockouts provides evidence that collusion was motivated and shaped (in part) by the desire to protect informational advantages. The knockout auctions are also an interesting demonstration of the ingenuity a ring can use in its quest for an efficient assignment of goods within the ring.

IV. PUBLIC AND PRIVATE ENFORCEMENT

A. THE SOCIAL WELFARE EFFECTS OF COLLUSION

At first glance, the social harm from bidder collusion is not evident. If an auctioneer has a fixed supply to dispose of, then the effect of collusion is simply a transfer of wealth from the parties represented by the auctioneer to the collusive bidders. This analysis is too simplistic though. First, organizing a bidding ring and the costs of litigating collusion are an obvious social loss. Second, if collusion depresses the expected return from an auction sale, then the number of items brought to auction will fall and output will be inefficiently restricted.[61] If collusion raises the expected cost of procurement, that will also inefficiently restrict output as the demand for procured products will fall. Recalling the prevalence of government auctions and procurements, we see a third source of inefficiency caused by bidder collusion. The transfer of wealth away from a government auction deprives society of a relatively efficient source of revenue that may be replaced by a less efficient source. Similarly, increased procurement costs attributable to collusion increase the burden from distortionary taxes.[62]

The social costs of collusion may be offset in some cases by social benefits from collusion.[63] For example, in a common values auction

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[61] Keith N. Hylton & Mark Lasser, *Measuring Market Power When the Firm Has Power in the Input and Output Markets, in* ECONOMIC INPUTS, LEGAL OUTPUTS: THE ROLE OF ECONOMISTS IN MODERN ANTITRUST 131, 137–38 (Fred S. McChesney ed., 1998) (discussing the interaction of power in input and output markets and the implications for antitrust policy).

[62] For a general discussion of the social costs and benefits of collusion, see MICHAL S. GAL, COMPETITION POLICY FOR SMALL MARKET ECONOMIES 161–64 (2003).

[63] Besides the informational benefits of collusion at common values auctions, collusion might be a socially valuable source of countervailing power when the auctioneer has market power. *See* Marshall & Meurer, *supra* note 2, at 356–59. Intuitively, collusion by bidders gives them power to resist the market power of the auctioneer and possibly create

a single bidder with better information than other bidders enjoys an informational rent. This rent provides an incentive to invest in information gathering. If two bidders both have superior information to other bidders because they have access to the same information, then they will compete away the informational rent at the auction. The rent can be restored if the bidders collude. Thus, collusion may provide a socially valuable incentive because it rewards firms that invest in information production.[64] Social value, however, depends on whether the information is actually socially useful and whether the expected cost of redundant investment outweighs the possible social benefit of the information.[65] Privately valuable information lacks social value when it helps one bidder gain surplus from other bidders and the auctioneer, but does not offer any allocative or productive gain.[66] For example, information that a used car up for auction has $1,000 in the glove compartment is privately valuable information, but it has no social value. In contrast, information about the amount of oil present under a particular off-shore oil tract has immediate value in forming a profitable bid, but it also has potential productive value in guiding efficient extraction of the oil. In another example, information that a particular used machine matches the needs of a particular factory provides social value because it helps guide the machine to the highest-value user.

Collusion by poorly informed bidders can also provide social benefits. If poorly informed bidders can improve the quality of their information by bidding jointly, then they can mitigate the winner's curse, which is a particular problem for poorly informed bidders. The main social benefit is more aggressive bidding, which increases revenue to the auctioneer.[67] The revenue gain is likely greatest when the bidders would not have participated in the auction without the joint bid.[68]

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a bilateral monopoly that generates more surplus than the original market structure with a monopoly auctioneer (or monopsony procurer). *Id.* Unfortunately, countervailing power does not necessarily lead to an increase in output or surplus. *Id.*

[64] Collusion might also create social value by discouraging wasteful investment.

[65] *See* Marshall & Meurer, *supra* note 2, at 352.

[66] *Id.* at 360–61.

[67] By itself, a revenue gain to the auctioneer is not socially beneficial—it is just a transfer. However, if collusion depresses auctioneer revenue, it will result in fewer units being brought to the market in the future. The consequent supply reduction is a social loss. Also, in the public sector context, a reduction in revenue from the sale potentially implies that distortionary taxes will be increasingly used to make up the shortfall.

[68] *See id.* at 353 (collusion to overcome informational disadvantage raises revenue). However, Hendricks et al., *supra* note 41, at 4, provide empirical evidence that joint bidding (even though legal during the interval covered by their data) is rare on offshore oil tracts

B. ENFORCEMENT PRIORITIES

Despite a longstanding commitment to aggressive enforcement, bid rigging continues to be a problem.[69] Better deterrence requires an increase in the expected sanctions faced by colluding bidders. Although improving detection of bidder collusion will be difficult, we propose increasing expected sanctions by increasing the probability of detecting collusion.[70]

Antitrust enforcers have trouble monitoring markets to detect collusion,[71] and, typically, public enforcement starts with a tip from an affected party[72] or an insider.[73] Recognizing the importance of private monitoring,[74] the DOJ adopted leniency programs in the 1990s to encourage

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where the risk of a dry hole is high and the winner's curse is more severe. Ironically, these are the auctions for which information sharing is most valuable.

[69] Ellen F. Kandell, *Pennsylvania's Anti-Rigging Act: A First Step Towards an Antitrust Law or the Only Step?*, 30 VILL. L. REV. 63, 63 (1985). In the 1980s states were plagued by bid rigging in highway construction projects. *Id.* at 63–64. Many states have specific bid-rigging statutes. *Id.* at 63. Under the parens patriae doctrine, state attorneys general have standing to represent taxpayers in their states in bid-rigging cases *Id.* at 88–89. *But see* Klemperer, *supra* note 2, at 183 (noting European authorities have allowed joint bidding that appears to be plainly collusive). Many states have specific bid-rigging statutes. *Id.* at 88, 90.

[70] *See* Chantale LaCasse, *Bid Rigging and the Threat of Government Prosecution*, 26 RAND J. ECON. 398 (1995) (analyzing a model in which colluding bidders adjust their behavior in response to strategic detection efforts by antitrust enforcers); Douglas D. Davis & Bart J. Wilson, *Collusion in Procurement Auctions: An Experimental Examination*, 40 ECON. INQUIRY 213 (2002). Because cheating and entry are unlikely at English auctions, there is potentially less evidence in English auction price data than one could find in other collusive markets. At any type of auction, a sophisticated and stable ring has significant latitude to generate winning and losing bids that disguise collusion. Further difficulties are created by the fact that the identity of potential bidders and the make-up of bidding rings often change in different parts of the country or as different items are auctioned.

[71] *See* William E. Kovacic, *Private Monitoring and Antitrust Enforcement: Paying Informants to Reveal Cartels*, 69 GEO. WASH. L. REV. 766, 774 (2001).

[72] Davis & Wilson, *supra* note 70, at 213 ("Tip-offs or complaints frequently expose conspiracies, but good reasons exist for suspecting that conspiracies detected in this fashion tend to be the least profitable.").

[73] Disgruntled employees and colluders have made complaints that prompted investigations. *See* General Accounting Office, *Justice Department: Changes in Antitrust Enforcement Policies and Activities*, GGD-91-2, 49 (Oct. 29, 1990). In a timber industry case a conspirator was promised logs in exchange for suppression of his bid, but the logs were never delivered and he alerted authorities about the collusion. United States v. Walker, 653 F.2d 1343, 1345 (9th Cir. 1981).

[74] Officials who run public procurements and auctions also are important potential monitors, provided that training and incentives are provided for public officials to detect collusion. Self-help measures available to private parties may not be available to public officials who are constrained by requirements that public procurements and auctions are relatively transparent.

insiders to provide tips about collusion.[75] William Kovacic proposed a bounty program as another step in that direction.[76]

The DOJ has embraced investigative techniques, such as wiretapping and electronic surveillance, to improve cartel detection.[77] Looking to the future, Patrick Bajari and Garrett Summers describe advances in econometric methods for identifying collusion through examination of bid data.[78] These detection tools can be used to follow up tips and to watch markets with a history of collusion, but they also should be used to routinely monitor auction markets for evidence of collusion.[79] Antitrust enforcers should devote more resources to the task of identifying auction

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[75] *See* Kovacic, *supra* note 71, at 787 (leniency programs encourage insiders to tip public enforcers to the existence of a cartel). In Part IV we study the incentives of competitors to challenge bidder collusion and identify conditions such that private and social incentives are likely to align.

[76] *See id.* at 766–68; *see also* Steven P. Schulenberg, Essays in Auctions and Collusion ch. 4 (Ph.D. dissertation, Penn State University, 2003), *available at* http://etda.libraries.psu.edu/theses/approved/WorldWideIndex/ETD-388. Private monitors can improve cartel detection, but steps should be taken to prevent bounty hunters from misusing the program. Kovacic discusses safeguards against misuse of bounties. Kovacic, *supra* note 71, at 793–95.

[77] *See* Judy Whalley, *Priorities and Practices—The Antitrust Division's Criminal Enforcement Program*, 57 ANTITRUST L.J. 569, 571–72 (1988).

[78] Patrick Bajari & Garrett Summers, *Detecting Collusion in Procurement Auctions*, 70 ANTITRUST L.J. 143, 144 (2002). *See also* Jonathan B. Baker, *New Horizons in Cartel Detection*, 69 GEO. WASH. L. REV. 824, 827–28 (2001) (describing new econometric tools for detecting bidder collusion); *see* Marshall & Marx, *supra* note 10 (explaining that close non-winning bids provide evidence of collusion at an independent private values, first-price sealed-bid auction). Even with excellent data on market characteristics it can be difficult to detect collusion. One reason is that collusion may be ineffective. By ineffective we mean that the ring's strategic behavior does not alter the price paid for the commodity relative to noncooperative behavior. If the ring reduces the price paid, then it is effective. Note that this will include cases where the coalition does not win the object but where the winning non-ring bidder alters his strategic bidding behavior in response to collusion by others. Identification of colluders is complicated by the possibility of "tanking." A ring may find it advantageous not to bid at all or bid unaggressively in early rounds of an auction so as to remove high-valuation non-ring bidders from the competition for items that will be offered later. Without undertaking this strategic action the high-valued non-ring bidders will oppose them on all items and force up the price paid. But, this implies that high-valued non-ring bidders will win items at depressed prices. In other words, the fact that a given bidder wins at a depressed price may not imply that the bidder is participating in a coalition.

[79] We doubt that over-deterrence is much of a problem in the area of bidder collusion. *See* Baker, *supra* note 78, at 826 (stating there is no evidence that aggressive enforcement against cartels has chilled legitimate behavior, such as joint venture formation); *but see* Athey & Bagwell, *supra* note 39, at 432 ("[A]ntagonistic antitrust policy, which limits firms' ability to communicate or exchange bribes, may thus limit productive efficiency without affecting prices.").

and procurement markets posing a risk of collusion and econometrically analyze the bid data for evidence of collusion.[80]

Proper risk assessment should establish enforcement priorities based on factors linked to the likelihood of collusion and the social cost from collusion in the affected markets. The traditional list of structural factors that facilitate collusion in posted-price markets is a good starting point: high concentration, entry barriers, repeated interactions among firms, homogeneous products, etc.[81] In addition, public enforcers should monitor ascending bid auctions more closely because cartels are more stable and profitable at such auctions.[82] In terms of social cost, the obvious starting point is the size of the market—larger markets deserve more scrutiny.

C. ENFORCEMENT BY COMPETITORS

Good antitrust policy augments public antitrust enforcement with private enforcement because private enforcers sometimes have better information or incentives than public enforcers.[83] Antitrust law carefully screens potential private plaintiffs through standing rules that help assure a plaintiff indeed has proper incentives and good information.[84]

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[80] Antitrust enforcement agencies work with other government agencies, and especially with procurement officials, to check for bid rigging. *See* ANDREW I. GAVIL, WILLIAM E. KOVACIC & JONATHAN B. BAKER, ANTITRUST LAW IN PERSPECTIVE: CASES, CONCEPTS AND PROBLEMS IN COMPETITION POLICY 972 (2002). It may be possible for sophisticated rings to hide collusion by carefully coordinating their bids, but previous rings have not been so cagey. *See* Bajari & Summers, *supra* note 78, at 163–64 (analysis shows that colluding bidders were not sophisticated enough to hide collusion from econometric scrutiny). *But see* Davis & Wilson, *supra* note 70, at 213 (citing a mixed view among antitrust economists as to whether collusion enforcement is worth the bother).

[81] *See, e.g.*, HOVENKAMP, *supra* note 1, at 144–52.

[82] An argument to the contrary holds that sealed-bid auctions should be a higher priority because collusion causes more social harm at sealed-bid auctions. That claim is plausible because the ring shades its bid at a sealed-bid auction and, therefore, it may lose an item to a non-colluding bidder even though the non-colluding bidder has a lower valuation for the item than the ring member with the highest valuation. We are not persuaded by this argument because revenue loss is likely to be the main source of inefficiency for many auctions (fewer items brought to the market in the long run and revenue shortfalls made up by distortionary taxes); the higher risk of successful collusion at the English auction could make the expected social cost higher even if the efficiency cost is lower ex post. Finally, Marshall and Marx have shown that collusion at English auctions may cause inefficient assignment of an item. *See* Marshall & Marx, *supra* note 9. The inefficiency arises because ring members are reluctant to disclose their true valuations to each other during the auction because that undermines their ability to claim rents after the auction when the ring divides the collusive gain. *Id.*

[83] Kovacic, *supra* note 71, at 774–76 (private monitoring helps uncover carefully concealed collusion, private parties have the best information and possibly better incentives than public enforcers).

[84] *See generally* Blair & Harrison, *supra* note 19; Brodley, *supra* note 19.

Auctioneers and procurers are the natural candidates to bring private suits against collusion, but sometimes they have relatively weak incentives or poor information. Many auctioneers and/or procurers are government officials, who may not have strong incentives to monitor and challenge collusion.[85] Furthermore, detection may be difficult even for highly motivated auctioneers. Unlike other torts, the victim may not recognize her injury. An auctioneer can recognize a low winning bid, and a procurer can recognize a high winning bid, but not know whether it was caused by collusion or simply unfavorable demand or cost conditions.

Private enforcement by competitors against horizontal restraints is severely limited by antitrust standing doctrines.[86] Competitors are potentially good candidates to be effective private attorneys general in the anti-collusion realm because they are likely to have good information about collusion.[87] Antitrust law is cautious, though, because competitors' incentives to bring suit may not align very closely with the social incentives to bring suit. Consider, for example, a posted-price market in which firms *A*, *B*, and *C* are competitors. A conspiracy between *A* and *B* to raise prices helps *C* even if *C* is excluded from the agreement. *C* would profit from the conspiracy by increasing its price or output. *C* has nothing to gain by challenging naked price fixing by its rivals and would only bring such a suit for opportunistic or anticompetitive reasons. *C* should be denied standing to promote judicial economy and reduce vexatious litigation.[88]

This argument against competitor standing was developed in the posted-price context, but Judge Posner recently extended it to bidder collusion.[89] *JTC Petroleum Co. v. Piasa Motor Fuels, Inc.* raised the question of whether a firm has standing to sue competitors for bid rigging. Judge Posner explained that normally a competitor should not have standing:

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[85] *See* Robert C. Marshall, Michael J. Meurer & Jean-François Richard, *The Private Attorney General Meets Public Contract Law: Procurement Oversight by Protest*, 20 HOFSTRA L. REV. 1, 3 (1991).

[86] *See* Brunswick Corp. v. Pueblo Bowl-O-Mat, Inc., 429 U.S. 477, 484 (1977) (developing the antitrust injury requirement). A cartel member qualifies for antitrust standing if it can demonstrate antitrust injury and satisfy the other factors listed in *Associated General Contractors*. Associated Gen. Contractors of Cal., Inc. v. Cal. State Council of Carpenters, 459 U.S. 519, 540–45 (1983) (standing should be denied when the alleged injury is too indirect or speculative or when it is difficult to identify and apportion damages); *see also* Volvo N. Am. Corp. v. Men's Int'l Prof'l Tennis Council, 857 F.2d 55, 68 (2d Cir. 1988).

[87] There are many examples of successful bidding rings that did not include all the members of a market. *See generally* Bajari & Garrett, *supra* note 78 (discussing examples of less-than-all-inclusive bidder collusion).

[88] *See* William J. Baumol & Janusz A. Ordover, *Use of Antitrust to Subvert Competition*, 28 J.L. & ECON. 247 (1985).

[89] JTC Petroleum Co. v. Piasa Motor Fuels, Inc., 190 F.3d 775 (7th Cir. 1999).

> A conspiracy of a firm's competitors to [raise prices or allocate customers] could only help the firm, by providing an umbrella under which it could sell a large quantity at a supracompetitive price generating supracompetitive profits just by setting price in between the conspirators' price and the lower, competitive price that would prevail in the absence of the conspiracy.[90]

In an auction setting in which bidders have independent valuations, collusion by a bidder's rivals typically helps (or has no effect on) a non-colluding bidder *provided* the auctioneer does not behave strategically. At a first-price sealed-bid auction the colluding bidders shade their highest bid (and obviously their complementary bids) more than would comparable noncooperative bidders. The effect is reduced expected revenue to the auctioneer and higher expected profit to both colluders and non-colluders.[91] The non-colluders profit from collusion because they win with higher probability at any given bid. Nevertheless, Judge Posner found that standing was appropriate in *JTC Petroleum* because the plaintiff plausibly alleged that its competitors had conspired with upstream suppliers to deny the plaintiff a cheap supply of input and, thereby, exclude the plaintiff from the market.[92] In other words, a plaintiff firm should have standing when incumbent colluding firms in the market use coordinated exclusionary tactics to deny the plaintiff entry to the market.[93]

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[90] *Id.* at 777–78.

[91] *See* Robert C. Marshall, Michael J. Meurer, Jean-François Richard & Walter Stromquist, *Numerical Analysis of Asymmetric First Price Auctions*, 7 GAMES & ECON. BEHAV. 193 (1994). In the model in that article there are five bidders, who each independently draw a valuation from the uniform distribution over the interval [0, 1]. In a first-price auction when all bidders act noncooperatively, the expected auctioneer revenue is .6666, and each bidder gets an expected profit of .0333. These numbers are compared to the cases when two, three, four, or five of the bidders collude. In these cases the auctioneer's expected revenue falls to .6510 with two colluders, .6089 with three, .5057 with four, and .0000 with five. The expected profit of cartel members rises to .0352 with two colluders, .0406 with three, .0567 with four, and .1667 with five. Significantly, excluded bidders enjoy even greater benefits from collusion. Their expected profits rise to .0371 with two colluders, .0488 with three, and .0860 with four. For a second-price (or English) auction the numbers are .6667, .6501, .6001, .4667, and .0000 for the auctioneer's expected profit in the face of increasing collusion. The numbers for the cartel members are .0417, .0556, .0833, and .1667 for cartels with two, three, four, and five members. The expected profit for excluded bidders is constant at .0333 regardless of the number of colluding bidders. These results are drawn from Tables 3 and 4, Marshall et al., *supra*.

[92] *JTC Petroleum*, 190 F.3d at 778 ("JTC, a maverick, was a threat to the cartel—but only if it could find a source of supply of emulsified asphalt. The claim is that the applicators got the producers to deny JTC this essential input into its business, and as a result injured it.").

[93] Competitors can use the same theory to gain standing to challenge collusion or mergers in posted-price or other market settings. *See* Volvo N. Am. Corp. v. Men's Int'l Prof'l Tennis Council, 857 F.2d 55, 71–74 (2d Cir. 1988); Brodley, *supra* note 19, at 46, 52 (emphasizing that colluding firms may attempt to exclude a maverick competitor); *id.*

The alleged collusion in *JTC Petroleum* occurred at a sealed-bid highway construction procurement,[94] a market with characteristics similar to the market in *Addyston Pipe*, and similar to most posted-price markets. The rationale for limiting standing to competitors threatened with exclusion makes sense in that context. However, we should be careful not to apply *JTC Petroleum* too broadly because competitors of colluding bidders sometimes deserve standing even absent a threat of exclusion. Bidder collusion may result in a non-colluding competitor suffering antitrust injury even in the absence of exclusionary conduct. The harm to the non-colluding bidder flows either from the strategic behavior of the auctioneer or from the presence of private information about a common value. These factors often distinguish auction markets from posted-price markets and should be accounted for when making antitrust policy.

A bidder at an oral auction does not benefit and may be harmed when other bidders collude. The colluding bidders stand ready to bid up to the highest valuation of any cartel member—this is exactly the way the cartel bidders would act noncooperatively. In addition, suspected collusion by bidders *A* and *B* may elicit a response from the auctioneer that hurts bidder *C*. For example, an auctioneer might withhold items from sale or strategically use a reserve price. Thus, non-colluding bidders in an oral auction may suffer as an unavoidable effect of strategic behavior by the auctioneer to discourage collusion.

To illustrate how the use a reserve price to combat collusion injures a non-colluding bidder, consider an English auction with three bidders in which each bidder has a probability of 1/5 of having a valuation of 100, 104, 118, 125, or 240. The item has no value to the auctioneer. The auctioneer and all bidders know this information, but each bidder's independent valuation is private information. With noncooperative behavior, the auctioneer optimally sets a reserve of 100 and sells the item (with probability one) to the highest value bidder at the second highest value.

Now suppose two of the three bidders collude, and collusion occurs before valuations are known. The reserve price which maximizes revenue for the seller is 118. Even with this reserve, coalition members have higher expected profit than they would by acting noncooperatively. In

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at 59 (mavericks are especially good candidates for merger challenges); Jonathan B. Baker, *Mavericks, Mergers, and Exclusion: Proving Coordinated Competitive Effects Under the Antitrust Laws*, 77 N.Y.U. L. Rev. 135 (2002).

[94] *JTC Petroleum*, 190 F.3d at 777 ("The plaintiff presented evidence both that the applicator defendants had agreed not to compete with one another in bidding on local government contracts and that the producers had agreed not to compete among each other either . . . .").

contrast, the excluded bidder never benefits from collusion and the implied higher reserve, and may be strictly worse off. For example, if the non-colluding bidder has a valuation of 104, and the two colluding bidders each have valuations of 100, then there is no award and no profit because the seller's strategic reserve is 118, whereas, with non-collusive bidding, the reserve price is 100, and the bidder with valuation of 104 would have won the item for a price of 100 and earned a profit of 4. Additionally, there are cases in which the price paid by the non-colluding bidder is raised to the reserve of 118, when it would have been either 100 or 104 in the noncooperative setting. Collusion also reduces the expected profit to the auctioneer, and the higher reserve leads to her inefficient retention of the item when all bidders have values below 118. Although they have different complaints, both the auctioneer and excluded bidder oppose collusion. In such a circumstance, standing for the excluded bidder makes sense.

In the common values framework competitor standing may be appropriate even without strategic behavior by the auctioneer. The key factor is the interaction of collusion and the winner's curse. Economic theory shows that informational asymmetry determines the distribution of profit in a common value setting.[95] If a given bidder's information is a strict subset of any other bidder's information, then the given bidder cannot make a positive return. When collusion exacerbates the informational disadvantage of a non-colluding bidder, it is likely that both the auctioneer and the excluded bidder will suffer. To illustrate, consider three bidders with different information about the underlying common value of an item for sale. The bidders hold overlapping and equally valuable information. Bidding noncooperatively they earn the same positive expected return. Suppose that two of the bidders can collude and pool their information. Furthermore, assume that by pooling their information they jointly know everything the excluded bidder knows plus some additional information. Then the excluded bidder is beset by an aggravated winner's curse. Her expected return falls to zero.[96] This harm to

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[95] *See* Marshall & Meurer, *supra* note 2, at 352–53.

[96] Consider a single object for sale that consists of three separate and distinct components. Each component has a value of zero with probability p and value V with probability 1–p. Bidder *A* observes the value of components 1 and 2, bidder *B* observes the value of components 2 and 3, and bidder *C* observes the value of components 1 and 3. Suppose the auction is second price and the auctioneer sets a reserve of zero. Then a symmetric equilibrium has a bidder bid zero if they observe two zeros, V if they observe one zero and one V, and 3V if they see two Vs. Note that bidders earn a positive payoff when they observe two Vs and the other bidders each observe one V. All other circumstances result in a zero payoff. Now, suppose bidders *B* and *C* collude. Also, suppose that they can make the object worth a very small amount more, *e*, by pooling their information. Then equilibrium behavior involves bidder *A* bidding zero when they see two zeros, bidding V

the excluded bidder coincides with harm to the auctioneer in the form of an expected revenue loss because of less aggressive bidding by all three bidders. Again, standing is warranted for an excluded bidder because the private and social incentives for litigation are closely aligned.[97]

Both strategic behavior by the auctioneer and problems created by the winner's curse possibly harmed bidders who were excluded from the used machinery ring. Recall the ring consisted of dealers who would buy machinery for resale to an end-user. Typically, the machinery would be refurbished before resale. The dealers excluded end-users and brokers from the ring. End-users would buy machinery to make a product.[98] Brokers would buy machinery for immediate resale to end-user customers when the brokers had standing orders.

There are several reasons that end-users were never invited to join. First, although an end-user might have been well-informed about the machinery specific to his production facility, such a bidder lacked the breadth of knowledge and expertise that machinery dealers possessed. Consequently, whereas an end-user might be valuable for reducing the price paid on a few machines, for all other machines they were of no value. It is disruptive to share the collusive gain with bidders who make no contribution to that gain. Second, end-users were infrequent auction attendees. If after winning an item at the main auction an end-user decided not to offer it for sale at the knockout there were few ways for

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when they see one zero and one V, and bidding 2V when they see two Vs. The coalition, knowing the true value, bids it (e when seeing three zeros, $V + e$ when seeing one V, $2V+e$ when seeing two Vs, $3V + e$ when seeing three Vs). The excluded bidder earns a zero profit in the face of collusion. The auctioneer is hurt as well. *Cf.* Paul Klemperer, *Auction Theory: A Guide to the Literature*, 13 J. ECON. SURVS. 227, 236–37 (1999) (a slight asymmetry in common values setting hurts revenue because a big winner's curse afflicts the disadvantaged party).

[97] In contrast, if relatively uninformed bidders collude in a common values setting this may raise expected revenue to the auctioneer because it reduces the effect of the winner's curse. For example, suppose bidder A is fully informed about the value of an item, and B and C have partial information about the item. The partially informed bidders will bid weakly because of the winner's curse, and revenue will be low. Suppose B and C collude and pool their information and thereby become fully informed. The colluding pair will be on equal footing with bidder A, and the winning bid will match the value of the item. The non-colluding bidder A would be harmed by this collusion, but should not be granted standing because the collusion raises the auctioneer's revenue.

[98] Several factors shape end-user demand for used as opposed to new machinery. The more obvious factors are apparent to a reader who considers why someone buys a used car instead of a new one. Demand for machine tools is sensitive to the business cycle. Producers of machine tools will quickly deplete their inventories in times of economic expansion. Users will then be left with two options—wait in queue for a new machine to be produced, or purchase the productive capacity in the used market. But the used machinery market is relatively robust to the business cycle. In a downturn, businesses that are liquidity constrained often will opt to purchase in the cheaper used market than buy a new machine.

the ring to punish him. On the other hand, if a dealer tried this he would face temporary expulsion from the ring or demotion in terms of his nesting level.[99] Third, dealers clearly saw that it was not in their best long-run interest to make auction attendance profitable for end-users. Exclusion from rings facilitated this.

The exclusion of brokers involves more subtle issues. Because brokers bid on machines for which they had standing orders from customers, all other machines were of no value to them. In contrast, dealers typically bought machines for inventory. So, it was common knowledge that a broker with a customer would almost always be willing to pay more for a machine than a dealer because the dealer needed to account for inventory costs in formulating a valuation and bid. If a broker started bidding at a knockout, the broker would be run up by the dealers as the latter tried to extract the surplus of the broker. Consequently, when a broker had a customer for a machine, he would prefer to bid noncooperatively at the main auction. If a broker had no orders for machines, then he would want to join the coalition to receive a share of the bonus money. Therefore, if a broker was asked to join a ring and responded affirmatively, the coalition did not want him, and, if he responded negatively, the ring did want him. As a result, brokers were never asked to join the ring.

End-users and brokers were, at times, harmed by the presence of a ring because of an auctioneer's response to the ring. Auctioneers would raise the reserve price to strategically counter the collusion but, by doing so, they risked not selling items that end-users or brokers might have won had a lower reserve been in place.[100] Beyond the harm they encountered from the presence of the ring, brokers were good candidates as private attorneys general (relative to end-users) because they interacted frequently with dealers and had a reasonable understanding of the relationships among dealers.

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[99] A given dealer typically had several machines in inventory that were co-owned with many different dealers. The warehousing dealer had substantial latitude in determining the final transaction price for the machine. The true final transaction prices were not verifiable. This provided dealers with an additional mechanism for punishing deviant ring bidders.

[100] Auctioneers sometimes use a protecting bidder who will bid for an item if the apparent winning bid is too low. The auctioneer will compensate the protecting bidder for implementing what is essentially a reserve policy. Other auctioneers combat collusion by using an unannounced reserve, i.e., simply reserving the right not to make an award. A different strategy that might benefit a non-colluding bidder is to use a "quick knock," whereby the auctioneer ends the auction early with a quick knock of his hammer and an award to a bidder who, the auctioneer believes, is not part of the ring.

V. AUCTION DESIGN

Good auction design complements antitrust enforcement, and both play a role in deterring bidder collusion,[101] but auction design balances other concerns as well. Besides collusion, an auction designer considers risk aversion, asymmetries in the distribution of valuations, correlation of valuations, liquidity constraints, and other factors when selecting an auction format.[102] Certain factors favor the choice of a sealed-bid auction to maximize revenue or total surplus, and other factors favor the English auction. Auction designers who are especially worried about collusion should choose the first-price sealed-bid format rather than the English or some other ascending bid format.[103]

A private sector auctioneer will typically design an auction to maximize expected revenue. Discouraging collusion aids revenue maximization but an optimal auction sometimes tolerates an increased risk of collusion to encourage more aggressive bidding. For example, an English auction may be preferred over a sealed-bid auction in a common values environment because the winner's curse depresses revenue more at a sealed-bid auction than an English auction.[104] An auctioneer might reasonably conclude that the greater risk of collusion from use of the English auction would have a smaller expected impact on revenue than the expected impact of the winner's curse.

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[101] *See* Klemperer, *supra* note 2, at 170, 172 (auction design is more effective in constraining collusion than antitrust enforcement); Owen M. Kendler, Comment, *Auction Theory Can Complement Competition Law: Preventing Collusion in Europe's 3G Spectrum Allocation*, 23 U. PA. J. INT'L ECON. L. 153, 160–61 (2002).

[102] Expected revenue is higher at a sealed-bid auction with risk-averse bidders. Expected revenue is higher at an English auction given correlated values. *See* Klemperer, *supra* note 96, at 234–35. Certain asymmetries in the independent private values environment can make the sealed-bid auction more profitable and others make the English auction more profitable. *See* Eric Maskin & John G. Riley, *Asymmetric Auctions*, 67 REV. ECON. STUD. 413 (2000).

[103] *See supra* text accompanying notes 26–35. *See also* Klemperer, *supra* note 2, at 170, 179; Marshall & Marx, *supra* note 10. In the spectrum auctions, Klemperer argues that auction designers should be especially mindful of collusion and other sorts of anti-competitive behavior. Klemperer, *supra* note 2, at 170 (Good auction design requires attention to collusion, entry-deterring, and predatory behavior. These issues are more important than the standard concerns of auction theorists: risk aversion, correlation of information, budget constraints, and complementarities.)

[104] Paul R. Milgrom & Robert J. Weber, *A Theory of Auctions and Competitive Bidding*, 50 ECONOMETRICA 1089, 1095 (1982) ("[W]hen bidders are uncertain about their value estimates, the English and second-price auctions are not equivalent; the English auction generally leads to larger expected prices. One explanation of this inequality is that when bidders are uncertain about their valuations, they can acquire useful information by scrutinizing the bidding behavior of their competitors during the course of an English auction. That extra information weakens the winner's curse and leads to more aggressive bidding in the English auction, which accounts for the higher expected price.").

The government should choose an auction design that maximizes expected social welfare. The government should be conscious of the welfare losses from taxation and, therefore, strive to maximize revenue at auctions and minimize costs at procurements.[105] But the government should also strive to maximize the size of the pie by assuring that auctions allocate items to the highest valuation bidders and procurements award contracts to the most efficient producer. Sometimes, productive or allocative efficiency clash with revenue maximization or cost minimization. Consider, for example, an asymmetric independent private values auction in which certain bidders draw their valuations from more favorable distributions than other bidders. The strong bidders tend to shade their bids more than the weak bidders, so it is possible for a weak bidder with a lower valuation to win a sealed-bid auction. In contrast, the bidder with the higher valuation always wins at the English auction; therefore, the English auction achieves greater allocative efficiency. Nevertheless, the sealed-bid auction may yield greater expected revenue.[106]

A. SPECTRUM AUCTIONS

A relatively successful experiment in auction design was undertaken by the FCC in the mid-1990s to award electromagnetic spectrum for various telecommunications applications. Congress called on the FCC to use auctions because of the disappointing earlier experience with a spectrum lottery.[107] With the advice of renowned microeconomic theorists, the FCC devised a simultaneous, ascending bid auction.[108] The FCC divided the country into regions and offered multiple licenses in each region. Ascending bids were submitted simultaneously for all licenses, and rounds of bidding continued until all bids stopped ascending.[109]

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[105] *See* Klemperer, *supra* note 2, at 169 (the revenue difference between good or bad auction design can be substantial; perhaps billions of dollars of government revenue are at stake in telecommunications auctions).

[106] Regardless of collusion risk, aggressive bidding by weak bidders may increase revenue and may offset the allocative inefficiency. *See* Klemperer, *supra* note 96, at 236.

[107] Thomas W. Hazlett, *Assigning Property Rights to Radio Spectrum Users: Why Did FCC License Auctions Take 67 Years?* 41 J.L. & ECON. 529, 530 (1998). Qualification for the lottery was rather easy and as a result much of the spectrum was allocated to speculators. The inefficiency of the initial allocations delayed the commercial introduction of cellular technology for at least 2 years. *Id.* at 533 ("Between $500 million and $1 billion in wasteful rent-seeking was likely expended on the cellular lotteries, while several times this sum was lost for the U.S. Treasury."). In the wake of this experience, Congress insisted the FCC determine an efficient method of allocating spectrum. *See* Preston McAfee & John McMillan, *Analyzing the Airwaves Auction,* 10 J. ECON. PERSP., Winter 1996, at 159, 160. ("In the 1993 legislation authorizing the FCC to hold auctions, Congress charged the FCC with encouraging an 'efficient and intensive use of the electromagnetic spectrum.'").

[108] *See* McAfee & McMillan, *supra* note 107, at 160.

[109] The auction rules included "activity rules," which required potential buyers to bid on a certain number of licenses in every round. Without the activity rules, the ascending

The auctions generated substantial revenue, and achieved a relatively efficient allocation of spectrum.[110] The auction designers chose the simultaneous ascending bid auction to achieve efficiency in the presence of complementarities and the winner's curse. Complementarities can arise because licenses covering neighboring geographic areas are likely to be more valuable if a bidder wins a license in each area. The auction format allowed bidders to acquire efficient bundles of licenses and also helped dampen the winner's curse.[111] In some markets, inefficient allocation at the auction is not a serious problem because resale moves items to the highest value user. But the experience with spectrum lotteries used prior to 1993 suggested that redistributing licenses after the auction would be costly and slow.[112]

The success of the first set of FCC spectrum auctions influenced several European telecommunications agencies to conduct simultaneous ascending bid auctions. Most of the auctions were not as successful in terms of revenue generation because collusion was more of a problem.[113] Collusion became apparent in subsequent FCC auctions as well, and it significantly reduced revenue.[114]

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bid auctions would need to be terminated at some arbitrary date, which would make the auction strategically similar to a first-price sealed-bid auction. *Id.*

[110] *See* Patrick S. Moreton & Pablo T. Spiller, *What's in the Air: Interlicense Synergies in the Federal Communications Commission's Broadband Personal Communication Service Spectrum Auctions*, 41 J.L. & ECON. 677, 678 (1998) (two broadband auctions conducted in the mid-1990s raised more than $17 billion in revenue for the U.S. Treasury); *id.* at 679 (finding empirical evidence of synergies in PCS licenses, and "evidence that some interlicense synergies may have reduced the size of winning bids, possibly by affecting the degree of competition for a license"); Peter Cramton, *The Efficiency of the FCC Spectrum Auctions*, 41 J.L. & ECON. 727, 728 (1998) (the FCC auctions achieved efficient license assignment).

[111] *See* McAfee & McMillan, *supra* note 107, at 161–62. They explain:

> The ascending bids let bidders see how highly their rivals value each license and which aggregations they are seeking. By the time equilibrium is approached, each bidding firm knows whether it is likely to be able to construct its preferred aggregation and roughly how much it is going to cost. With all licenses open for bidding simultaneously, a bidder has flexibility to seek whatever license aggregation it wishes, as well as to switch to a back-up aggregation if its first-choice aggregation becomes too expensive.

Id. at 161.

[112] *See id.* at 163 (trading after the auction would correct inefficient initial allocation, but it could be costly and incomplete); Cramton, *supra* note 110, at 727–28 (same).

[113] *See* Klemperer, *supra* note 2, at 170; Kendler, *supra* note 101, at 182 (joint ventures in the Dutch 3G auction reduced the number of major bidders so it just equaled the number of licenses). Klemperer warns that predation is also a problem in repeated ascending bid auctions. *See* Klemperer, *supra* note 2, at 174.

[114] *See* Peter Cramton & Jesse A. Schwartz, *Collusive Bidding in the FCC Spectrum Auctions*, 1 CONTRIBUTIONS TO ECON. ANALYSIS & POL'Y 1 (2002), *available at* http://www.bepress.com/bejeap ("We find that six of the 153 bidders in the DEF auction regularly

The factors that make the spectrum auctions allocatively efficient also make them especially vulnerable to collusion. The transparency and frequency of the bidding aids information flow, as well as diminishing problems from complementarities and the winner's curse. But these properties also facilitate communication within rings, make cheating easier to detect, and make punishment easier. During the early rounds of certain FCC spectrum auctions, bidders encoded messages in their bids. The last several digits of each bid were of little consequence to the bidders, so they allegedly used these digits to communicate with their rivals and suppress competition.[115] Furthermore, the spectrum auctions share a pro-collusive feature with English auctions; a ring's chosen winner does not have to shade its bid, so cheating is not a problem.

Regardless of whether the auction designer chooses a sealed-bid or ascending bid[116] auction, there are several measures that can reduce the risk of collusion. Rigorous enforcement of antitrust law is the most obvious.[117] In addition, auction design choices can reduce the risk by

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signaled using code bids or retaliating bids. These bidders won 476 of the 1,479 licenses for sale in the auction, or about 40% of the available spectrum in terms of population covered.").

[115] *See* News Release, Department of Justice, Antitrust Division, *Justice Department Sues Three Firms over FCC Auction Practices* (Nov. 10, 1998), *available at* 1998 WL 792334 (DOJ filed suit against three firms that allegedly used coded bids to collude at a PCS auction); United States v. Mercury PCS II, L.L.C., No. 98-2751, 1999 WL 1425379 (D.D.C. Apr. 29, 1999) (consent agreement barring signaling through bids at FCC auctions); Cramton & Schwartz, *supra* note 114, at 3 ("[W]e believe that bidders in the DEF auction took advantage of signaling opportunities to coordinate how to assign the licenses."); Klemperer, *supra* note 2, at 170–71 (European bidders have signaled each other to facilitate collusion by using early bids to communicate in multi-unit ascending bids auctions). A startling example occurred when U.S. West encoded the number indicating the Rochester, Minnesota, region into a couple of its bids. Cramton & Schwartz, *supra* note 114, at 4–5. The FCC designated Rochester as 378D. Apparently, U.S. West wanted to dissuade McLeod from bidding in Rochester, and U.S. West submitted bids of 62,378 and 313,378 in regions where McLeod had been active but where U.S. West had not been active.

Collusion cases like this demonstrate the difficulty in proving agreement as opposed to unilateral action. Nevertheless, the government had some success in the PCS auctions, and success in a similar case involving the airline industry. *See* United States v. Airline Tariff Publ'g Co., 836 F. Supp. 9 (D.D.C. 1993); United States v. Airline Tariff Publ'g Co., No. 92-2854, 1994 WL 502091, 1994 WL 454730 (D.D.C. Aug. 10, 1994) (settlement with remaining defendants); Justice Department's Competitive Impact Statement at 15, United States v. Airline Tariff Publ'g Co., 1994 WL 454730 (D.D.C. 1994) (No. 92-2854) (fare notifications "intended to send a message" to a competitor not consumers). Regardless, a unilateral message sent through the bids may violate Section 5 of the FTC Act.

[116] *See* Klemperer, *supra* note 2, at 179 (explaining methods of improving ascending bid auctions to make them less vulnerable to collusion); Cramton & Schwartz, *supra* note 114, at 14–15 (same).

[117] Antitrust enforcement against collusion in spectrum auctions has been too weak, especially in Europe. *See* Klemperer, *supra* note 2, at 183.

encouraging entry, restricting the ability of bidders to communicate, and using a reserve policy and related strategic tactics.[118] An auctioneer can encourage entry of marginal bidders by adjusting their bids to favor them,[119] by gathering information and disseminating it to bidders (which eases the winner's curse for less informed bidders),[120] or by encouraging joint bidding.[121] However, auctioneers and auction designers should guard against the use of joint bidding as a tool for collusion. The FCC strongly encouraged firms to form joint ventures, especially designated entities,[122] but it also wisely required ventures be formed by a specific date prior to the auction.[123] A Swiss spectrum auction did not set a deadline for joint ventures, last-minute joint ventures essentially eliminated competition, and it was too late for other bidders to enter.[124]

Stringent reserve price policies and suppression of information about bidders help reduce the expected harm from collusion, but these policies might be unattractive because of offsetting costs. Usually the reserve price is preannounced, but some auctioneers reserve the right to refuse to make an award on any grounds and use that discretion to combat suspected collusion.[125] Because a binding reserve means the auctioneer inefficiently retains the item up for auction, an optimal reserve balances the benefits of higher revenue from more aggressive bidding against the risk of no award.[126] Suppressing the identity of bids and bidders makes

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[118] McAfee & McMillan, *supra* note 107, at 170 (a maverick bidder, ALAACR, entered broadband markets that appeared under-priced); Klemperer, *supra* note 96, at 239 (the auctioneer gains more from attracting bidders than investing in a better auction design).

[119] Various government auctions and procurements have used scoring systems that favored small or disadvantaged businesses. *See* Ian Ayres & Peter Cramton, *Deficit Reduction Through Diversity: How Affirmative Action at the FCC Increased Auction Competition*, 48 STAN. L. REV. 761 (1996). Bias in favor of marginal bidders can increase auction revenue and decrease procurement cost.

[120] *See* Marshall & Meurer, *supra* note 2, at 353–54.

[121] Kendler, *supra* note 101, at 181 (possibly procompetitive joint ventures that increase competition); Hendricks et al., *supra* note 41, at 27 (no evidence that joint bidding in one area led to coordinated bidding in other areas).

[122] Cramton & Schwartz, *supra* note 114, at 15 (preferences for small bidders encourages entry).

[123] Bidders were provided an explicit opportunity to form and register joint ventures prior to the auction.

[124] Klemperer, *supra* note 2, at 174.

[125] *See* United States v. Bensinger Co., 430 F.2d 584 (8th Cir. 1970) (a buyer rejected all bids in a procurement; the government later proved the bidders were colluding); Klemperer, *supra* note 2, at 175 (a reserve price that was too low was extremely costly to the Swiss government in a telecommunications auction). Auctioneers profitably use reserves even when they do not suspect collusion; they use the reserve to stimulate higher bidding.

[126] Cramton & Schwartz, *supra* note 114, at 15 (high reserve prices mitigate harm from collusion but the potential for the reserve to bind makes this ambiguous). For a clear example of the efficiency cost of retaining an item, consider auctions for perishable

it harder for a ring to form and harder for a ring to detect defection.[127] However, designers of the spectrum auction believed suppression of this information would have made it harder for bidders to extract information from bids—this information extraction diminished the winner's curse and improved aggregation of neighboring licenses in the spectrum auctions.[128]

B. TIMBER AUCTIONS

U.S. Forest Service auctions offer another opportunity to consider auction design in the face of possible bidder collusion.[129] Historically, the Forest Service has sold tracts of timber from National Forests to mills and logging firms using both English and sealed-bid auctions.[130] Despite longstanding suspicion of widespread collusion, successful prosecution has proven difficult.[131] Like used machinery auctions, timber auctions involve specialized bidders,[132] who often make substantial investments gathering information about heterogeneous timber tracts. Unlike the machinery auctions, the auctioneer (Forest Service) actively varies the auction design with an eye on possible collusion.[133] Furthermore, the Forest Service is aware of the importance of private information about the common value of the tracts and produces and disseminates information in order to mitigate the effect of the winner's curse.

The timber auctions are similar in many ways to off-shore oil tract auctions. Valuations for bidders at both auctions exhibit features of the independent private values model because bidders differ in terms of extraction or harvesting costs. But both auctions also exhibit features of

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commodities like fish or flowers. If the auctioneer actually retains those items, there could be a total loss of value.

[127] *Id.* at 14. When bidder information is fully revealed, it is easier for firms to signal the way U.S. West apparently did at the PCS auction. And because spectrum auctions may take several weeks to complete, bidders can enter into a subcontracting agreement on a totally unrelated project, as a method of hiding side payments.

[128] McAfee & McMillan, *supra* note 107, at 170.

[129] A detailed description of Forest Service transactions in the timber industry can be found in Laura H. Baldwin, Robert C. Marshall & Jean-François Richard, *Bidder Collusion at Forest Timber Auctions*, 105 J. POL. ECON. 657 (1997).

[130] From 1976–1990 the Forest Service conducted "well over a thousand" auctions per year in the northern and western U.S., generating about $1 billion per year in revenue. Susan Athey & Jonathan Levin, *Information and Competition in U.S. Forest Service Timber Auctions*, 109 J. POL. ECON. 375, 379 (2001).

[131] Baldwin et al., *supra* note 129, at 658.

[132] *See* Philip A. Haile, *Auctions with Resale Markets: An Application to U.S. Forest Service Timber Sales*, 91 AM. ECON. REV. 399, 401 (2001) (most bidders represent mills that tend to specialize in particular types of timber).

[133] *See* Athey & Levin, *supra* note 130, at 380 (the Forest Service decides whether to use an oral or sealed-bid auction based on expected competition and composition of tract).

the common values model. Oil companies face shared uncertainty about the amount of oil available at a tract. Timber bidders face shared uncertainty about the quality and quantity of timber on a given acreage.[134]

Timber auction winners resell much of the timber they harvest; also, they often subcontract part of the harvest, or even sell the entire harvesting contract.[135] Because ancient growth timber is so heterogeneous, historically mills have been extremely specialized.[136] With such specialization, a timber tract often appears to be a large pie to the firms in the area. The winner of a tract wants certain slices with certain logs suitable for its production process. The rest are resold to the firms that value them most highly. Resale makes bidders' valuations more correlated and aggravates the winner's curse; resale also facilitates collusion by providing a way to camouflage side-payments. If colluding bidders are specialized in different types of timber, then enforcement authorities will have a difficult time determining the competitive resale price. A savvy coalition can pay a depressed price for the timber at the auction and share the collusive gain through the resale market. The auction winner can make implicit side-payments by selling timber in the secondary market at favorable prices to colluding mills.[137]

Collusion is likely to be common in timber auctions because of the prevalence of English auctions,[138] the frequency of the auctions, and opportunities to disguise side-payments through subcontracts and resale.[139] Nevertheless, English auctions might be attractive to the Forest Service given the common value component inherent in many timber auctions.[140] The Forest Service sometimes chooses sealed-bid auctions rather than English auctions when it is especially worried about collusion. The Forest Service probably should take stronger action to mitigate the

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[134] Certain timber auctions are best modeled as independent private values; other auctions have a substantial common values component. *See* Athey & Levin, *supra* note 130, at 398 (evidence of common values).

[135] Haile, *supra* note 132, at 401.

[136] Some mills handle only a certain peeler grade of Douglas fir for veneers. Others produce clear sawtimbers. Still other mills are set up to process ancient trees that are substantially rotten.

[137] In contrast, if the bidders do not specialize, resale could still be used to share collusive gains, but enforcement authorities will find it far easier to establish market prices and thereby determine if interfirm exchanges have occurred at depressed prices.

[138] Haile, *supra* note 132, at 401 (English auctions are more common than sealed-bid timber auctions).

[139] *Id.* at 402 (the active resale market facilitates collusion).

[140] *See supra* note 104 and accompanying text.

winner's curse, and then it could move more aggressively toward sealed-bid auctions.

Before explaining how the Forest Service can mitigate the winner's curse, we need to say a bit more about the informational setting of timber auctions. The ability to survey a 200-acre tract of ancient growth timber and accurately estimate the quantity of merchantable timber by species and the quality of that timber takes many years to develop. The ability to accurately estimate quality implies that a firm can sell logs from a tract to other firms whose production facilities are best suited to handling these logs. The Forest Service usually gathers information about a tract by performing a "cruise" of the tract. They disclose this information to bidders, and then bidders usually conduct an independent cruise.[141] The bidders in a given area are usually much better at evaluating timber quality and quantity than the Forest Service. This creates an incentive for collusion among those bidders to protect their informational advantage.[142]

The Forest Service should take a simple step to diminish this incentive to collude. Historically, the information about log quality and quantity is collected by the Forest Service during harvest, but the quality information is not made available to the general bidding public. This policy creates an information rent for the winning bidder. If an adjacent tract is brought up for sale, then the current winner will have a significant advantage over competitors because it knows the quality of the timber in that drainage area. If two bidders have bought tracts nearby a third newly announced sale, then they will have an incentive to collude so as to preserve their informational rents. However, this informational rent and the corresponding incentive for collusion have been created by the Forest Service. If the Forest Service would simply make the quality information publicly available, then no such motivation for collusion would exist.[143]

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[141] *See* Athey & Levin, *supra* note 130, at 381 (companies invest in private cruises).

[142] Many mills specialize in the use of a given factor input but compete in competitive output markets (veneers, sawtimbers, plywood). This makes the factor input market an important source of rents. But the evidence of collusion developed so far starts with the assumption that the independent private values model is appropriate. *See* Baldwin et al., *supra* note 129, at 659, 688 (evidence of collusion at English auctions of timber in the northwestern U.S.); Lance Eric Brannman, *Potential Competition and Possible Collusion in Forest Service Timber Auctions*, 34 ECON. INQUIRY 730 (1996) (evidence of collusion at Forest Service auctions); Athey & Levin, *supra* note 130, at 408 (evidence that "informational rents" in scale sales "may be largely competed away").

[143] Besides reducing the winner's curse, these steps also tend to reduce the value of private investment in cruising and, therefore, save society the cost of redundant information production.

VI. CONCLUSION

A large number of questions always come to mind when considering bidder collusion. How do members know what objects to bid on at the auction? How high should they bid? If an item is won by a member of a coalition, do they own it? Do they need to transfer moneys to members of the coalition? If an item won by a member belongs to the coalition, how is ultimate ownership determined? How is the realized collusive gain shared among ring members? What incentives are there for cheating on the collusive agreement? How can the coalition dissuade and/or monitor members to deter cheating? And, how do the answers to each of these questions depend upon the auction scheme under consideration? We hope our detailed descriptions of stable bidding rings give antitrust lawyers some insights into these questions.

The fundamental message of this article is that the standard analysis of cartel behavior in posted-price markets is often inadequate when applied to collusion by bidders at an auction or procurement. Auction schemes differ in their susceptibility to collusion, which has implications for the allocation of enforcement resources. Auction markets often feature heterogeneous products, and bidders often expend significant resources to understand the item being offered in order to formulate a bid. Further, there are circumstances where non-colluding bidders are damaged by the collusion and, therefore, should have standing. Once policy makers recognize these differences they will be better able to combat collusion through improved enforcement and auction design.