NEW RESEARCH ON THE EFFECTIVENESS OF BIDDING RINGS: IMPLICATIONS FOR COMPETITION POLICIES

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I. INTRODUCTION

Many antitrust authorities' statements imply that bid rigging is patently more harmful and deserving of higher penalties than ordinary price fixing violations. For example, under U.S. federal sentencing guidelines, there is a one-point increase in the culpability score for corporate cartelists that engage in bid rigging.[2] Moreover, individuals convicted in the United States are also sometimes charged with fraud, which can add years to the bid-rigging incarceration penalties imposed. There are also widespread concerns that the rigging of government tenders is related to public corruption, especially in newer democracies (The Economist 2016). In Europe, bid rigging is also treated with greater severity.[3] And multilateral organizations, such as the OECD and the International Competition Network, have given special attention to the problems of enforcement against bidding rings manipulating government tenders.[4]

This antipathy toward bid rigging relative to the more common form of collusive conduct (classic price fixing) is puzzling given that bidding rings achieve *lower* overcharges on average. The median overcharges on modern private international cartels run about 25 percent lower than the median overcharges on price-fixing cartels.[5]

There is empirical evidence that antitrust penalties are more severe for rings than for classic price-fixing cartels. Data on 309 modern private international cartels finds that, when no 3rd-party assistance is implicated, the median severity of penalties on 105 rings is 128 percent higher than for 204 classic cartels; when the cartels have assistance from trade associations, median bid-rigging penalties are six times more severe than

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2 A one-point increase in the culpability score for cartelists adds up to 8 percent of affected commerce to the recommended U.S. fine for a similar classic cartel (USSG. *Guidelines Manual 2016.* Washington, DC: United States Sentencing Commission (2016): Chapter 8, Section 2R1.1. [https://www.ussc.gov/sites/default/files/pdf/guidelines-manual/2016/GLMFull.pdf]

3 For example, Germany and Italy have laws permitting bid-riggers to be sentenced to prison terms, whereas other price-fixing violations do not (Wagner von Papp, Florian. *Criminal Antitrust Law Enforcement In Germany: "The Whole Point Is Lost If You Keep It A Secret! Why Didn't You Tell The World, Eh?"* (2010). [available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1584887]

4 The OECD has more than a dozen publications focused on competition problems surrounding public procurement. For example, (OECD, *Recommendation of the OECD Council on Fighting Bid Rigging in Public Procurement. (C(2012)115 - C(2012)115/CORR1 - C/M(2012)9).* Paris (17 July 2012). [http://www.oecd.org/daf/competition/RecommendationOnFightingBidRigging2012.pdf] and OECD, *Fighting Bid Rigging in Public Procurement: Report on implementing the OECD Recommendation.* Paris (2016). [http://www.oecd.org/daf/competition/Fighting-bid-rigging-in-public-procurement-2016-implementation-report.pdf.

5 Connor, John M. & Robert H. Lande, How High Do Cartels Raise Prices? Implications for Optimal Cartel Fines, *Tulane Law Review* 80 (December 2005): Table 4.

price-fixing cartels (Figure 1).[6] That is, relative to the harm generated, bidding rings are in fact fined more harshly than classic price fixing around the world.

Fig. 1. **Median Severity** of Total Penalties by Type of Pricing Conduct

Median
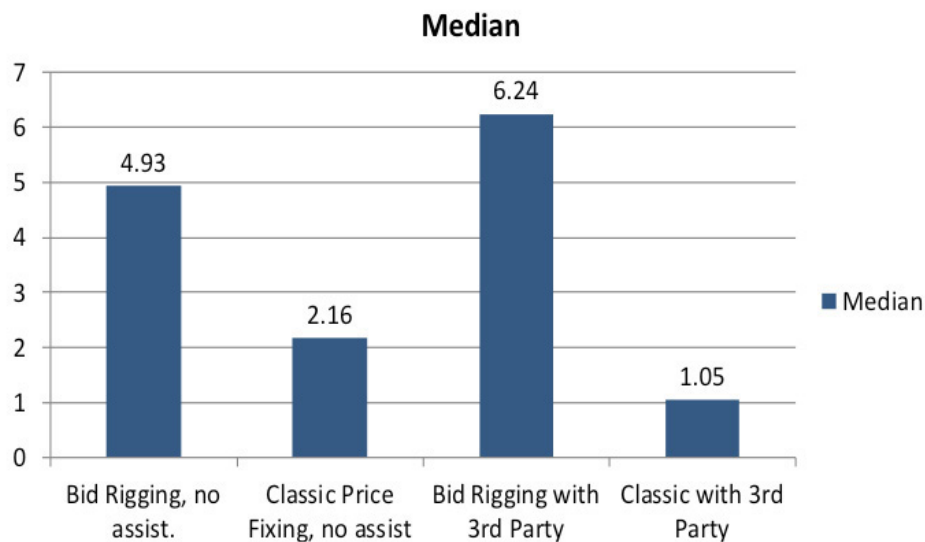
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The aggregate data used to construct Figure 1 imply that bid rigging is widely treated as an aggravating factor in setting cartels fines in most jurisdictions, whether there are explicit guidelines for this factor or not. Although suggestive, grouped data may fail to account for variations in bid-rigging overcharges correlated with industry, geographic location, or other underlying explanatory factors. Meanwhile, other empirical research finds no statistically significant impact of bid-rigging on overcharges after several other cartel and market factors are controlled for.[7]

In this paper, we survey the economic literature on collusion, with a special focus on bidding rings, and we draw upon large data sets to empirically examine potential explanatory variables for success among bidding rings. Economic theories of auctions have made many advances, but empirical verification has lagged behind. We then discuss our recent meta-analysis model of overcharges arising from bid rigging, which led us to conclude that the price effects of bidding rings, controlling for industry fixed effects, *are* significantly affected by buyer market concentration, seller industry concentration, and two temporal features. No comparable analysis of the price effects of bidding rings has previously been published in the economic literature. We conclude by discussing the policy implications of these findings.

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6 Severity is the ratio of monetary penalties to affected commerce of the cartel. Data from Connor, John M., *Price-Fixing Overcharges Master Data Set*. (Spreadsheet dated October 20, 2017), where 3rd-party assistance (trade associations, consultants, etc.) was *not* cited in the case narrative. The mean average severity of penalties was 93 percent higher for rings.

7 For example, Connor, John M. & Yuliya Bolotova, Cartel Overcharges: Survey and Meta-Analysis, *International Journal of Industrial Organization* 24 (Nov. 2006): 1109-1137, available at http://ssrn.com/abstract=788884; Bolotova, Yuliya, John M. Connor & Douglas J. Miller, Factors Influencing the Magnitude of Cartel Overcharges: An Empirical Analysis of the US Market, *Journal of Competition Law and Economics* Vol. 5, No. 2 (June 2009): 361 - 381.

II. ECONOMIC CONCEPTS OF BID RIGGING

Bid rigging is a form of price fixing with several unique conceptual features. Beginning in the early 1960s, the development of game theory brought about several advances in industrial organization economics. Current economic reasoning tends to relegate bidding rings to collusion within auctions that have few members in the ring.[8]

Bid rigging is in some ways a distinctive form of explicit collusive conduct. Bidding rings are formed with the object of *lowering* the prices of goods sold in an auction below a more competitive but-for price. Products offered in auctions include physical items (antiques, fine art, land, used farm equipment, and the like). Rings are also formed to *raise* the prices of projects or supply contracts for either government-sponsored services (i.e. bidding for tenders), industrial inputs for private buyers (bidding on Requests for Quotes), or sales directly to consumers. Cartels that do not principally engage in the manipulation of bids are called, somewhat confusingly, "price cartels" or "classic cartels."[9]

Price-fixing cartels and bidding rings are similar in that participants agree voluntarily to join a secret association because collusion increases the likelihood of increasing the pool of monopoly profits (collective rationality). Rings pick an auction winner who will bid below the competitive price of an item offered for sale or designate a sealed-bid winner who will bid higher than the competitive price of a tender.[10] Generating profits in bidding rings also requires an agreement about a viable mechanism for sharing the spoils (individual rationality) and a mechanism for punishing deviants from the collusive agreement. McAfee & McMillan demonstrate that pre-auction agreements about side payments can be sufficient to incentivize collusion.[11]

The structures of rings can vary widely. An important distinguishing feature of the industries that historically employ open-outcry auctions is that there is heterogeneity in lots or batches available for sale.[12] If information about the quality of items in an auction is not symmetric, part of a bidding-ring agreement usually involves sharing the private information about quality known only to some of the members within the larger group of ring participants. Bidding rings agree to suppress the auction price by permitting only one of its members to make realistic bids against non-members, but they regard the winner as a sort of custodian of the ring's property. A related motive for the formation of bidding rings is the fact that members of the ring can have an asymmetric advantage over the seller (or the auctioneer) in assessing the quality of the products that affect market (resale) values (Marshall & Marx 2012: 57).

In the case of sealed-bid auctions, the tenders issued by buyers contain specifications that can ensure homogeneous quality. However, potential suppliers of the products described in the buyer's Request for Proposal (RFP) may be better informed about costs than procurement managers in private firms or civil servants working in government (Marshall & Marx 2012: 173-180). Members of an auction ring can select the winner through a secret pre-auction knockout auction or a series of post-sale knockout auctions among cartel members, plus a rule for the winner to reward non-winners (i.e. the side payments).[13] Prior agreements also usually require the non-winners to bid and lose in auctions

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8 Klemperer, Paul, Auction theory: A guide to the literature, *Journal of Economic Surveys* 13 (1999): 227-286.credits a 1961 article by Vickey with first applying game theory to analyzing equilibrium prices generated by *competitive* auctions. The application of game theory to auctions began in the late 1970s, but theoretical developments on *collusion* in auctions were rather limited up until the late 1990s (Klemperer 1999: 25). More recent advances are discussed Marshall, Robert C. & Leslie M. Marx, Bidder Collusion, *Journal of Economic Theory* 133 (2007): 374-402 and their important book *The Economics of Collusion: Cartels and Bidding Rings*. Cambridge: The MIT Press (2012) ("Marshall & Marx 2012"). A limitation of much of this theoretical auctions-theory literature is that theorists often focus on contrasting first-price with second-price auctions, even though the latter are uncommon in natural markets. Marshall & Marx (2012) generally discuss only two types of rings: open-outcry auctions and sealed-bid tenders.

9 Although rare, some cartels engage in both types of collusive conduct, depending on the customers.

10 Cartels can also implement collusive agreements to reduce output. However, bidding rings do not usually have an output-reducing conduct option, other than boycott of an auction that is delayed as a result. Similarly, rings do not usually have an ability to punish cheaters by increasing the quantity of output that creates nonprofitable price levels.

11 McAfee, R. P. & J. McMillan, Bidding Rings, *American Economic Review* 82 (1992): 579-599. Their model assumes that all bidders are part of the cartel and have private information (differing reservation prices) drawn from the same distribution. Convergence is not guaranteed if bidders are required to pay for the asymmetric information (Matthews, A. A. Information Acquisition in Discriminatory Auctions, in *Bayesian Models in Economic Theory*, Marcel Boyer & R. E. Kihlstrom (editors). New York: North Holland (1984).

12 For example, packaged cigarettes are not auctioned, but bales of cured tobacco leaf are; used farm equipment is auctioned, but not new tractors; houses are not generally auctioned, but bundles of many houses are. Similarly, requests for proposals for large construction projects (e.g. major office towers or public works) or complex tailor-made equipment (power-station turbines and large passenger airplanes) are typically handled by bidding processes.

13 Since the latter 20th century, side-payments are probably not enforceable contracts in most jurisdictions or may be difficult to hide, and agreements on rotating winners may be violated with impunity. An older method of punishment not seen often since the late 20th century is to have participants post bonds and agree to have a secretariat sell those bonds of cheaters to the remaining members of a cartel or ring. However, bond posting, if observed, is a super-plus factor indicating the fact of collusion.

or to submit cover bids in sealed-bid tenders. Alternatively, members of the ring may agree in advance to offer highly profitable bid prices and may agree as to which of its members will offer the lowest, winning bid (which is set well above the costs of supply).[14] Collusive profits can be shared through side payments after each procurement episode or, when tenders are repetitive, ring members can agree to rotate winning bids. In seal-bid auctions, bidding rings can agree on winners based on territorial divisions, customer allocations, time-rotations, or (to fool buyers) a formula that incorporates randomness.

Bidding rings face many of the same managerial challenges in forming and effectuating collusion as do classic price-fixing cartels,[15] but many of the factors are not identical.[16] The principal determinants in common are: high sales concentration within the cartels, small numbers of buyers, and a high cartel share of the market. Other less consistent factors include equal cost conditions across cartelists, low rate of innovation, high barriers to industry entry, inelastic demand, steady or predictable growth in demand, standardized industry contracts, a history of industry collusion, agreements on market quotas or territories, and the use of joint sales agencies. Many of these determinants are difficult to measure.

In general, cartel collusion works best when the participants are few and identical,[17] and bidding rings are more effective if they recruit a high share of all potential bidders and maintain a stable membership from auction to auction.[18] Large numbers of participants make acceptable side agreements more difficult to negotiate. However, a long history of collusion, a homogeneous business culture, or the assistance of a trusted third party can facilitate collusive agreements even with large numbers. Moreover, when a bidding ring faces large numbers of similar tenders over time, then repeated-games strategies can be used as enforcement mechanisms.[19] Thus, frequently repeated auctions tend to be more effective in creating overcharges than one-off events; similarly, frequent communication among ring members aids collusive trust and effectiveness.[20] The meetings of trade associations, technical-standards committees, or attendance at meetings arranged by a specialized management consultant can facilitate frequent communications.[21]

An inability to adequately monitor quantities or prices among participants, combined with internal enforcement mechanisms that may be costly or weak, can result in defections from a ring's agreement. The ideal situation is complete information *transparency* among cartel or ring members, but complete *secrecy* with non-members. This is why the sharing of sensitive, strategically important confidential data is generally considered a super-plus factor for the evidence of collusion. In ascending-bid (English) auctions, rings are more profitable if the identity of all bidders can be observed (say, through the exclusive use of numbered paddles in one room). Similarly, in sealed-bid auctions profits are generally higher when all information about the bids and bidders are transparent, which is often the case in procurement rules followed by public institutions. The presence of shill bidders is potentially destabilizing to a ring.

Market-share agreements, while not necessary, improve the stability of collusive agreements and resolve the problem of allocation of collusive monopoly profits. These agreements may require periodic (e.g. annual) meetings to compensate participants for unintentional deviations from agreed quotas. For this reason, an increase in interfirm transfers during a collusive period is very strong evidence for the fact of collusion, as is an increase in the stability of market shares.

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14 Indeed, evidence that the difference between the winning bid and second-best bid has narrowed is a plus factor in identifying seal-bid collusion. Similarly, evidence that items became owned post-auction by non-winners is considered very strong evidence of a knock-out auction and, hence, of collusion.

15 Hendricks, Kenneth & Robert H. Porter, An Empirical Perspective on Auctions, Chapter 32, pp. 2073-2143, in *Handbook of Industrial Organization: Volume 3* (Mark Armstrong & Robert Porter editors). Amsterdam: Elsevier (2007).

16 However, the overlap in facilitating conditions for effective cartels and for rings is not perfect (Marshall & Marx 2012: 248).

17 That is, they employ the same technology of production, operate at similar levels of output and capacity, and the like. Participants with different costs, information sets, or customer bases can frustrate agreement on a collusive price. These differences make cooperation in the terms of a collusive contract difficult and give rise to greater incentives to cheat on the cartel contract.

18 Pure brokers frustrate collusion in auctions. They are rarely if ever invited to join rings. All bidders that buy to own for resale (i.e. non-brokers) have economic incentives to join auction bidding rings if the costs of detection are low enough. Thus, a high member cartel share of industry supply increases the effectiveness of rings because it also implies few brokers are in the fringe. Suborning an auctioneer or bribery to serve a ring is the best solution for collusive effectiveness because it converts an oligopolistic ring into a monopoly.

19 Athey, Susan & K. Bagwell, Optimal Collusion with private Information, *RAND Journal of Economics* 32 (2001): 428-465.

20 Frequent meetings permit cartels to make repeated, coordinated price-change announcements (Marshall & Marx 2012: 213-239). Indeed, the frequency of price announcements and the lead times before implementation increase during collusion, but the size of price increases tends to be lower. The proportion of announcement by members with small shares increases during collusion. These patterns make detection more difficult and tend to lower buyer resistance.

21 In a sample of 22 EC-punished cartels, about half of them had third-party assistance mentioned as an aggravating factor in the decisions, and of those cases virtually all of them also had market-share quotas (Marshall & Marx 2012: 125-128).

Auction theory offers a rich set of suggestions for explaining the price effects of bidding rings, useful in understanding the performance of specific, well-documented rings. However, empirical modelling to explain variation in ring overcharges with cross-sectional panels of bidding rings is unlikely to be able to incorporate all of the richness of detail that auction theory proposes. In large samples of modern bid-rigging infringements, many factors are simply unknown or unmeasurable. Details of bid-rigging conduct or auction design simply go unmentioned in most of the posted decisions of antitrust authorities, in the business press, or in follow-up published studies by academics. In order to obtain a sufficiently large data set for statistical analysis, such details may be sacrificed. In other words, in exploratory analyses of the type performed in this paper, the explanatory power of the model may be lower than ideal.

III. ESTIMATING BID-RIGGING OVERCHARGES

Growing out of the general interest of IO economists in market power, the first journal papers empirically analyzing overcharges of bidding rings using formal economic methods started appearing in 1989.[22] Since then empirical studies of overcharges have used data from public tenders for sewer construction; federal-government procurement of frozen fish; state road-building contracts; real estate auctions in Washington, DC; and school milk procurement.[23]   Each of these studies found positive overcharges arising during periods of overt collusion.[24]

Developments in auction theory also inspired empirical studies of bid rigging. Most empirical testing of auctions consists of bidding patterns in ostensibly competitive auctions and most study single-product auctions over time.[25] Marshall & Marx (2012: 248-255) present a detailed empirical analysis of 620 sealed-bid auctions held by the Russian Government during 2001-2007 to award petroleum and natural-gas leases.[26] A large plurality of these auctions had only two bidders and ended after one bid was submitted at the Government's minimum permissible price. Only auctions with at least two bidders could result in a lease being awarded. The study finds that at least 13 bidders and as many as 26 companies are shills (necessary to fulfill the two-company required minimum), which made many bids into monopsonies. The authors conclude that if there was a bidding ring, it was not very disciplined.

A third strand of the cartel literature is the statistical analysis of auctions and bid rigging intended to test game-theoretic notions.[27] A good example of an empirical study of imperfect competition in auction markets for stamps.[28] They apply a structural model to comparing the number of bidders and winning bids across two types of auction rules (open auction bidding and sealed bidding) in auctions for timber conducted by the U.S. Forest Service in the western United States. This study finds evidence of mild oligopoly pricing with sealed bids, but no collusion when open-outcry was the rule.

Statistical analyses of data on large samples of bid rigging episodes over time are exceedingly rare. Previous meta-analyses of price-fixing-cartel and bidding-ring overcharge rates have found no significant differences.

IV. EMPIRICAL DATA ON BID-RIGGING

In this section, we show the principal features of the Price-Fixing Overcharges (PFO) data set. This spreadsheet assembles more than 2000 estimated overcharges from all types of cartels that operated over several centuries, but this data set has only limited information on cartel struc-

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22 However, Judge Taft seems to be the first to have computed bidding-ring overcharges in his 1898 decision in *Addyston Pipe*.

23 See references in Connor & Werner (2018).

24 These studies were generally made possible by U.S. "freedom-of-information" laws that mandate public access to bids for public project tenders. Although such laws also exist outside the United States, relatively few have been exploited there to obtain data to statistically analyze bid rigging of public tenders.

25 For example, Bajari, Patrick & Ali Hortacsu, *Are Structural Estimates of Auction Models Reasonable? Evidence from Experimental Data: NBER Working Paper No.* (May 25, 2005).

26 It is noteworthy that in their 302-page book, other than occasional references to antitrust decisions about well-known cartels, this is nearly the only empirical work on bid rigging summarized in the text by the authors. Rather, empirical findings are relegated to footnotes in order to illustrate theoretical points.

27 Hendricks, Kenneth & Robert H. Porter. An Empirical Perspective on Auctions, Chapter 32, pp. 2073-2143, in *Handbook of Industrial Organization: Volume 3* (Mark Armstrong & Robert Porter editors). Amsterdam: Elsevier (2007 provide a survey this economic literature.

28 Athey, Susan & K. Bagwell, Optimal Collusion with private Information, *RAND Journal of Economics* 32 (2001): 428-465.

tures, membership, or penalties imposed.[29] Grouped data and simple trend analyses can illustrate patterns that may be analytically significant for statistical testing.[30]

There are roughly four times as many classic price-fixing estimates of overcharges as there are for bid-rigging episodes. For reasons relating to changing priorities in the economic profession and data availability, almost all bid-rigging overcharges appear for rings that ended after the late 1950s (Figure 2).[31] The *Great Electrical Equipment* cartel of 1950-1957, prosecuted in 1958-1961 in the United States, seems to have been a watershed event for antitrust law and for stimulating studies of bidding rings.

Fig. 2. Number of Bid-Rigging Overcharges Estimates per Year

Year Episode Ended
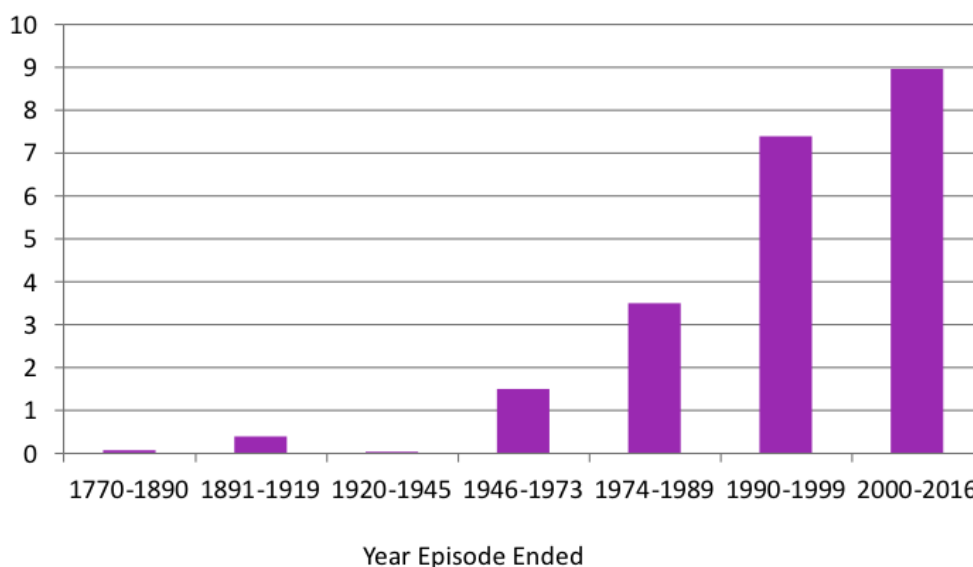
Before 1946, bid-rigging episodes accounted for only 4.7 percent of all reported overcharges; during 1946-1989, it rose to 42 percent; but after 1989 it fell to 24 percent (Figure 3). These data seem to indicate a nine-fold increase in the proportion of bid-rigging schemes after World War II compared to 1770-1945. However, we suspect that the change in the mix of cartel pricing conduct in the sample may reflect either the availability of data, changes in the composition of cartelized industries, or the changing preferences of economic researchers, rather than objective market conditions. Thus, rather than reflecting an objective surge in the share of bid rigging in natural markets, more likely explanations may lie in the direction of newly available data sets, enforcement priorities, and keen interest by economists in testing new models of auctions that appeared in the 1980s. It is possible that the increase in bid-rigging cases seen in our sample after 1946 is in part due to the advent of open-records laws.[32] What may seem like a refocusing in research efforts may also be a consequence of greater opportunities to obtain trans-actions prices. In sum, we believe that the proportion of bid rigging has likely been a more consistent 20 to 30 percent of all cartels across most historical periods.

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29 See John M. Connor, Cartel Overcharges, pp. 249-387 of *The Law and Economics of Class Actions*, in Vol. 29 of *Research in Law and Economics*, edited by James Langenfeld (March 2014). Bingley, UK: Emerald House Publishing Ltd.

30 Details and additional findings are available in Connor & Werner (2018).

31 Data for figures and statistical facts are from John M. Connor. *Price-Fixing Overcharges Master Data Set*, (Spreadsheet dated October 20, 2017). ("Connor 2017").

32 U.S. open records laws were instituted in the 1960s and 1970s. The U.S. federal Freedom of Information Act in 1967 and similar national laws elsewhere opened up valuable, large data sets on government tenders, for public works construction, for example. In the 1970s, many U.S. states passed similar laws. Similar laws were passed in Western Europe a bit later.

Fig. 3. Proportion of Overcharges from Bid-Rigging Episodes
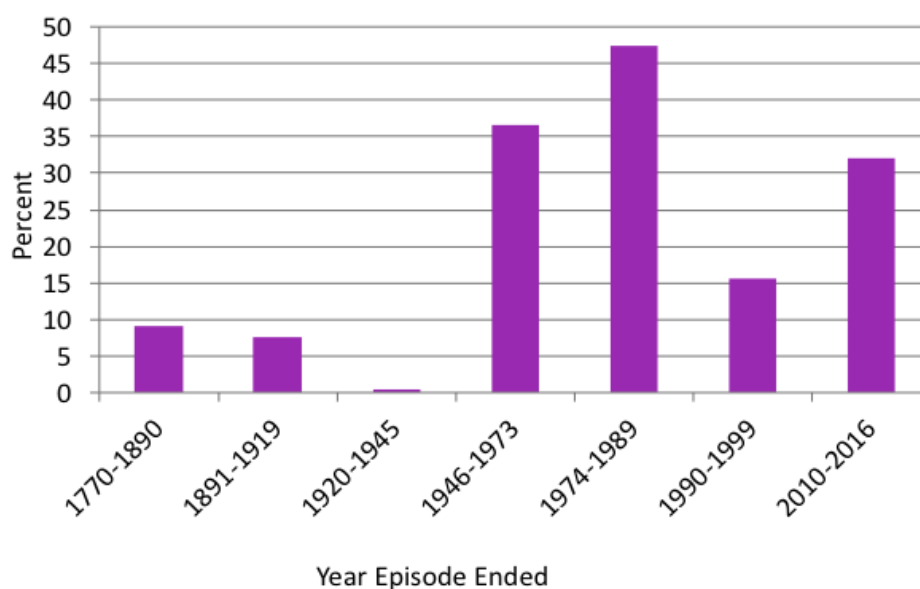
Studies of bid-rigging cartels in the 1970s and 1980s tended to focus on sub-national cartels in the United States, most of them in local dairy or construction industries. In the 1980s, these localized industries were the preferred targets of the U.S. DOJ's enforcement, which generated follow-on private damages cases.[33] Relatively few *international* cartels rely primarily on rigging auctions or tenders for public projects.[34]

Median overcharges from grouped data are higher for classic price fixing than they are for bid-rigging. On average for the whole time period, cartels engaged in "classic" price-fixing conduct generated six percentage points (32 percent) higher median episodic overcharges than those observed for bid-rigging conduct.

Studies of many bidding rings suggest that they were ineffective in controlling market prices. When only *effective* cartel episodes are examined (i.e. those with positive overcharges), classic price-fixing cartels show a remarkable 88 percent higher median overcharge than bid-rigging episodes.[35] Because bid-rigging cartels often are organized to exploit tenders for government public-works projects, some economists have hypothesized that government buyers are less competent in detecting rigged bids than are professional industrial buyers (Cohen & Scheffman 1989:345).[36] Relatively few international cartels engage primarily in bid rigging, so this conduct category may be confounded with geographic extent or industry type (most are found in construction cartels with only a national or regional scope).

Overcharges also vary systematically by the location of the cartels. PFO data show that there are significant differences in median overcharges among cartels that operated in various major regions of the world. Single-nation cartels in Western Europe display distinctly lower median overcharges than those that operated across multiple nations in Western Europe (Connor & Werner 2018: Figure 10). The highest aver-

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33 Lanzillotti, Robert F., The Great School Milk Conspiracies of the 1980s, *Review of Industrial Organization* 11 (1996):413-458.

34 The first *known* international bid-rigging cartel with overcharge estimates was the global *Heavy Electric Power Equipment* cartel (1945-1993). One possible earlier international example is the global *Quinine* cartel (1894-1966), which sold its final products through tenders issued by the militaries of many countries; moreover, the use of bid rigging by buyers in this cartel is also possible, because most raw quinine bark was sold to processors at a monthly auction in Amsterdam up to 1914.

35 Connor 2017: Table 7.

36 However, the sixty-plus cartels in the *Auto Parts* markets do not support this hypothesis, as the buyers were the world's largest auto makers.

age overcharges are achieved by global cartels, which may be one reason bid-rigging overcharges are relatively low.[37] Cartels confined to one continent hew closely to the median all-cartel average. The few geographic differences we observe may be due to the skills of the cartelists in each region, and to different business cultures, detection preferences, or inherent economic conditions across geographic regions.

Finally, we analyzed overcharges of cartel duration into two conduct categories: with and without third-party assistance.[38] Despite measurement problems, there is an extraordinary difference in the average durations of collusion between classic cartels and rings: rings endure twice as long with third-party help than without (while for cartels duration is shorter with assistance) (Connor & Werner 2018: Figure 12). This pattern suggests, as does the theory, that third-party assistance ought to be a significant factor in explaining price effects *through* its effect on duration. That is, duration and third-party assistance positively interact.

V. STATISTICAL ANALYSIS OF BID-RIGGING PRICE EFFECTS

To further understand the determinants of overcharges by bid-rigging cartels (Connor & Werner 2018) specify a reduced form regression model using a variety of potentially explanatory variables related to market structure, geography, and industry characteristics. The results of this analysis are described in a non-technical fashion in this section.

Our results suggest that, consistent with expectations, buyer and seller concentration have significant effects on the ability of bidding rings to suppress prices. When rings have high shares of their industries and face smaller numbers of buyers, rings are more effective in suppressing prices.[39] Finally, the model results suggest that cartels engaging in bid-rigging against government purchasers do not overcharge said governments more than bidding rings selling to private buyers.

Two temporal factors tend to be highly significant explanatory variables.[40] The price effects of bidding rings are inversely associated with the duration of collusion and are positively related to macroeconomic downturns during the collusive period.[41] Both of these results are, we believe, novel findings in the cartel price-fixing literature.[42]

Lastly, the model also investigates a variety of geographic variables to explain bid-rigging overcharges. However, various measures of bidding-ring geography proved to be disappointing explanatory factors, though a few outcomes contained hints that are worthy of additional future research.

VI. ANTITRUST POLICY DISCUSSION

There are two reigning theories on the optimal approach to suppressing the injurious effects of overt collusion. One approach is *deterrence*, which seeks to impose a set of penalties so severe that would-be-cartelists are discouraged entirely from *forming* new cartels – cartel infanticide, if you will. The U.S. Federal Sentencing Guidelines ("USSGs") are founded upon optimal deterrence principles. With no dramatic improvement in detection rates, optimal deterrence would likely require North American and European fines and other penalties to rise dramatically higher than current monetary penalties (Connor & Lande 2007).

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37 Few rings are global in scope (i.e. straddling continents). Dividing cartels into geographic expansiveness categories is in many ways more revealing about the mechanics of price effectiveness. When cartelists organize collusion in a sub-national region – typical of bid rigging – overcharges are lowest. The greater the geographic expanse of collusion, the greater the overcharge rates (Connor & Werner 2018: Figure 11). Two economic features may explain this trend: expansiveness of a collusive territory is positively related to the smallness of production in the fringe and to expanded opportunities for geographic price discrimination.

38 In some cases, assisting entities were fined nominal amounts for their culpability; in other cases, members of the collusive groups simply met at association meetings.

39 Specifically, comparing nearly perfectly competitive market structure to a duopoly structure results in a 23-percentage-point increase in bid-rigging overcharges. Similarly, when there are hundreds of buyers for the cartelized good, typical overcharges drop by 15 percentage points (compared to smaller numbers of buyers).

40 Including annual variables hardly improved the model's goodness of fit. Neither of the supplementary time trend controls is statistically significant.

41 The duration effect is significant but small (two or three percentage points price effect), but the recession effect is large (around 20 percentage points).

42 However, this finding does reinforce the longstanding hypothesis that collusion by any means is able to better survive the turbulence of a recessions (Berle, Adolf A. & Gardiner C. Means. *The Modern Corporation and Private Property*, New York: Macmillan (1933)).

Alternatively, a newer school of thought argues that leniency programs, antitrust screening techniques, and other enforcement improvements have raised markedly the rate of detection of clandestine cartels. If so, then proponents say that monetary penalties need not rise dramatically in order to *dissuade or destabilize* existing cartels.[43] This "Dissuasion School" is primarily interested in reducing cartel harms by shortening duration, rather than lowering the overcharge rates of existing effective cartels. Our empirical results on duration do not support the Dissuasion School, because we find that overcharges and duration are inversely related.

Very few formal guidelines for fining cartels mention bid rigging *per se* as an aggravating factor. Those in the United States call for very modest uplifts in fines. In practice, however, most jurisdictions apply more severe fines to rings than they do to classic cartels. Our statistical results give little support for this practice. We tested whether collusion was enhanced when government tenders were the targets of collusion, and found no such effect. This result questions the practice of setting government fines much higher when rings collude against public institutions as opposed to private buyers.[44] Our analysis suggest that antitrust sanctions guidelines should not necessarily treat bid rigging *per se* more harshly than other forms of collusion. Rather, the problem seems to be sub-optimal fines or low detection rates for *all* cartels and, in many jurisdictions, a legal system that is underdeveloped or hostile for private damages actions. Cartel studies contain rich suggestions for improving private rights of action against rings.[45]

Our *statistical* findings suggest that the economic injuries from contemporary bidding rings can be lowered in four ways. First, enforcement resources ought to be deployed in an anti-cyclical fashion. When recessions occur, antitrust authorities should shift resources away from merger and monopoly investigations and increase the sizes of their cartel units; investigators and forensic specialists from police agencies should also be deployed likewise. Second, managers of antitrust authorities should insist on a proper analysis or study of the structure of the purchasing industries. If they are atomistic, then fewer cases in this category should be pursued. Third, when governments are the main or sole buyers, antitrust authorities tend to ramp up resources to extract severe penalties. Our results suggest that this is an unwise redeployment. Rings exploiting private buyers deserve proportionality of enforcement. Fourth, our results also imply that antitrust authorities may have overlooked the efficacy of opening up bidding to larger numbers of better-informed purchasers. There may be a public role for setting up well-designed electronic auctions in industries prone to collusion or to improve reporting suspicions of collusion in auctions to the authorities (e.g. *individual* whistleblower reward policies seem to be working well in the few jurisdictions where they have been tried). Similarly, policies that encourage the entry of new firms in concentrated industries can also pay off. Fifth, it appears that a criminal regime with relatively high fines, an active private damages/class-action legal system, and heavy incarceration for cartel managers is conducive to lower overcharges and marginally better deterrence. Other jurisdictions should adopt similar enforcement methods.

However, we recognize that even a strong commitment to severe antitrust enforcement may not translate into effective suppression of bid rigging. For one, the factors that stimulate the formation of new cartels, that stabilize existing cartels, and that contribute to the effectiveness of ongoing cartels are not always congruent. For example, in an empirical study of prosecuted EU cartels, formation was positively related to profit shocks, the entry of new competitors, and the degree of buyer power, whereas theory suggests that these three market factors *destabilize* ongoing cartels.[46] Thus, policies that may improve cartel detection or dissuasion may not be effective in deterrence. Laboratory market experiments also confirm the difficulties of effectively designing anti-cartel policies.[47]

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43 The dissuasion approach implications for ideal penalty levels depend on parameters that are difficult to measure. Roughly speaking, doubling present penalties in the U.S. or EU may be sufficient to dissuade. See Harrington, Joseph E. *Are penalties for cartels excessive and, if they are, should we be concerned?* (posted at https://joeharrington5201922.github.io/blog.html, downloaded February 13, 2014)

44 This statistical result reinforces the descriptive data presented above: *median and mean average* bid-rigging overcharges were generally much lower than classic price fixing.

45 Marshall & Marx (2012, 2014) identify "super-plus factors" that are sufficient conditions for the fact of explicit collusion in bidding rings. Many of these factors are observable if preceded by extensive court-mandated, plaintiff-friendly discovery. For ascending-auction bidding rings they propose as plus factors: evidence of fairly rapid inter-bidder product transfers, suppression of prices below the but-for price from a well-formulated econometric model, a pattern of forbearance in bidding against the winner, and ultimate ownership of the goods for sale by non-bidding participants (non-winners) of the public auction (Marshall & Marx 2012: 244-246). For sealed-bid auctions, they propose the following plus factors: evidence of prior overt communications by ring members agreeing on low-priced bids, frequent closeness between the winning bid and the second-lowest bid; and suppression of winning prices below the but-for price from a well-formulated econometric model (Marshall & Marx 2012: 246-248).

46 Herold, Daniel & Johannes Paha, *Predicting Cartel Formation: SSRN Working Paper No. 2740528* (July 19, 2016), available at https://ssrn.com/abstract=2740528.

47 For example, Hinloopen, Jeroen & Sander Onderstal. Going Once, Going Twice, Reported! Cartel Activity and the Effectiveness of Antitrust Policies in Experimental Auctions. *European Economic Review* 70 (2014): 317-336.) demonstrate that, in the context of two standard types of auctions (the open-outcry English auction and the first-price sealed-bid auction), the widely adopted leniency program has a perverse effect on cartel stability. Antitrust enforcement *without* a leniency program ("detect and punish") had *no* effects on cartel deterrence, stability, or winning bids. Using the size of the winning bids (roughly, the inverse of overcharges), the experiments find that the policy regime does not affect English-auction bid levels. But in first-price auctions, leniency programs *are* effective in reducing bids (raising overcharges) relative to conventional policy regimes (*ibid*. Table 7).

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