GOVERNANCE AND THE EFFICIENCY OF ECONOMIC SYSTEMS
GESY

Discussion Paper No. 468

Buyer Resistance for Cartel versus Merger

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June 2014

Financial support from the Deutsche Forschungsgemeinschaft through SFB/TR 15 is gratefully acknowledged.

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June 12, 2014

Abstract

Procurement practices are affected by uncertainty regarding suppliers' costs, the nature of competition among suppliers, and uncertainty regarding possible collusion among suppliers. Buyers dissatisfied with bids of incumbent suppliers can cancel their procurements and resolicit bids after qualifying additional suppliers. Recent cartel cases show that cartels devote considerable attention to avoiding such resistance from buyers. We show that in a procurement setting with the potential for buyer resistance, the payoff to firms from forming a cartel exceeds that from merging. Thus, firms considering a merger may have an incentive to collude instead. We discuss implications for antitrust and merger policy.

*An earlier version of this paper was entitled "Cartel versus Merger." The authors thank the Human Capital Foundation (http://www.hcfoundation.ru/en/), and especially Andrey Vavilov, for financial support. We are grateful to George Bittlingmayer for discussions about the Addyston case and providing us with the Transcript of Record for the case proceedings, and we are grateful to Keith Hylton for discussions on cartel law before the Sherman Act. The paper also benefitted from the comments of the editor and two anonymous referees and discussions with Alexei Alexandrov, Stephen Davies, Hans Friederiszick, Martin Graffenberger, Ed Green, Joe Harrington, Barry Ickes, Mark Ivaldi, Doh-Shin Jeon, Bruno Jullien, Bill Kovacic, Vijay Krishna, Mike Meurer, Chip Miller, Saša Pekeč, Lars Persson, Alexander Raskovich, Patrick Rey, Mike Riordan, Jean Tirole, Keith Waehrer, Greg Werden, and Jun Zhou and from the comments of participants at the Bosphorus Workshop on Economic Design and Cartels: A Conference in Honor of Robert F. Lanzillotti and seminar participants at Bates White LLC, Curtin University, Deakin University, Duke University, ESMT, LaTrobe University, Monash University, Research Institute of Industrial Economics, Toulouse School of Economics, University of Adelaide, University of Melbourne, University of New South Wales, University of Technology Sydney, University of Western Australia, and the U.S. Department of Justice. We thank Gustavo Gudiño and Hoël Wiesner for valuable research assistance.

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1 Introduction

In the late 1800s, although neither mergers nor cartels were illegal,[1] many firms chose to form a cartel rather than merge.[2] Although cartels in this period did not need to hide their existence to avoid prosecution, they operated in a clandestine manner to disguise their presence from their customers.[3] This suggests that a key benefit of cartel formation versus merger is that a cartel can take advantage of customer beliefs that the policing action of competition is still in place.

Procurements commonly include an element of "buyer resistance," whereby buyers that are concerned that the policing action of competition is not adequate can resist high prices. As shown through a review of municipal procurements (see Appendix A.1), which are typically organized as sealed-bid competitive procurements, buyer resistance to high prices often comes in the form of buyers rejecting all bids in an initial procurement and then after some delay holding a new procurement with additional bidders present.[4] Colluding firms often face buyer resistance that limits their ability to implement collusive price increases.[5]

Considering the tradeoffs between merger and cartel formation, a merged entity does not incur costs associated with disguising its existence from its customers, and a merged entity does not have to overcome the difficulties faced by cartels associated with incentives for cartel members to secretly deviate from the terms of a collusive agreement (see Stigler,

[1] Mergers as an effort to monopolize were not recognized as a violation of the law until the resolution of *Northern Securities v. U.S.* (197 U.S. 400) (hereafter *Northern Securities*) in 1904. The operation of a cartel was not recognized as a violation until decisions of 1897 and thereafter (Bittlingmayer, 1985, p.77).

[2] As described by George Bittlingmayer (1985, p.77): "Perhaps as much as one-half of U.S. manufacturing capacity took part in mergers during the years 1898 to 1902. These mergers frequently included most of the firms in an industry and often involved firms that had been fixing prices or that had been operated jointly through the legal mechanism of an industrial trust. ... The Sherman Antitrust Act was passed in 1890, and the first crucial decisions making price fixing illegal – *Trans-Missouri* (1897), *Joint Traffic* (1898), and *Addyston* (1899) – occurred just before or during the first stages of the merger wave. Merger of competing firms remained unchallenged until 1904."

[3] See Hylton (2003, pp.30–37).

[4] The ability of federal procurement officials to reject all bids is formalized in the U.S. Federal Acquisition Regulations, which state: "Invitations may be cancelled and all bids rejected before award but after opening when ... (6) All otherwise acceptable bids received are at unreasonable prices, or only one bid is received and the contracting officer cannot determine the reasonableness of the bid price; (7) The bids were not independently arrived at in open competition, were collusive, or were submitted in bad faith." (U.S. Federal Acquisition Regulations, Section 14.404 Rejection of bids, https://www.acquisition.gov/Far/reissue/FARvol1ForPaperOnly.pdf)

[5] In the Vitamins Cartel, which included firms BASF, Roche, and Daiichi, "When BASF's customers resisted the increase, Roche supported the rise by also announcing an increase.... According to Daiichi, the concerted increase was unsuccessful because of customer resistance...." (EC Decision in *Vitamins*, par. 325) In the Cartonboard Cartel, where colluding firms sold product to packaging manufacturers referred to as converters, "The converters have on some occasions resisted a proposed price increase for cartonboard on the ground that their own customers would in their turn refuse to accept a price increase for packaging ...." (EC Decision in *Cartonboard*, par. 19)

1964). Thus, in the absence of agency problems and transaction costs inherent in large firms as in Williamson (1985) or Coase (1937), one might expect a merged entity to be able to do anything that a cartel can do and also potentially be able to do things that a cartel cannot. However, a clandestine cartel may be able to take advantage of customer beliefs that the policing action of competition might still be in place, and thus may face reduced buyer resistance. Thus, firms may prefer cartel over merger.

There are, of course, other possible explanations for a preference for cartel over merger. For example, collusion might allow the suppression of rivalry among a larger number of firms than would be permitted through merger. High fixed costs or other transactions costs of a merger might create a preference for collusion. If executives of one merging firm could lose their jobs as part of the consolidation, but would keep their jobs in the case of collusion, then they might resist a merger. Finally, if price setting behavior is similar under cartel and merger, then the firms may be close to indifferent between the two, choosing one if the other is not feasible. Although we recognize these other possibilities, we focus on the choice between merger and collusion under buyer resistance and on a model that is designed to address that issue.

In this paper, we examine whether one can understand the decision by firms to form a cartel rather than merge as an equilibrium response to buyer resistance. We consider a model in which firms have an opportunity to merge, collude, or remain noncooperative and in which there is a procurement process with the possibility for buyer resistance. We model buyer resistance as the ability of the buyer to reject initial bids and hold a new procurement after inviting additional bidders to participate.[6] In Section 2, we discuss the details of one such episode that received attention in the landmark Addyston Pipe conspiracy. For additional examples, see Appendix A.1.

As we show, firms may find a cartel structure to be more profitable than a merger when customers are uncertain as to whether nonmerged firms are operating as a cartel or not. We show that in an environment where buyers are strategic, firms prefer to collude rather than merge.

We are able to quantify the expected payoff gain from collusion versus a merger within the context of our model. We show that the incremental payoff from collusion relative to a merger with no cost efficiencies can be substantial and that the efficiency effects of a merger may not be sufficient to offset these gains. We discuss evidence from prosecuted cartels that is consistent with a choice of collusion over merger in Appendix A.2.

While cartels and horizontal mergers have been widely studied in the past,[7] there is

[6] For other approaches to modeling buyer resistance, see Harrington and Chen (2006) and Marshall, Marx, and Raiff (2008).

[7] On cartels, see the survey article by Levenstein and Suslow (2006) and the references therein. On

not much work that addresses the incentives for firms to choose between these two forms of industrial organization.[8] An exception is Bittlingmayer (1985), which directly addresses why many firms preferred colluding over merging in the past. Building on Sharkey (1973), Bittlingmayer (1985) emphasizes the role of fixed costs in industries with uncertain demand. Bittlingmayer argues that in cyclical industries, where fixed costs can be recovered during periods of high demand but not during periods of low demand, firms may prefer collusion because it allows them the flexibility to coordinate only during period of low demand, when it is necessary to recover fixed costs.

Bittlingmayer (1985) also argues that early antitrust decisions against cartels raised the cost of maintaining cartels, which left firms with merger as the next best option and resulted in the first large-scale merger wave in the U.S. between 1898 and 1904. Stigler (1950) suggests that firms in the past might have preferred to cartelize rather than merge due to the obstacles posed by large capital requirements for mergers. Stigler argues that mergers became feasible because of the development of a sound market for securities by the New York Stock Exchange at the end of the 19th century and the removal of restrictions on the formation of large corporations after 1880.

Our paper is also related to the literature examining whether a merger might trigger entry. In our model, a cost to firms that merge rather than forming a cartel is that buyers respond to the merged market structure by being more likely to encourage entry. The Horizontal Merger Guidelines of the U.S. Department of Justice and Federal Trade Commission recognize the issue of merger-induced entry with discussion of how such entry affects their evaluation of proposed mergers. Werden and Froeb (1998) use merger simulations to show that in the absence of significant efficiency gains, mergers by price-setting firms may not induce entry, implying that competition authorities cannot rely on entry to remedy anticompetitive effects from mergers. Spector (2003) extends this work, establishing conditions under which, in the absence of efficiency gains, any profitable merger decreases welfare even if it does induce entry. In contrast, Cabral (2003) shows that with endogenous entry, the possibility of post-merger entry substantially improves the effect of a merger on consumer welfare, and Davidson and Mukherjee (2007) show that with endogenous entry, under certain conditions, all privately beneficial mergers are socially beneficial.

In our model, the prices offered by colluding sellers to the buyer are constrained by the

mergers, see the survey article by Mookherjee (2006) and the references therein.

[8] One could offer a Coasian (1937) explanation for the choice between a cartel and a merged entity. The trade-off between the costs of maintaining and operating a cartel versus the cost of running a large merged entity due to, say, diseconomies of scale or agency problems, is likely to influence the "merge or cartelize" decision for firms. See Nocke and White (2007) for the effects of vertical mergers on incentives to collude and Kovacic et al. (2009) for effects of horizontal mergers. For an examination of the tradeoff between merger and predation, see, e.g., Persson (2004).

ability of the buyer to shift demand to a later period in order to qualify an additional seller to particulate in the procurement. In Snyder (1996), the buyer can also constrain collusive prices through the threat to shift demand to a later period, but the effect there arises from the dynamic nature of the game and the fact that the buyer can accumulate demand over time.[9] As Snyder (1996) shows, because buyers that have larger per-period demand are better able to create periods of high and then low demand, in equilibrium larger buyers get lower prices from sellers.

In additional related literature, in a durable goods environment, Ausubel and Deneckere (1987) show that a cartel has the commitment power to maintain static monopoly prices while a monopolist lacks this ability. Thus, industry profits are higher when incumbent firms collude rather than merge.[10]

The remainder of this paper is organized as follows. Section 2 provides motivating background and empirical evidence. Section 3 presents our model. Section 4 provides our results and considers various robustness checks. Section 5 considers merger efficiencies. Section 6 concludes.

2 Background

The *U.S. v. Addyston Pipe and Steel Co.*[11] case of 1898 is considered to be a landmark event in antitrust history (Bittlingmayer, 1982). In 1894, six southern manufacturers of cast iron pipes,[12] which are used to transport water and gas by cities and municipalities, entered into a conspiracy.[13] Before a procurement, the cartel members would participate in a pre-

[9] Snyder (1996) considers a dynamic game in which in each of an infinite number of periods, there is a procurement in which sellers submit bids. The dynamics are provided by the fact that the buyer, who has a fixed demand in each period, can decline to purchase in some periods, accumulating a backlog of unmet demand, and then purchase a larger amount in a later period. The accumulation of demand (or the threat of accumulating demand) can benefit the buyer because, as described in Rotemberg and Saloner (1986), the existence of periods of high demand followed by periods of anticipated low demand makes it more difficult for sellers to sustain collusion because the gain from a deviation in the high demand period is large relative to the future punishment for deviating.

[10] In the same paper, Ausubel and Deneckere (1987) also show that the monopolist gains the ability to commit to maintaining future prices at the static monopoly level if there is a potential entrant at each time period.

[11] *U.S. v. Addyston Pipe and Steel Co.,* 85 Fed. 271 (6th Cir. 1898) (hereafter *Addyston*). See also *U.S. v. Addyston Pipe & Steel Co.*, 175 U.S. 211 (1899).

[12] The firms involved were: Addyston Pipe and Steel Company, Dennis Long & Co., Howard-Harrison Iron Company, Anniston Pipe and Foundry Company, South Pittsburgh Pipe Works, and Chattanooga Foundry and Pipe Works.

[13] The cartel divided the U.S. into two territories, Pay Territory and Free Territory. For every ton of pipe shipped into the Pay Territory by a member, the member made a payment, referred to as a bonus payment, into a pool. For shipments into the Free Territory, no bonus payments were necessary. The cartel "reserved" certain cities for particular cartel members, which meant that other cartel members would not meaningfully

auction knock-out, bidding on the per-ton bonus payment they would make into the cartel pool. The winner—the firm that bid the highest per-ton bonus payment—would represent the cartel in the actual procurement and bid an amount fixed by the "representative board" of the cartel.[14] The other cartel members would "protect" this bid by submitting phantom bids.[15]

After about two years of operation, suspicion about the existence of the cartel was raised when at a procurement in Atlanta, cartel members that were within a hundred miles of the city bid one to two dollars higher than a noncartel company (R.D. Wood & Co.) that was one thousand miles away. All bids were rejected as being too high and a new procurement was held. Anniston (for whom Atlanta was reserved) then bid considerably lower than its original bid, suggesting that bids were not competitive in the first instance.[16]

An initial civil suit against the defendants in 1896 was decided in favor of the cartel, but in a landmark 1898 verdict, Howard Taft declared the cartel illegal.[17] The *Addyston* case, along with the railroad cartel cases involving the Trans-Missouri Freight Association and the Joint Traffic Association,[18] was instrumental in defining illegal collusion under Section 1 of the Sherman Act (Bittlingmayer, 1985).

Cartels were not illegal under the common law that existed before the Sherman Act,[19] although agreements among cartel members may have been deemed unenforceable if their primary function was restraint of trade (Jones, 1921, p.17; Hylton, 2003, pp.30–37). The Sherman Act of 1890 made cartel agreements criminal offenses and thus a matter for public enforcement authorities.[20]

While the *Addyston*, *Trans-Missouri,* and *Joint Traffic* verdicts set precedents for *collusion* being a criminal offense under the Sherman Act, in 1904 the *Northern Securities* verdict set a precedent for *merging* to form a monopoly being an offense under the Act.[21] In fact

compete for any contract with the designated cartel members in those cities. At the end of every month, the bonus payments made by the members were tallied and divided among the members based on their capacities. Transcript of Record of the Supreme Court of the United States, October Term 1899, No. 51, *Addyston Pipe and Steel et al. vs The United States* (hereafter *Addyston* Transcript of Record), p.296.

[14] *Addyston* Transcript of Record, p.70.

[15] *Addyston* Transcript of Record, p.296.

[16] *Addyston* Transcript of Record, p.299.

[17] The Supreme Court upheld the decision in 1899 in the first unanimous decision in a Sherman Act case (Whitney, 1958).

[18] *U.S. v. Trans-Missouri Freight Association*, 166 U.S. 290 (1897) (hereafter *Trans-Missouri*); *U.S. v. Joint Traffic Association*, 171 U.S. 505 (1898) (hereafter *Joint Traffic*).

[19] According to Hylton (2003, p.37), "no common law action for conspiracy to restrain trade existed." Thorelli (1954, p.53) argues that "the vast majority of cases at common law were private suits between parties to restrictive arrangements." For a more detailed discussion see Thorelli (1954, pp.36–53).

[20] See Hylton (2003, pp. 90-104) for a detailed discussion of the Sherman Act and the common law principles.

[21] *Northern Securities v. U.S.*,197 U.S. 400, was an historic Supreme Court case under the Sherman Act

in 1895, in *U.S. v. E.C. Knight,* the Supreme Court decided in favor of the American Sugar Refining Company, which was a virtual monopoly formed through the consolidation of sugar refineries.[22] Thus, there was a period between 1895 and 1904 when a large consolidation was not deemed illegal by the Supreme Court, but a cartel was.

In 1899, a little more than a year after the antitrust decision against the *Addyston* cartel by the Sixth Circuit in 1898, the cartel members merged to form the United States Cast Iron Pipe and Foundry Company (USCIP&F).[23] The firms initially chose collusion over merging, and only upon being prosecuted for collusion did they decide to merge. In fact, prior to the first wave of industrial mergers, which happened between 1898 and 1904, the chosen form of cooperation among firms in a wide range of industries seems to have been collusion rather than merger (Jones, 1921, p.6).

A review of the ten largest (in net value) manufacturing industry groups according to the U.S. census of 1900, shows that at least eight of those ten industry groups include industries in which firms that had previously cartelized went on to merge. (See Appendix A.2.) For example, in the meat packing industry, cartel members agreed to merge just ten days after their cartel was disrupted by a Department of Justice investigation.[24]

For more recent evidence, we review the European Commission decisions in cartel cases available on the European Commission website in Appendix A.2. This evidence suggests that when authorities take away collusion as an option, firms sometimes turn to mergers, acquisitions, or joint ventures as second-best options.[25]

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involving the merger of major railroad companies, which lead to the creation of Northern Securities. In 1904, the merged entity was dissolved.

[22] *U.S. v. E.C. Knight*, 156 U.S. 1 (hereafter *E.C. Knight*).

[23] Whitney (1958, vol. 2, p.7). The event involved the merger of more than two firms and so might also be referred to as a consolidation.

[24] Whitney (1958, vol. 1, p.33). As an example from the "chemicals and allied products" industry group, there was a cartel in gunpowder manufacturing called the Gunpowder Trade Association from 1872 to 1902 (by which time 95% of the industry was in the association). In 1902, Du Pont Co. took over the second-largest manufacturer, Laflin & Rand, which was also part of the association. This and subsequent mergers were consistent with the advice of Du Pont's lawyers, who cited *Addyston* as an example of collusion being perceived as illegal and cited *E.C. Knight*, where consolidation resulting in a virtual monopoly was allowed, as an example of a merger being less likely to be prosecuted (Bittlingmayer, 1985).

[25] A link between merger and collusion may also exist because the due diligence process associated with the consummation of a merger could uncover evidence that leads to the detection of a cartel. Alternatively, Ganslandt, Persson, and Vasconcelos (2012) provide a model in which merger and collusion are linked because, in their model, a merger facilitates collusion. In their environment with indivisible costs of collusion, relatively symmetric firms may be motivated to merge in order to create a relatively larger firm that is more able to cover the indivisible costs.

3 Model

3.1 Overview

We begin by considering a benchmark model that does not account for merger efficiencies, and then we introduce merger efficiencies.

We consider a procurement setting with a buyer, two incumbent sellers, and one potential new seller. In terms of the number of players, this is minimal if we are going to allow for buyer resistance by a strategic buyer that enhances competition by inviting a previously unqualified seller to participate.

We consider two coordination regimes, one in which sellers must compete noncooperatively and another in which sellers may form a cartel or merge. If the sellers merge, this is observed by all players. If the sellers do not merge, then the sellers observe whether a cartel has been formed, but the buyer does not and so is uncertain about the existence of a cartel. The cost state for the sellers is either low cost or high cost. The cost state is observed by the sellers but not by the buyer. The buyer purchases through a competitive procurement, but the buyer retains the right to suspend the procurement and invite the potential new seller as a bidder. It is costly to the buyer to do this, but it may allow the buyer to obtain a better price.

After observing the initial bids, the buyer forms beliefs about the cost state and whether there is collusion. There is a cost to the buyer of reprocurement, so if the cost state were known to be high, then there would be nothing to be gained from reprocurement and the buyer would be better off accepting high initial bids. But if the cost state is low, then the buyer may prefer to reject high initial bids because of the potential for obtaining a lower price through reprocurement. Firms would like to submit high bids but are disciplined by the threat that the buyer might reject the bids and qualify additional sellers in response.

We show that in this model, the two incumbent sellers are able to obtain higher profits if they form a cartel than if they merge. Relative to the case of merged firms, when nonmerged firms submit high bids, the buyer, who is uncertain about the existence of the cartel, attaches a greater probability to high bids being the result of high costs. Thus, given that the new seller only reduces the buyer's expected payment in a low-cost environment, the buyer is less likely to incur the cost to invite the new seller when a cartel (whose existence is not observable to the buyer) submits a high bid compared to when a merged entity submits a high bid. As a result, in the absence of merger efficiencies, firms find it more profitable to collude than to merge.

3.2 Framework

There is one buyer that wishes to procure a single item by means of a first-price procurement. There are three potential sellers: two incumbent sellers, which we label seller 1 and seller 2, and one new potential seller, which we label seller 3. We assume that with probability $\rho \in (0,1)$, the cost state is low and each seller i has cost zero, and that with probability $1-\rho$, the cost state is high and all sellers' costs are equal to 1. Sellers observe whether they are in the low-cost or high-cost state, but the buyer does not.

As just described, we assume that the sellers' costs of producing the item are bounded above by 1. In addition, we assume that the buyer has a value for the item that is substantially greater than 1. Together, these imply that the buyer sets a reserve price of 1, refusing to accept bids greater than 1, but accepting any bid less than or equal to 1.

We assume that with probability $\xi \in (0,1)$, sellers 1 and 2 are able to form a cartel or merge if they so choose. However, with probability $1-\xi$, communication costs or other organizational impediments (or, in the case of collusion, aversion to illegal activity) prevent sellers 1 and 2 from being able to form a cartel or merge. The sellers observe whether the environment permits them to form a cartel or merge, but the buyer does not, although if the sellers choose to merge, that is observed by the buyer.

We assume that the buyer can qualify seller 3 to participate as a bidder and reconduct the procurement at cost $k > 0$ to the buyer.[26]

The timing and information in the model is as follows:

Stage 0 (industry structure): The cooperation state determining the ability of the sellers to form a cartel or merge is realized and observed by the sellers but not by the buyer: cartel or merger is possible with probability ξ and not possible with probability $1-\xi$. If the formation of a cartel or merger is possible, then sellers 1 and 2 choose between merging and forming a cartel.[27] We assume that seller 3 observes whether sellers 1 and 2 are behaving noncooperatively, have merged, or have formed a cartel. The buyer, however, only observes whether sellers 1 and 2 have merged or not. (If sellers 1 and 2 do not merger, the buyer knows that they are either behaving noncooperatively or have formed a cartel, but cannot observe which.) The state of the sellers' costs is realized

[26] In many industries potential suppliers have to be pre-qualified before they are allowed to participate in the procurement. Supplier qualification process is usually costly for the procurer as it typically involves verification of quality and reliability requirements, on-site visits, and verification of insurance coverages and credit-worthiness. By limiting the quantity or scope of products or services being procured, or by otherwise redefining procurement terms, buyers may be able to encourage entry by alternative suppliers.

[27] We can also allow the firms to have the option of choosing to remain as noncooperative bidders, but in equilibrium this option is not chosen.

and observed by the sellers but not by the buyer: low with probability ρ and high with probability $1-\rho$.

Stage 1 (initial bidding): The buyer announces a procurement and all players observe the buyer's reprocurement cost k. Sellers costs are determined by the cost state.[28] A merged entity or cartel bids to maximize the joint payoff of the merged or colluding sellers. In the noncooperation state, sellers bid noncooperatively.

Stage 2 (evaluation of bids): After observing the bids, the buyer decides either to make an award to the low bidder at the amount of its Stage-1 bid or to void the initial bids and incur cost k to reconduct the procurement with seller 3 as an additional qualified bidder, in which case Stage 3 is reached.

Stage 3 (reprocurement): Sellers submit bids (the cost state remains the same), with seller 3 bidding noncooperatively, and the buyer makes an award to the low bidder at the amount of its Stage-3 bid.

We use Perfect Bayesian Equilibrium (PBE) as our solution concept.[29] In analyzing the equilibria of this game, it will be useful to break it into two separate games. We define the "merger game" to be the game above but with $\xi = 1$ and where the sellers' are required to merge. We define the "cartel game" to be the game above, but where sellers are required to act as a cartel when the cooperation state allows them to do so. This allows us to analyze the tradeoff to sellers between merging and forming a cartel and so identify equilibria of the larger game. In particular, given a PBE of the merger game and a PBE of the cartel game, where the merged entity's expected payoff in the merger game is less than a cartel's expected payoff in the cartel game, then there exists a PBE of the larger game involving the same behavioral strategies and beliefs in which the firms choose to form a cartel when the cooperation state allows them to do so.

4 Results

To analyze the game, consider the stages in reverse order.

[28] If the cost state is realized prior to the sellers' decision to merge or collude, then the results we describe below continue to hold in the low-cost state; however, the analysis is different for the high-cost state. If the cost state is realized prior to the seller's choice, then in the high-cost state the sellers are indifferent between merging, colluding, and remaining independent. Thus, the buyer's posterior beliefs are not pinned down. In the low-cost state, the buyer's posterior belief on the low-cost state following a bid of 1 would be the same as described above, so the equilibrium of the continuation game would be unchanged.

[29] If the sellers always choose to collude in the favorable cooperation state, then following the observation of a merged entity, the buyer's beliefs as to the cost state are not pinned down by Bayes' Rule. However, in a Perfect Bayesian Equilibrium, Bayes' Rule is applied even following histories that have probability zero in equilibrium and so the buyer's belief on the low-cost state conditional on observing merged firms is ρ, the prior probability of the low-cost state. See Fudenberg and Tirole (1991, p.332, condition B(ii)).

4.1 Stage 3: Post-entry bidding

Stage 3 is only reached if seller 3 has entered. Seller 3 knows whether it is competing against a merged entity, cartel, or two other noncooperative bidders.

In the high-cost state, each bidder has a cost of 1 and bids 1. The buyer pays 1 (plus the reprocurement cost k) and all sellers have zero surplus. In the low-cost state, each bidder has a cost of 0 and bids 0. The buyer pays 0 (plus the reprocurement cost k) and all sellers have zero surplus.

In what follows, to avoid uninteresting cases in which the buyer never qualifies seller 3, we assume that $k < 1$. If k is greater than 1, then the buyer prefers to accept the maximum bid of 1 in Stage 1 rather than move to Stage 3, where, at best, the buyer purchases the item for a price of 0 but must pay the reprocurement cost of k.

4.2 Stage 2: Evaluation of bids

Whether the buyer invites seller 3 to enter depends upon whether the firms merged in Stage 0, the reprocurement cost k, and the buyer's inferences from the observed bids regarding the cost state and collusion.

In the merger game, a bid less than or equal to k is accepted because the buyer can do no better in expectation through reprocurement.[30] A bid greater than k but less than 1 is rejected if it leads to the inference that the cost state is low because then the buyer can do better in expectation through reprocurement.

It remains to consider the buyer's response to a bid of 1. If the buyer rejects a bid of 1, its payment will be 0 or 1 depending on whether the cost state is low or high. Thus, the buyer is indifferent between accepting and rejecting the bid of 1 if

$$\Pr\left(\text{low cost} \mid b_m = 1\right) \cdot 0 + \left(1 - \Pr\left(\text{low cost} \mid b_m = 1\right)\right) \cdot 1 + k = 1.$$

Solving this for k, we get

$$k = \Pr\left(\text{low cost} \mid b_m = 1\right). \tag{1}$$

We let α_m denote the probability with which the buyer accepts a Stage-1 bid of 1 by a merged entity.

In the cartel game, noncooperative firms bid 0 in the low-cost state. Thus, in the cartel game if the buyer observes that both bids are equal to 1, it believes it is facing either a cartel in the low-cost state or it is facing bidders (whether colluding or not) in the high-cost state.

[30] Given that we allow continuous bidding increments, there is no equilibrium in which the buyer rejects a bid of k because then the merged entity's best response would be to bid arbitrarily close to but less than k.

The buyer is indifferent between accepting and rejecting a bid of 1 if

$$\begin{aligned}&\Pr\left(\text{low cost and cartel} \mid b_1 = b_2 = 1\right) \cdot 0 \\ &+ \left(1 - \Pr\left(\text{low cost and cartel} \mid b_1 = b_2 = 1\right)\right) \cdot 1 + k = 1,\end{aligned}$$

where the left side is the buyer's expected cost if it rejects the bids, and the right side is the buyer's cost if it accepts a bid of 1. Solving this for k, we get

$$k = \Pr\left(\text{low cost and cartel} \mid b_1 = b_2 = 1\right). \tag{2}$$

If a buyer facing nonmerged firms receives two bids of 1, we let α_c be the probability that it accepts a randomly chosen bid and $1 - \alpha_c$ be the probability that it rejects both bids.

4.3 Stage 1: Initial bidding

In the initial bidding, in the high-cost state, all bids less than 1 are weakly dominated by a bid of 1, and so we have the following result.

Lemma 1 *In any PBE involving non-weakly-dominated bids, all bidders bid* 1 *in the high-cost state.*

Given Lemma 1, in any PBE involving non-weakly-dominated bids, the buyer's posterior belief on the low-cost state following a bid less than 1 is 1. Thus, it is a unique best reply for the buyer to accept bids that are less than k and reject bids that are greater than k but less than 1. It follows that in equilibrium a merged entity or cartel will never bid less than k. It also follows that in equilibrium a merged entity or cartel will never bid more than k but less than 1. To see this, note that in the low-cost state a merged entity or cartel prefers a positive bid less than k, which is accepted, over a bid that is more than k but less than 1, which is rejected. Thus, we have the following result.

Lemma 2 *In any PBE involving non-weakly-dominated bids, in the low-cost state a merged entity or cartel bids either* k *or* 1*.*

Given Lemma 2, we consider equilibria in which in the low-cost state the merged entity or cartel mixes between bidding k and 1, with probability β_m on a bid of 1. We consider equilibria in which a bid of k is accepted with probability 1,[31] and as described above we

[31] In any equilibrium in which the merged entity or cartel bids k, that bid is accepted with probability 1. If there exists an equilibrium in which a bid of k is not accepted with probability one, then there is an outcome-equivalent equilibrium in which it is.

let α_m be the probability with which the buyer accepts a bid of 1 from a merged entity and α_c be the probability with which the buyer accepts a bid of 1 when it receives two bids of 1 from nonmerged firms. Competitive firms bid zero in the low-cost state.

Given bidding strategy β_m, the buyer's posterior on the low-cost state following a bid of 1 from a merged entity is

$$\gamma_m \equiv \frac{\beta_m \rho}{\beta_m \rho + 1 - \rho}.$$

In equilibrium, if $\beta_m \in (0,1)$, the merged entity must be indifferent between bidding k and receiving payoff k and bidding 1 and receiving payoff 1 with probability α_m and payoff zero with probability $1-\alpha_m$. If $\beta_m = 0$, then it must be that $k \geq \alpha_m$, and if $\beta_m = 1$, then it must be that $k \leq \alpha_m$. We can write this as

$$\alpha_m \begin{cases} \leq k & \text{if } \beta_m = 0 \\ = k, & \text{if } \beta_m \in (0,1) \\ \geq k, & \text{if } \beta_m = 1. \end{cases}$$

In equilibrium, if $\alpha_m \in (0,1)$, the buyer must be indifferent between accepting a bid of 1 and paying 1 and rejecting a bid of 1 and paying zero with probability γ_m and 1 with probability $1-\gamma_m$ plus the reprocurement cost k, implying that $1 = 1 - \gamma_m + k$, which using the definition of γ_m implies $\beta_m = \frac{k-\rho k}{\rho - \rho k}$, which lies in $(0,1)$ if and only if $k < \rho$. If $\beta_m = 0$, then $\gamma_m = 0$, which implies $\alpha_m = 1$, which implies $\beta_m = 1$, which is a contradiction. Putting these together, we have

$$\beta_m = \begin{cases} \frac{k-\rho k}{\rho - \rho k}, & \text{if } k < \rho \\ 1 & \text{otherwise} \end{cases} \quad \text{and} \quad \alpha_m = \begin{cases} k, & \text{if } k < \rho \\ \in [k,1], & \text{if } k = \rho \\ 1, & \text{otherwise.} \end{cases}$$

As this shows, for high reprocurement cost, the merged entity always bids 1. Otherwise, the merged entity mixes. As the reprocurement cost increases from zero to ρ, the merged entity is increasingly likely to bid 1.

In the cartel game, similar to the case of a merged entity, there exists an equilibrium in which cartel firms submit identical bids, randomized between k and 1, with probability β_c on bids of 1. The difference is that with nonmerged firms, the buyer's posterior on the low-cost state following bids of 1 is

$$\gamma_c \equiv \frac{\beta_c \rho \xi}{\beta_c \rho \xi + 1 - \rho},$$

implying that

$$\beta_c = \begin{cases} \frac{k-\rho k}{\rho\xi-\rho\xi k}, & \text{if } k < \frac{\rho\xi}{1-\rho+\rho\xi} \\ 1 & \text{otherwise} \end{cases} \quad \text{and } \alpha_c = \begin{cases} k, & \text{if } k < \frac{\rho\xi}{1-\rho+\rho\xi} \\ \in [k,1], & \text{if } k = \frac{\rho\xi}{1-\rho+\rho\xi} \\ 1, & \text{otherwise.} \end{cases}$$

Thus, the cartel bids 1 for a larger range of reprocurement costs relative to a merged entity. In the range of reprocurement costs where both the cartel and merged entity mix, the cartel places greater probability weight on bids of 1.

As Figure 1 shows, in the low-cost state, the cartel's expected bid is greater than the merged entity's expected bid for all values of the reprocurement cost less than ρ.

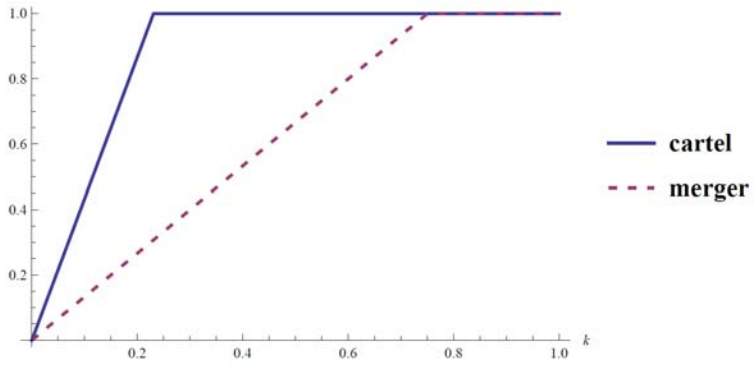

Figure 1: Expected bids in the low-cost state by a cartel and merged entity as a function of k (assumes $\rho = 0.75$, $\xi = 0.1$)

The equilibria for the cases of merged and nonmerged firms are similar. However, the key difference is that the posterior beliefs following the observation of bids of 1 differ. For the case of nonmerged firms, bids of 1 could be the result of high costs or possibly a low-cost cartel attempting to pool with the high-cost bidders. Because the cartel has the possibility to pool with high-cost noncooperative firms as well as high-cost cartels, the posterior belief on costs being low following the observation of bids of 1 is lower in the case of nonmerged firms than in the case of merged firms. That means that the buyer is more likely to accept bids of 1 made by nonmerged firms than a bid of 1 made by a merged firm. Because the buyer is more likely to accept bids of 1 made by a cartel, the cartel is more likely to submit bids of 1 than the merged entity.

4.4 Stage 0: Cartel versus merger

Consider Stage 0, during which the industry structure for the suppliers is determined. If the state is such that coordination is possible, firms 1 and 2 decide whether to merge or form a cartel. Conditional on k, the expected payoff from merging is

$$\rho\left(\beta_m\alpha_m + (1-\beta_m)k\right) = \begin{cases} \rho k, & \text{if } k < \rho \\ \in [\rho k, \rho], & \text{if } k = \rho \\ \rho, & \text{if } k > \rho, \end{cases}$$

and the expected payoff from forming a cartel is

$$\rho\left(\beta_c\alpha_c + (1-\beta_c)k\right) = \begin{cases} \rho k, & \text{if } k < \frac{\rho\xi}{1-\rho+\rho\xi} \\ \in [\rho k, \rho], & \text{if } k = \frac{\rho\xi}{1-\rho+\rho\xi} \\ \rho, & \text{if } k > \frac{\rho\xi}{1-\rho+\rho\xi}. \end{cases}$$

Thus, for any reprocurement cost k, firms at least weakly prefer to form a cartel rather than merge, and for $k \in (\frac{\rho\xi}{1-\rho+\rho\xi}, \rho)$, the firms strictly prefer to form a cartel.

As shown in Figure 2, which depicts expected payoffs in the low-cost state, for low values of k, i.e., $k < \frac{\rho\xi}{1-\rho+\rho\xi}$, the expected payoff from merging and forming a cartel is the same. In both cases, the bidders mix between bidding k and bidding 1, and because the bid of k is accepted with probability 1 and the bid of 1 is accepted with probability k, the expected payoff for both is k. The expected payoff is also the same for high values of k, i.e., $k > \rho$, where the buyer always accepts a bid of 1 regardless of whether the bidders are merged or not. For intermediate values of k, the expected payoff from cartel is greater.

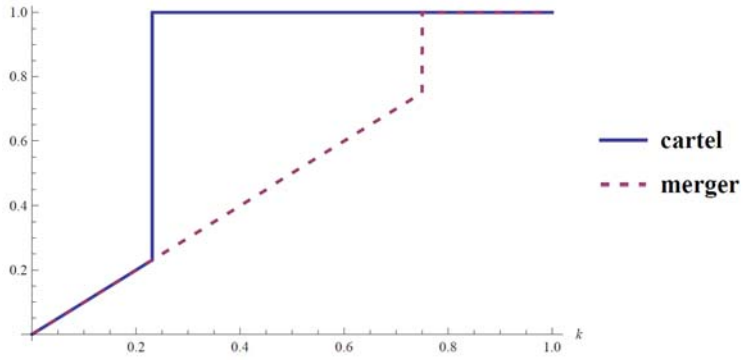

Figure 2: Expected payoffs to sellers 1 and 2 in the low-cost state as a function of k (assumes $\rho = 0.75$, $\xi = 0.1$)

In the context of our model, the incremental payoff from forming a cartel versus merging

can be substantial. For example, for the parameters shown in Figure 2, in the low-cost state, the payoff from a cartel can be over three times that of a merger. If we assume k is uniformly distributed on $[0, 1]$, then under the parameters of Figure 2, in the low-cost state the expected payoff from forming a cartel is almost 50% larger than from merging. The advantage of cartel over merger varies with ρ and ξ as depicted in Figures 3 and 4. For extreme values of ρ, the probability of the low-cost state, of either zero or 1, there is no benefit to cartel over merger. The benefit to cartel comes from its affect on the buyer's posterior belief on the low-cost state following the observation of a high bid, but if there is no uncertainty about the cost state, then this effect is not present.

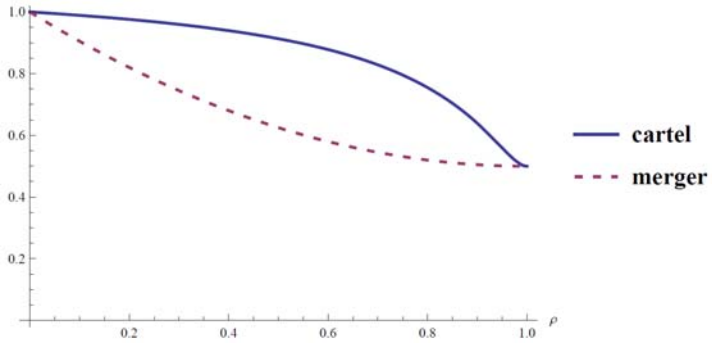

Figure 3: Expected payoffs to sellers 1 and 2 in the low-cost state as a function of ρ (assumes $k \sim U[0, 1]$ and $\xi = 0.1$)

As shown in Figure 4, the incremental benefit of forming a cartel over merging is greater when ξ, the probability that the state of the world permits collusion, is low. The cartel benefits from a buyer's belief that a cartel is unlikely and so high bids most likely reflect competitive bidders in the high-cost state.

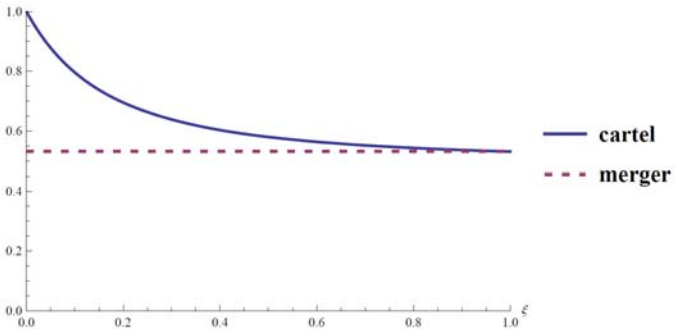

Figure 4: Expected payoffs to sellers 1 and 2 in the low-cost state as a function of ξ (assumes $k \sim U[0, 1]$ and $\rho = 0.75$)

We formally state our result that the sellers are weakly better off choosing a cartel over a merger, and strictly better off for some values of k, as follows.

Proposition 1 *In the unique PBE outcome involving non-weakly-dominated bids, the continuation payoff from forming a cartel is weakly greater than from merging, and strictly greater for* $k \in \left(\frac{\rho\xi}{1-\rho+\rho\xi},\ \rho\right)$.

As we have demonstrated above, a cartel is better able to exploit the buyer's uncertainty about the state to successfully submit high bids when in the low-cost state. Additional uncertainty about the existence of a cartel leads the buyer to be more lenient in terms of accepting higher prices relative to when it faces a merged entity. Stated differently, a merged entity faces greater buyer resistance than firms operating as a cartel when the buyer is uncertain as to whether the firms are in a cartel or acting noncooperatively.

We assume a particular type of buyer resistance, namely the ability of the buyer to, at a cost, induce an additional supplier to bid at the procurement. In the low-cost state, this effort on the part of the buyer reduces the price it must pay to zero. We can allow more general buyer resistance by letting R_m and R_c denote the benefit to the buyer from resistance in the low-cost state relative to paying a price of 1 when facing a merged entity and cartel, respectively. In the model of this paper, $R_m = R_c = 1$ because the presence of seller 3 reduces the price to zero in the low-cost state; however, buyer resistance might take different forms and might be differentially effective against a merged entity versus a cartel. Assuming that following a bid of one in the low-cost state, when the buyer resists, the merged entity or cartel receives an expected payment of $1 - R_m$ or $1 - R_c$, respectively, then the equilibrium in the more general model has similar characteristics to the one derived here, but the decision in stage 0 by sellers 1 and 2 whether to merge or collude depends on the effectiveness of buyer resistance vis-a-vis merged firms versus cartels.

4.5 Immediate qualification of seller 3

In our model, it is not a choice for the buyer to immediately qualify seller 3; however, that option can be introduced. If the buyer immediately qualifies seller 3, then it holds a single auction, buying at the lowest bid. In this extensive form, the buyer at least weakly prefers to consider bids from sellers 1 and 2 before potentially qualifying seller 3. In fact, the buyer's expected payment is lower if it holds the Stage 1 procurement without seller 3

than if it immediately qualifies seller 3, regardless of the cost state.[32] A similar result holds conditional on the buyer's observing nonmerged firms. Thus, the buyer weakly prefers to "test the waters" by soliciting bids from sellers 1 and 2 before qualifying seller 3. The buyer benefits from being able to use the information obtained in the first procurement to inform its decision about whether or not to incur the expense of qualifying an additional supplier.

4.6 More than two incumbent sellers

The results of our model hold with $N > 2$ incumbent sellers as long as the firms remain symmetric and as long as the all N firms simultaneously choose either to form an all-inclusive cartel or an all-inclusive merger. Given our assumption that costs are either zero or one, we could also allow firms to choose to form a non-all-inclusive cartel, but this does not happen in equilibrium because non-all-inclusive collusion yields zero payoff for the firms because in that case the cartel must compete with the noncooperative sellers outside the cartel. In addition, under the assumption of that firms choose either an all-inclusive cartel or an all-inclusive merger, the results easily extend to the N-firm case in a more general model with continuous costs. However, with continuous costs, allowing for non-all-inclusive cartels or mergers would lead to the usual tractability problems associated with having asymmetric bidders at a first-price auction.

4.7 Cost structure of the sellers

In a prior version of this paper (Kumar et al., 2013), we consider an alternative cost structure such that in the low-cost state the sellers' *idiosyncratic* costs are distributed uniformly between zero and one and are independent conditional on the low-cost state. In the

[32] If the buyer immediately qualifies seller 3, its expected payment is $\rho \cdot 0 + (1-\rho) \cdot 1 + k = 1 - \rho + k$. Conditional on observing a merged entity, the buyer's expected payment in the low-cost state is

$$\begin{aligned} \beta_m \alpha_m + (1-\beta_m)k + \beta_m(1-\alpha_m)k &= \beta_m \alpha_m (1-k) + k \\ &= \begin{cases} \frac{k^2}{\rho}(1-\rho) + k, & \text{if } k < \rho \\ 1, & \text{otherwise.} \end{cases} \\ &\leq 1 - \rho + k, \end{aligned}$$

and the buyer's expected payment in the high-cost state is

$$\begin{aligned} \alpha_m + (1-\alpha_m)(k+1) &= \begin{cases} 1 - k^2 + k, & \text{if } k < \rho \\ 1, & \text{otherwise.} \end{cases} \\ &\leq 1 - \rho + k. \end{aligned}$$

high-cost state the cost are identically equal to one.[33] Thus, in the low-cost state sellers have imperfectly correlated costs and upon reaching Stage 3 their expected payoffs are non-zero. The latter ensures that seller 3 has an incentive to enter in Stage 3 even if it faces a non-zero entry cost—it enters the procurement as long as the cost of entry is at most equal to its expected payoff from participation.

Our main result continues to hold in this environment. Specifically, we solve for an equilibrium such that in both the merger game and the cartel game the buyer's actions are characterized by two cut-offs in the cost of qualifying seller 3. In particular, when the buyer observes a Stage 1 bid equal to 1: (i) if the qualification cost is less than the lower cutoff, the buyer qualifies seller 3 with probability 1; (ii) if the qualification cost is greater than the higher cutoff, the buyer qualifies seller 3 with probability 0; and (iii) if the qualification cost is between the two cutoffs, the buyer qualifies seller 3 with probability within $(0, 1)$.

Let $\overline{k}^M$ and $\overline{k}^C$ be the higher cutoffs for the merger game and cartel game respectively. We show that irrespective of the value of ξ, in equilibrium $\overline{k}^C < \overline{k}^M$. Therefore for $k \in (\overline{k}^C, \overline{k}^M)$, the buyer behaves differently in the cartel versus the merger game. In the cartel game the buyer accepts a bid of 1 in Stage 1, but in the merger game it does not accept such a bid. As a result, for these values of k, the cartel's payoff is greater than that of the merged entity's. Moreover, we show that for all other values of k, the cartel's payoff is at least equal to that of the merged entity's. Thus, forming a cartel is preferred over a merger in this environment as well.

4.8 Allowing collusion with seller 3

In our model firms 1 and 2 cannot collude or merge with firm 3; however, we could allow potential collusion with firm 3 without changing our main results. One way of modelling collusion with firm 3, similar to how collusion between 1 and 2 is modelled, is to assume that the environment is either "collusion-free" or "collusion friendly." Formally, with probability $\xi' \in (0, 1)$, after firms 1 and 2 have either merged or formed a cartel and after firm 3 has been invited, firms 1 and 2 can choose to collude with firm 3.[34] With probability $1 - \xi'$, collusion with firm 3 is not possible due to high communication costs or other impediments. Whether the environment allows collusion with 3 is observed by all sellers but is not observed by the buyer.

[33] We can allow for a diffuse cost distribution in the high-cost state as well, but this does not result in any additional insights. Our only requirement is that the low-cost and the high-cost states have disjoint supports. Essentially, we model the different cost states as a result of a shift in the support of the cost distribution.

[34] Firms 1 and 2 are indifferent between collusion and merger with firm 3. The second procurement is the last stage of the game, and in that stage the buyer makes a purchase if the lowest bid is less than or equal to 1. Thus, collusion and merger yield the same payoff of 1.

This additional feature of the model changes the equilibrium beliefs and strategies as follows: if the state is such that collusion with 3 is possible, then all sellers always bid 1 both in stage 2 and in stage 1, and sellers 1 and 2 are indifferent between merging and colluding in the first stage.[35] If the state does not allow collusion with 3, then the sellers' equilibrium bids are similar to those characterized in the baseline model. The only difference comes from the change in the buyer's posterior beliefs. The new posterior beliefs are:

$$\gamma_m^{'} = \frac{\beta_m \rho(1-\xi^{'})}{\beta_m \rho(1-\xi^{'}) + \rho\xi^{'} + 1 - \rho} = \frac{\beta_m \rho(1-\xi^{'})}{\beta_m \rho(1-\xi^{'}) + 1 - \rho(1-\xi^{'})}$$

and

$$\gamma_c^{'} = \frac{\beta_c \rho\xi(1-\xi^{'})}{\beta_c \rho\xi(1-\xi^{'}) + 1 - \rho\xi(1-\xi^{'})}$$

Letting $\rho^{'} \equiv \rho(1-\xi^{'})$, we can rewrite the posterior beliefs as

$$\gamma_m^{'} = \frac{\beta_m \rho^{'}}{\beta_m \rho^{'} + 1 - \rho^{'}} \text{ and } \gamma_c^{'} = \frac{\beta_c \rho^{'} \xi}{\beta_c \rho^{'} \xi + 1 - \rho^{'}}.$$

Thus, allowing for potential collusion with firm 3, modelled as above, is equivalent to scaling down the prior probability of the low-cost state. As a result, the buyer accepts a bid of 1 and the sellers bid 1 more often in equilibrium. In this augmented model, when the environment is such that 1 and 2 can choose to collude or merge, but it is not possible for them to collude with 3, firms 1 and 2 weakly prefer collusion over merger as in the baseline model.

4.9 Cartel detection

In our model a cartel has no incentive to try to disguise its presence other than using bids that mimic bids in the high-cost state. However, in the case of nonmerged firms, bids of k in Stage 1 allow the inference of collusion. In addition, Stage 3 bids that are zero when the Stage 1 bids are 1 also allow the inference of collusion in the first stage. If a cartel faced penalties from detection, either from legal enforcement or from lost future profits due to increased buyer resistance in the future (for example, the equilibrium might revert to that associated with a merged entity), then that would potentially affect cartel behavior.

As an example, suppose that any payments to a colluding firm from the buyer must be reimbursed (plus some infinitesimally small penalty paid to a regulator to avoid indifferences) if the behavior produces an inference that with probability one the cost state is low but the

[35] In our model, forming cartel can be more profitable than a merger only when buyer resistance is possible. If firms 1 and 2 are allowed to collude with firm 3, then buyer resistance is infeasible and collusion and merger are payoff equivalent.

firms were bidding above zero because they were colluding. Then a cartel in the low-cost state will only bid 0 or 1 in the low-cost state. If a bid of 1 by the cartel is accepted, the cartel is not detected and there is no penalty, but if a bid of 1 is rejected, then the cartel's payoff is zero. In this revised model, let $\hat{\beta}_c$ be the probability weight on 1 in the cartel's strategy, $\hat{\gamma}_c$ be the buyer's posterior on the low-cost state following bids of 1, and $\hat{\alpha}_c$ be the buyer's acceptance probability. The optimality of the cartel's strategy implies that $\hat{\alpha}_c = 0$ whenever $\hat{\beta}_c < 1$, and the optimality of the buyer's strategy implies that when $\hat{\alpha}_c \in (0,1)$, the buyer is indifferent between accepting a bid of 1 and paying 1 and rejecting it and having an expected payment of $1 - \hat{\gamma}_c + k$, which implies $\hat{\beta}_c = \frac{k-\rho k}{\rho\xi - \rho\xi k}$. It follows that an equilibrium is

$$\hat{\beta}_c = \begin{cases} \frac{k-\rho k}{\rho\xi-\rho\xi k}, & \text{if } k < \frac{\rho\xi}{1-\rho+\rho\xi} \\ 1 & \text{otherwise} \end{cases} \quad \text{and } \hat{\alpha}_c = \begin{cases} 0 & \text{if } k < \frac{\rho\xi}{1-\rho+\rho\xi} \\ \in [0,1], & \text{if } k = \frac{\rho\xi}{1-\rho+\rho\xi} \\ 1, & \text{otherwise.} \end{cases}$$

The expected payoff for a cartel with detection concerns as modeled here, conditional on k, is

$$\rho\hat{\beta}_c\hat{\alpha}_c = \begin{cases} 0, & \text{if } k < \frac{\rho\xi}{1-\rho+\rho\xi} \\ \in [0,\rho], & \text{if } k = \frac{\rho\xi}{1-\rho+\rho\xi} \\ \rho, & \text{if } k > \frac{\rho\xi}{1-\rho+\rho\xi}. \end{cases}$$

It is clear that the expected payoff for a cartel is reduced when there are detection concerns, in particular the cartel with detection concerns has payoff 0 instead of k in the low-cost state when $k < \frac{\rho\xi}{1-\rho+\rho\xi}$, but it is still the case that the expected payoff from forming a cartel is greater than from merging when $k \in \left(\frac{\rho\xi}{1-\rho+\rho\xi},\ \rho\right)$. This size of this range is concave in ρ and decreasing in ξ. As shown in Figure 5, depending on parameters, sellers may still prefer to form a cartel even with detection concerns. The figure shows that when k is uniformly distributed on $[0,1]$, the expected payoff from forming a cartel with detection concerns exceeds that from forming a merger for values of ρ and ξ sufficiently low, i.e., when the cost-state is sufficiently likely to be low and when it is sufficiently unlikely that cartels are able to form.

We conclude that even with detection concerns, as long as penalties for collusion are not too severe, low-cost cartels can continue to have an advantage over merged entities because they face less buyer resistance, enabling them to more often obtain business at high prices.

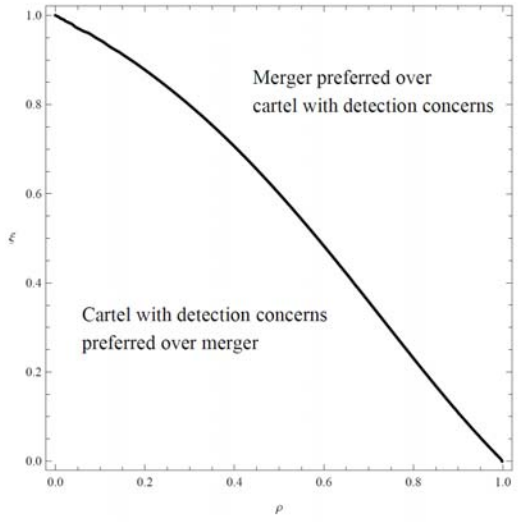

Figure 5: Parameter ranges for which the expected payoff to sellers 1 and 2 in the low-cost state is greater as a merged entity versus a cartel with detection concerns (assumes $k \sim U[0,1]$)

5 Merger efficiencies

There are many potential motivations for mergers. A merger may create value by, for example, increasing economies of scale, enabling cross-product selling, improving management, or combining unique capabilities or resources. Cross-border mergers may allow firms to, for example, overcome adverse government policy, circumvent tariffs, circumvent barriers to trade, or facilitate entry into a new market. In addition, mergers may be motivated by concerns of diversification, taxes, managers' personal incentives, or other things. (See, e.g., Andrade, Mitchell, and Stafford, 2001.)

The U.S. Horizontal Merger Guidelines state that "a primary benefit of mergers to the economy is their potential to generate significant efficiencies."[36] A prior history of collusion between merger applicants indicates that, in the past, the firms chose collusion over merger, indicating that efficiency gains were outweighed by other considerations, such as the increase in buyer resistance that comes with merger. Competition authorities may want to evaluate claims of cost efficiencies from the proposed merger in light of this history.

When authorities take away collusion as an option, firms may turn to merger as a second-best option. The evidence from the industrial merger wave of 1898 to 1904 suggests that there is a benefit to forming a clandestine cartel even when compared to a merger among all

[36] U.S. Horizontal Merger Guidelines, p.29, available at http://www.justice.gov/atr/public/guidelines/hmg-2010.pdf (accessed November 26, 2012).

of the firms in an industry.[37]

The timing of a merger raises interesting questions. A merger following a period of collusion may reflect value to the parties from suppression of rivalry as well as from merger efficiencies, where those merger efficiencies were previously outweighed by the benefit of reduced buyer resistance from collusion. A merger that apparently does not follow a period of collusion raises the question of why any merger efficiencies are sufficient now to induce a merger, but not previously.

There are a number of ways in which one might allow for merger efficiencies within the context of our model. To offer one extreme example, consider the case in which when firms merge, the probability of the low-cost state is one.[38] We can compare the expected payoffs of a merged entity with this type of extreme cost efficiencies to a merged entity without efficiencies and to a cartel. For the purposes of this comparison, we assume that the reprocurement cost k is uniformly distributed over the interval $[0, 1]$. The merged entity with extreme cost efficiencies always bids k, so the merged entity's expected payoff is $\frac{1}{2}$. The cartel's payoff for a given k is $\rho\left(\beta_c\alpha_c + (1-\beta_c)k\right)$, implying an expected payoff of

$$\begin{aligned}\pi_c(\rho) &= \int_0^{\frac{\rho\xi}{1-\rho+\rho\xi}} \rho\left(\frac{k-\rho k}{\rho\xi-\rho\xi k}k + (1-\frac{k-\rho k}{\rho\xi-\rho\xi k})k\right)dk + \int_{\frac{\rho\xi}{1-\rho+\rho\xi}}^1 \rho dk \\ &= \int_0^{\frac{\rho\xi}{1-\rho+\rho\xi}} \rho k dk + \int_{\frac{\rho\xi}{1-\rho+\rho\xi}}^1 \rho dk,\end{aligned}$$

which one can show is greater than $\frac{1}{2}$ for $\rho \in \left(\frac{3+\sqrt{1-4\xi}-2\xi}{4-4\xi+2\xi^2}, 1\right)$, which is nonempty for $\xi \in \left(0, \frac{1}{4}\right)$. Thus, as long as the cooperation state that allows cartel formation is sufficiently rare, there exists $\overline{\rho} < 1$ such that cartel is preferred to merger for all $\rho \in (\overline{\rho}, 1)$.

As you can see from Figure 6, for $\xi = 0.1$, cartel formation is preferred over a merger with extreme cost efficiencies for all ρ greater than approximately 0.55. (Note that Figure 3 provides expected payoffs in the low-cost state, whereas Figure 6 provides overall expected payoffs, multiplying by the probability ρ of the low-cost state.)

We conclude from Figure 6 and related calculations that, in theory, it is possible for the value to a clandestine cartel in terms of reduced buyer resistance to be sufficiently large that

[37] See Waehrer (1999) on incentives for firms to form smaller versus larger merged entities and Waehrer and Perry (2003) on incentives for only a subset of firms in an industry to merge in environments with strategic buyers. Recent empirical work by Davies, Ormosi, and Graffenberger (2014) and Marx and Zhou (2014) points to an increase in mergers among formerly colluding firms once the collusion ends.

[38] We have considered other ways to model this, including assuming that sellers draw their costs from the uniform distribution on $[0, 1]$ in the low-cost state and that a merger with efficiencies has a cost of zero in the low-cost state. This reinforces the basic conclusion that the buyer resistance effect can outweigh even seemingly significant merger efficiencies.

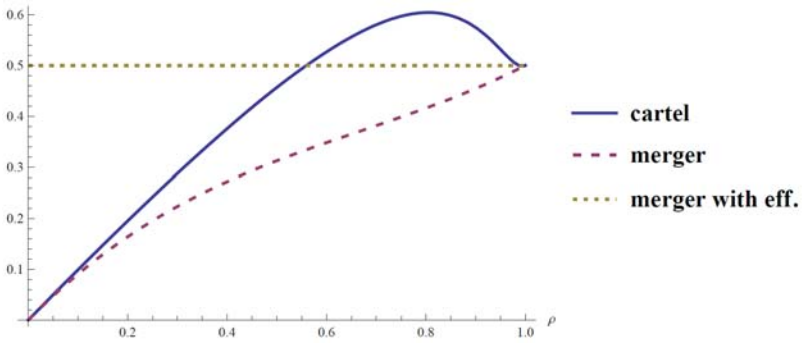

Figure 6: Expected payoffs to a cartel and merged entity with and without cost efficiencies as a function of ρ (assumes $k \sim U[0,1]$ and $\xi = 0.1$)

it could outweigh even significant merger efficiencies.

6 Conclusion

It might seem that a merged entity should be able to do anything that a cartel can do, plus more, and so should earn higher profits than a cartel. But in the late 1800s, when firms were relatively unencumbered in the choice between merging or forming a cartel, many chose to function as a cartel. In a review of recent cartel cases at the European Commission, a substantial number of cartel cases are followed by mergers, acquisitions, or joint ventures among a subset of the colluding firms.

Whereas a merger is a publicly observed event, a cartel is a clandestine operation. Other noncartel firms in an industry may be aware of the existence of a cartel, but the buyers that procure from colluding firms are usually uncertain about the existence of the cartel. In a model that parallels buyer procurement practices as well as the informational environment that confronts procurement participants, we show that a cartel can hide behind the possibility that their members might be noncooperative bidders to enhance their profits relative to a merged entity. Our model suggests that the incremental profits available to firms from collusion rather than merger can be substantial and can potentially outweigh even significant merger efficiencies.

The results suggest that buyers should, if possible, maintain the ability to cancel a procurement after observing the bids and to hold a new procurement with additional qualified bidders. In addition, the results have a number of implications for procurement policies. Procurement policies should limit restrictions on the types of bidders that purchasers can qualify to participate in procurement, particularly following an initial procurement in which bids were viewed as high. Procurement policies should not impose required waiting peri-

ods before reprocurement or require that the terms of a procurement be modified before a replacement procurement can be held. In the context of our model, these policies would increase the reprocurement cost k, which increases incentives for collusion among sellers and disadvantages the buyer.

Related to the evaluation of mergers, the results suggest that competition authorities should evaluate claims of significant cost efficiencies by merger applicants in light of any history of collusion between the firms. Merger applicants with a history of collusion should be asked to explain why the firms previously viewed cost efficiencies as sufficiently small that they chose to forego those cost efficiencies and instead suppress rivalry by colluding rather than merging.

We show that even in environments where mergers do not require government approval, cartels can be preferred to merger by the firms in an industry because collusion allows them to suppress rivalry while mitigating buyer resistance. If government scrutiny of mergers increases the costs associated with merging, then there will be more industries in which the firms choose cartel over merger. Although it seems reasonable that the social cost of a cartel is larger than the social cost of approving a merger that should not have been approved, this tradeoff is not part of current merger review because policy makers condition on firms obeying the antitrust laws in the event that the merger is not approved. Although there are many possible motivations for merger, if the suppression of rivalry was an important motivation for the merger, but the merger was not approved, then the firms may have an incentive to consider collusion.

Overall, our analysis highlights the importance of accounting for strategic action by buyers during the procurement process. In practice, buyers are not passive but, rather, actively evaluate the competitive process during a procurement and make profit-enhancing adjustments to increase the policing function of competition as deemed appropriate.

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A Appendix For Online Publication

A.1 Appendix: Bid rejections and reprocurement in practice

In order to seek the best value when acquiring products or services, firms typically use competitive procurements. Governments, whether local, state or federal, are typically required by law to use competitive procurements. In order to participate in a procurement, a seller must either be directly invited by the buyer or satisfy a qualification process to be included in the bidding. For example, a seller with inadequate financial resources to ensure completion of a contract, or one that has performed poorly in the past, may be excluded from participation in a current procurement. In addition, a potential bidder that does not expend resources to qualify and that is unknown to the buyer may be excluded. For any typical competitive procurement, it is common for there to exist potential suppliers that are either not invited to bid or that do not seek qualification as a bidder.

Almost all procurement rules allow for the buyer, after receipt of all bids, to make no award and void the procurement. During the course of a procurement, a buyer may observe actions by the bidders, including their actual bids, that cause the buyer to believe that they are not obtaining the best value. In that case, a buyer may undertake some incremental action to invigorate the policing action of the competitive process and reconduct the procurement with this new competitive pressure in place. One such action is to invite and seek qualification of sellers that did not participate in the initial round of bidding. If one or more new sellers can be identified, then the procurement may be reopened and new bids solicited.

Overall, a common sequence for procurements in private industry and the public sector is as follows.

1. *Initial bidding:* Invite qualified sellers to participate and obtain initial bids.
2. *Evaluation:* If the initial bids are "reasonable," then make an award. If the bids provide the buyer with less surplus than expected, then consider voiding the initial procurement.
3. *Possible additional bidding:* If the initial procurement was voided, consider seeking additional competitive pressure, conducting a new procurement, and making an award based on the new bidding.

These common procurement practices guide our modeling framework.

In what follows, we provide a review of public procurements conducted by U.S. cities and towns, which generated the observations above. As background, in these procurements the bid specifications typically indicate that the city has the right to award the contract to the lowest responsive bidder, or to reject any and all bids.

In Table A.1, we summarize twenty recent examples of procurements in which all initial bids were rejected by the relevant government decision maker because the lowest responsive bid was unacceptably high for the buyer.[39]

Table A.1: Bid rejections and reprocurement[40]

City	Project	Industry	Number of Bidders	Date	Reason for Rejection
Belmont	Overhaul and upgrade Sewer and Pump Station pumps, holding tanks, and consultants	Construction / Renovation	4	01.09.07	Not sufficient funding in project budget to award to low bidder
Belmont-2	Sanitary Sewer Rehabilitation Ralston Avenue Pipe Bursting and Pipelining	Construction / Renovation	2	09.14.04	Two received bids exceed the anticipates costs. The City will redesign and re-advertise the project
Clinton	Install water and sewer infrastructure for Sampson Square Apartments	Construction	3	02.16.10	Lowest bid greater than grant funding
Des Moines	Golf Course Repairs – damaged from erosion and slope failure	Construction	2	10.11.10	Lowest bid was 53% over project estimate and exceeded project budget
Folsom	Revitalization Project	Construction	2	07.20.09	Low bid exceeded engineer's estimate
Fresno	Delivery of Ortho Poly Phosphate Blend to the Surface Water Treatment Facility	Ortho Poly Phosphate Blend Delivery	1	05.01.07	Want to obtain greater bidder participation and lower pricing
Fresno-2	Landscaping around City Hall and Santa Fe Depot	Landscaping	4	10.02.07	There is a reasonable expectation that additional bids will be received through a future rebid, thereby, reducing the cost of this item
Lacey	Construct a treatment facility and booster station at reservoir site	Construction	5	05.24.07	Low bidder withdrew because of data errors and next apparent low bidder's value higher than engineer's estimate
Missoula	Stripping and stockpiling topsoil, and large rocks, rough grading, earth moving, landscape contouring and removal of excess granular materials	Construction	2	6.3.09	Both bids were above the anticipated budget for this project
Piedmont	Build children's play area	Construction	3	07.19.04	Large discrepancy between architect's estimate for the base bid work versus the low bid

[39] The right to reject all bids can be exercised by government purchasing authorities for other reasons as well, e.g., bids are found to be non-responsive, bid documents are defective and/or incomplete, or there is evidence of inadequate competition.

[40] We refer to the procurements by the name of the city. The full citations are provided at the end of this appendix.

Table A.1: continued

City	Project	Industry	Number of Bidders	Date	Reason for Rejection
Pinole	Information Network Technology Support Services	IT Support	2	06.15.10	Both responses were for more than double the budgeted amount
Plant City	Furnishing and Installing a 12,000 Gallon Diesel Tank	Fueling	13	8.24.09	Lowest bid was above City's budget for project
San Rafael	Tennis and Basketball Court Renovation	Construction	4	08.02.10	Lowest bid exceeded Engineer's Estimate
Shasta Lake	Build Native American Cultural Resource Center	Construction	7	09.08.10	Low bid exceeds available funding
Silver City	Re-roof library and replace HVAC units in library	Construction/Roofing	4	11.10.09	Town issued bid up to $185,000 from fund but all bids exceeded this amount
Suisun City	Landscaping along Bikeway	Landscaping	7	09.07.10	Lowest bid exceeded engineer's estimate
Tracy	Fire Department wants to purchase Triple Combination Fire Pumper	Fire Apparatus Manufacturers	6	08.05.08	The low bid with tax was higher than the authorized budgeted amount
Villa Park	Mesa Drive Widening & Guard Rail Project	Construction	9	12.16.08	The lowest qualified bid was approximately 44% higher than the engineer's estimate of the project.
Woodinville	Build bridge	Construction	2	06.13.05	The lowest bid exceeded engineer's estimate by approximately 30%
Woodinville-2	Install Fire Detection and Alarm System at City Hall Annex Building	Maintenance	2	07.02.01	The lowest bid was higher than the project funding.

In the cases we reviewed, it is common for the buyer (the city) to have comprehensive cost estimates of the project before soliciting bids. However, usually no formal reserve price is announced prior to bidding. It can happen that all received bids are beyond initial cost estimates or the cost limits established by the purchasing authorities. When the lowest received bid substantially exceeds the cost estimates or limits, the city councils may void the initial bids and announce reprocurement.

For example, in September 2006, the City Council of Belmont procured a contract for pump station rehabilitation. The contract was to be awarded to the lowest responsible bidder for an amount up to the engineer's estimate of $520,000. Four general contractors submitted bids as follows: $695,000, $724,000, $787,000 and $859,000. After evaluation, the city council rejected all bids and re-advertised the project in Spring 2007.[41]

Bids may be rejected with the expectation of lower future bids. For example, Fresno's reason for rejecting the bid it received in March 2007 was that: "There is a reasonable expectation that additional bids will be received through a future rebid, thereby, reducing

[41] Belmont, pp.1–2.

the cost of this item."[42] Lacey identified the possibility of seeking more competitive bids as a key reason for rebidding its contract.[43]

In many of the examples listed in Table A.1, all bids were rejected because they were above what buyer believed to be a reasonable level. For example, Piedmont received three bids for its project, but there was a large discrepancy between the architect's cost estimate for the project and the lowest bid. According to the staff report, "the difference between the base bid architect's estimate and base bids actually received is obviously disappointing and troubling."[44] The city council rejected all bids, re-worked the project specifications, and re-conducted the procurement. Folsom rejected all bids because "the lowest responsive bid was received from McGuire and Hester for $3,737,259.80 and was $1.55 million over the engineers estimate."[45] San Rafael rejected all bids because "the lowest bid of $161,232.50 is $36,232.50 more than the Engineer's Estimate."[46] Villa Park rejected all bids due to the high cost of the lowest bid, which was above the engineer's estimate.[47] Woodinville rejected all bids because "the low bid amount for this project exceeded the engineer's estimate by approximately 30%."[48]

In other examples, the stated reason for rejection includes the low bid being above the approved budget for the project.[49]

To summarize, a review of procurement examples reveals the following phenomena: 1. When the buyer is uncertain about the cost environment, it can infer information from the observed bids. 2. If the initial bids are viewed as reasonable, then the buyer makes an award to the lowest bidder. 3. If the initial bids are viewed as too high, the buyer may void the initial procurement and seek additional bidders to participate in a new procurement. 4. Budget-constrained buyers may reject bids even if there is no expectation of obtaining more favorable bids through reprocurement.

References for Online Appendix A.1

1. *Belmont:* Staff Report to Honorable Mayor and Council Members (January 9, 20007), *available at* http://www.belmont.gov/Upload/Document/ D240003037/4K-CC-010920 07.pdf.

[42] Fresno, p.4.
[43] Lacey, paragraph 5.
[44] Piedmont, p.1.
[45] Folsom, p.3.
[46] San Rafael, p.1.
[47] Villa Park, p.1.
[48] Woodinville, p.1.
[49] See, e.g., Clinton, Des Moines, Missoula, Pinole, Plant City, Shasta Lake, Tracy, and Woodinville-2.

2. *Belmont-2:* Staff Report to Honorable Mayor and Council Members (September 14, 2004), *available at* http://www.belmont.gov/Upload/ Document/D240001279/4H-CC 09142004.pdf.
3. *Clinton:* City Council Special Meeting (February 16, 2010), *available at* http://www.city ofclintonnc.com/departments/clerk/ board_minutes/ 2010/02-16-10.pdf.
4. *Des Moines:* Agenda Item Number 45 (October 11, 2010), *available at* http://www.dm gov.org/government/CityCouncil/Resolutions/ 20101011 /45.pdf.
5. *Folsom:* Staff Report to Chairman and Board Members (July 20, 2009) *available at* http://www.folsom.ca.us/agendas/MG114294/AS114305/ AS11 4307/ AI115705/ DO11 5729/DO_115729.pdf.
6. *Fresno:* Report to the City Council (May 1,2007) *available at* http://www. fresno.gov/ CouncilDocs/Agenda5.1.2007/1c.pdf.
7. *Fresno-2:* Report to the City Council (October 2, 2007) *available at* http://www. fresno.gov/ CouncilDocs/agenda10.2.2007/1f.pdf.
8. *Lacey:* Regular Meeting of the Lacey City Council (May 24, 2007), *available at* http:// www.ci.lacey.wa.us/city-government/city-council/city-council-2/city-council-meetings/ council- meetings/2007-council-agendas-minutes/05-24-2007-council_minutes.
9. *Missoula:* Conservation Committee Report (June 3, 2009), *available at* http://www.ci. missoula.mt.us/archives/80/090603cons.pdf.
10. *Piedmont:* City Council Staff Report (July 19, 2004), *available at* http:// www.ci. piedmont.ca.us/html/govern/staffreports/7_19_04/dracena.pdf.
11. *Pinole:* City Council Report (June 15, 2010), *available at* http://www.ci. pinole.ca.us/ admin/docs/cc-rda/2010/2010-06-15/07F.pdf.
12. *Plant City:* Agenda Report to City Commission (August 24, 2009), *available at* http:// www.plantcitygov.com/DocumentView.aspx?DID=2261.
13. *San Rafael:* San Rafael City Council Agenda Report (August 2, 2010), *available at* http://www.cityofsanrafael.org/ccfiles/Meeting%20Reports/ 2010/08-02-10/ City% 20Council/Staff%20Rpts/PW_Santa%20Margarita %20Project%20Reject%20bids.pdf.
14. *Shasta Lake:* Report and Recommendations to City Manager (September 8, 2010), *available at* http://www.ci.shasta-lake.ca.us/Agenda%20 Packets/2010/09.21.10/7.2.pdf.
15. *Silver City:* Regular Council Meeting (November 10, 2009), *available at* http://www. townofsilvercity.org/r/legal_notes/2009%2011%2010% 20Minutes%20 Regular%20Coun cil.pdf.
16. *Suisun City:* Regular Council Meeting (September 7, 2010), *available at* http://www. suisun.com/Data/CC-RDA/2010/20100907/Item9.pdf.
17. *Tracy:* Agenda Item 1.F (August 5, 2008), *available at* http://www.ci. tracy.ca.us /uploads/fckeditor/File/city_council/agendas/2008/08/05/01f. pdf
18. *Villa Park:* City Council Meeting (december 16, 2008), *available at* http://www.villapark. org/Agendas-Minutes/2008/121608/16.PDF.

19. *Woodinville:* Resolution No. 299 (June 13, 2005), *available at* http://ww w.ci.wood inville.wa.us/Documents/CityHall/Resolutions/Resolution%2 0299.pdf.
20. *Woodinville-2:* Resolution No. 202 (July 2, 2001), *available at* http://ww w.ci.wood inville.wa.us/Documents/CityHall/Resolutions/Resolution%2 0202.pdf.

A.2 Appendix: Historical evidence of collusion followed by merger

In Table A.2, we review the ten largest (in net value) manufacturing industry groups according to the U.S. census of 1900 for evidence of industries with cartels followed by mergers.[50] The information provided in Table A.2 is not exhaustive. We provide representative examples of the observed phenomenon for the time period closely following the passage of the Sherman Act.

[50] U.S. Census Office (1902, p.325). The Twelfth Census classified industries into fifteen groups. The industry groups absent in our sample from the Census classifications are (i) clay, glass, and stone products, (ii) vehicles for land transportation, (iii) shipbuilding, (iv) miscellaneous industries, and (v) hand trades. Our sample includes the ten most valuable groups excluding miscellaneous industries and hand trades.

Table A.2: Evidence of the pattern of collusion followed by merger

Census industry group	Industry with cartel followed by merger	Merger year	References for existence of cartel and merger year
Food and kindred products	Meat packing	1903	Whitney (1958, vol. 1, pp.31,34)
	Sugar refining	1887	Genesove and Mullin (1998, p.358)
	Corn refining	1897	Whitney (1958, vol. 2, p.258)
Textiles	Cordage	1887	Thorelli (1954, p.78)
	Cotton yarn	1899	Dewing (1914, pp.307-308)
Iron and steel and their products	Wire nails	1898	Lamoreaux (1985, pp.69-74), Jones (1921, p.194)
	Tin cans	1901	Whitney (1958, vol. 2, p.197)
	Tin plates	1898	Lamoreaux (1985, pp.14-15,115)
Paper and printing	Newsprint	*	Whitney (1958, vol. 1, pp.334-335)
	Strawboard	1889	Weeks (1916, pp.305-306)
	Wallpaper	1898	Whitney (1958, vol. 1, p.356)
Chemicals and allied products	Gun powder	1902	Whitney (1958, vol. 1, p.192)
	Cottonseed oil	1889	Thorelli (1954, p.79)
Metals and metal products, other than iron and steel	Farm machinery	1902	Jones (1912, p.232)
Liquors and beverages	Whiskey	1891	Ripley (1916, pp.27,31)
Leather and its finished products	Sole leather (tanning)	1893	Dewing (1914, p.18)
Lumber and its remanufactures	**		
Tobacco	***		

* Some cartel members merged with the Union Bag and Paper Co. The date is uncertain.

** In the lumber industry it was common for manufacturers to participate in price fixing associations. In at least one case the association subsequently attempted to merge, but decided against it due to legal barriers (U.S. Department of Commerce, 1914, pp.256, 274).

*** The five largest tobacco product manufacturers merged in 1890. They merged after considering and deciding against forming a cartel (Porter, 1969).

To the extent that sellers in the industries listed in Table A.2 sell to individual consumers, who in many cases face posted prices that they view as take-it-or-leave-it offers, buyer resistance may not be relevant. However, in industries where manufacturers sell to intermediaries, those intermediaries may well have sufficient power to resist high prices. Although we have not reviewed information on the structure of the supply chains in the industries listed in Table A.2 for the time period to which that table applies, it seems likely that then, as today, much of the business-to-business transactions involved a comparison of bids. Thus, the benefit of collusion over merger in terms of mitigating buyer resistance offers at least a partial explanation for the movement of industries from collusion to merger during a time period when the cost of collusion in terms of legal risk increased.

To move to a more recent time period, we also review the 55 industrial cartel decisions issued by the European Commission in 2001–2010,[51] we find evidence of mergers, acquisitions, or joint ventures among at least two of the co-conspirators after the end of the cartel period in 24 (44%) of the cases.[52] The observation of mergers, acquisitions, or joint ventures after the end of collusion suggests that those forms of coordination were likely feasible in the earlier period when the firms instead choose to collude. The choice of collusion instead of merger suggests that in these cases merger efficiencies were inadequate to outweigh the benefits of collusion.

The 24 cases are listed below, with the date following the case name indicating the end of the cartel period (not the release date of the decision): *Airfreight*: (2006) KLM acquired Martinair 2008. *Candle waxes*: (2005) Eni acquired ExxonMobil lubricant businesses 2007; Sasol Wax acquired Shell's stake in Merkur Vaseline Verwaltungs GmbH JV 2007; numerous JVs. *Carbonless paper*: (1995) Bolloré bought Papeteries Mougeot's carbonless paper operations in 2002. *Copper Fittings*: (2001) Aalberts Industries acquired Comap (a Legris subsidiary) 2006. *Copper Plumbing Tubes*: (2001) Boliden acquired HME 2002; KM Europa Metal acquired IMI 2002; Outokumpu-Boliden-others combined. *DRAM*: (2002) Infineon attempted to invest in Hynix 2002; Infineon-Nanya JV 2004; NEC-Toshiba JV 2007; Hynix-Toshiba JV 2011. *Elevators and escalators*: (2003) Schindler Holding AG and ThyssenKrupp AG jointly bought Constructions Industrielles de la Mediterranee 2010. *Food Flavour Enhancers*: (1999) Takeda-Daesang JV 2006. *Gas insulated switchgear*: (2004) Hitachi-Mitsubishi JV 2003; Toshiba-Mitsubishi JV 2003; Areva acquired Alstom 2004; Areva-Mitsubishi JV 2007; Schneider Electric and Alstom acquired Areva T&D SA 2010. *Graphite Electrodes*: (1998) SGL Carbon-Tokai JV 2006. *Hydrogen peroxide*: (2000) Solvay-Air Liquide JV 2012. *Industrial and medical gases*: (1997) AGA AB, NV Hoek Loos, BOC Group Plc joined Linde Group 2000, 2003, 2006; Air Liquide acquired Messer; Air Liquide-Air Products JV 2004.

[51] The EC Decisions are available at http://ec.europa.eu/competition/cartels/cases/cases.html (accessed November 25, 2012). We exclude non-industrial products, such as bananas, grains and oilseeds, beer, and tobacco, banking-related cartels, *SAS/Maersk Air*, and *Fine Art Auction Houses*. We also exclude cases whose decisions do not identify the cartel participants (*Cement and related products, Paper envelope, Polyurethane foam*, and *Smart card chips)*.

[52] We are grateful to Stephen Davies, Martin Graffenberger, and Jun Zhou for their detailed comments on this analysis. We focus on mergers/acquisitions/joint ventures that take place within the same (relevant) product and geographic market as the cartel. For example, in *Airfreight*, the relevant market for the cartel infringement is "non-passenger air transport" in the EEA and the US. Thus, we exclude a 2011 joint venture among Qantas, JAL, and Mitsubishi that focused on passenger transport in Japan. We exclude *Bitumen Spain* even though Compania Espanola de Petroleos S.A., Galp, BP Oil Espana, and Repsol YPF purchased shares of CLH in 2002 because the purchase of CLH shares took place in September 2002, which appears to be prior to the cartel dissolution, which reportedly coincided with the dawn raid in October 2002. Similarly, in *DRAM* we exclude Micron's attempt to acquire Hynix in April 2002 because it was prior to reported cartel dissolution in June 15, 2002.

Industrial Tubes: (2001) KME acquired Ourokumpu's int. in JV 2004. *International removal services*: (2003) Team acquired Allied 2007. *LCD*: (2006) Hannstar-LG Display strategic alliance 2008. *Methacrylates*: (2002) Degussa-Arkema JV 2007. *Organic Peroxides*: (1999) Degussa acquired Laporte 2001. *Plasterboard*: (1998) BPB acquired Gyproc Benelux SA 2002; Lafarge-Knauf Deutsche JV. *Power transformers*: (2003) Alstom acquired Areva T&D's transmission business 2010. *Prestressing steel*: (2002) Mittal Steel and Arcelor merged 2006. *Sodium Chlorate*: (2000) Kemira acquired Finnish Chemicals 2005; Kemira acquired Arkema's water coagulant business 2007; Kemira acquired Akzo Nobel's iron coagulant business 2009. *Sorbates*: (1996) Daicel Chemical Industries acquired Hoechst Nanning's sorbate capacities 2002. *Specialty Graphite*: (1998) Carbone-Lorraine-Nippon Carbon JV 2005; SGL-Tokai JV 2006. *Vitamins*: (1999) Takeda-BASF JV 2001; Takeda-Sumitomo JV 2002; Solvay-BASF JV 2005; BASF acquired Takeda 2006.

Furthermore, the evidence is consistent with the benefit to firms from merging being reduced by buyer resistance. as shown in Table A.3, considering the 25 EC decisions for industrial cartels in the period 2001–2005, we classify the demand side of the market as relatively concentrated or relatively fragmented based on the information in the EC decisions. We focus on the 25 EC decisions for industrial cartels in the period 2001–2005 in order to allow sufficient time for mergers, acquisitions, and JVs to form. If significant buyer resistance is less likely from fragmented buyers, then firms will have more of an incentive to merge when buyers are fragmented. Consistent with this, in our sample we find that a merger, acquisition, or joint venture among the former co-conspirators is more than twice as likely when the buyers are fragmented than when they are concentrated.

Table A.3: Buyer power and post-collusion mergers

	Concentrated buyers		Fragmented buyers	
EC Decision	No M/A/JV	M/A/JV	No M/A/JV	M/A/JV
Carbonless Paper 20-Dec-01	1			
Choline Chloride 9-Dec-04	1			
Citric Acid 5-Dec-01			1	
Concrete Reinforcing Bar 17-Dec-02			1	
Copper Plumbing Tubes 3-Sep-04		1		
Electrical and mechanical carbon and graphite products 3-Dec-03			1	
Food flavour enhancers 17-Dec-02				1
Graphite electrodes 18-Jul-01				1
Industrial and medical gases 24-Jul-02				1
Industrial Bags 30-Nov-05			1	
Industrial tubes 16-Dec-03				1
Methionine 2-Jul-02			1	
Methylglucamine 27-Nov-02			1	
Monochloroacetic Acid 19-Jan-05	1			
Needles 26-Oct-04			1	
Organic peroxides 10-Dec-03				1
Plasterboard 27-Nov-02				1
Rubber chemicals 21-Dec-05			1	
Sodium Gluconate I 2-Oct-01			1	
Sodium Gluconate II 29-Sep-04			1	
Sorbates 1-Oct-03				1
Specialty Graphite 17-Dec-02				1
Thread 14-Sep-05			1	
Vitamins 21-Nov-01				1
Zinc phosphate 11-Dec-01	1			
Total	4	1	11	9

Assuming that significant buyer resistance is more likely to come from relatively concentrated buyers, among the cases where significant buyer resistance was less likely, Table A.4 shows that 45% have mergers, acquisitions, or joint ventures among at least two of the co-conspirators after the end of the cartel period, but only 20% among the cases where significant buyer resistance was more likely. This evidence is consistent with the results of this paper showing that the payoff to merging (or other observable coordination) is reduced in environments with buyer resistance.

Table A.4: Mergers, acquisitions, or joint ventures by formerly colluding firms

	Buyers for cartel product	
	Concentrated	Fragmented
M/A/JV	1	9
No M/A/JV	4	11
Share with M/A/JV	20%	45%

References

Andrade, Gregor, Mark Mitchell, and Erik Stafford (2001), "New Evidence and Perspectives on Mergers," *Journal of Economic Perspectives* 15(2): 103–120.

Athey, Susan (2001), "Single Crossing Properties and the Existence of Pure Strategy Equilibria in Games of Incomplete Information," *Econometrica* 69: 861–890.

Ausubel, Lawrence M. and Raymond Deneckere (1987), "One is Almost Enough for Monopoly," *RAND Journal of Economics* 18: 255–274.

Bajari, Patrick L. (2001), "Comparing Competition and Collusion: A Numerical Approach," *Economic Theory* 18: 187–205. Entry: The Effects of Mergers and Acquisitions on Entry in the Banking Industry," *Journal of Business* 77(4): 797–834.

Bittlingmayer, George (1985), "Did Antitrust Policy Cause the Great Merger Wave?," *Journal of Law and Economics* 28: 77–118.

Bittlingmayer, George (1982), "Decreasing Average Cost and Competition: A New Look at the Addyston Pipe Case," *Journal of Law and Economics* 25: 201–229.

Coase, Ronald (1937), "The Nature of the Firm," *Economica* 4: 386–405.

Davidson, Carl and Arijit Mukherjee (2007), "Horizontal Mergers with Free Entry," *International Journal of Industrial Organization* 25: 157–172.

Davies, Stephen, Peter L. Ormosi, and Martin Graffenberger (2014): "Mergers After Cartels: How Markets React to Cartel Breakdown," Available at SSRN: http://ssrn.com/abstract=2383534.

Dewing, Arthur S. (1914), *Corporate Promotions and Reorganizations,* Cambridge, MA: Harvard University Press.

Fudenberg, Drew and Jean Tirole (1991), *Game Theory*, Cambridge, MA: MIT Press.

Ganslandt, Mattias, Lars Persson, and Helder Vasconcelos (2012), "Endogenous Mergers and Collusion in Asymmetric Market Structures," *Economica* 79: 766–791.

Genesove, David and Wallace P. Mullin (1998), "Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890–1914," *RAND Journal of Economics* 29(2): 355–377

Graham, Daniel A. and Robert C. Marshall (1987), "Collusive Bidder Behavior at Single Object Second Price and English Auctions" *Journal of Political Economy* 95: 1217–1239.

Graham, Daniel A., Robert C. Marshall, and Jean-Francois Richard (1996), "Lift-Lining," *Advances in Applied Micro-Economics* 6: 15–40.

Harrington, Joseph E., Jr., and Joe Chen (2006), "Cartel Pricing Dynamics with Cost Variability and Endogenous Buyer Detection," *International Journal of Industrial Organization* 24: 1185–1212.

Hylton, Keith (2003), *Antitrust Law: Economic Theory and Common Law Evolution*, Cambridge, UK: Cambridge University Press.

Jones, Eliot (1921), *The Trust Problem in the United States*, New York: The Macmillan Company.

Kovacic, William E., Robert C. Marshall, Leslie M. Marx, and Steven P. Schulenberg (2009), "Quantitative Analysis of Coordinated Effects," *Antitrust Law Journal* 76(2): 397–430.

Kumar, Vikram, Robert C. Marshall, Leslie M. Marx, and Lily Samkharadze (2013), "Buyer Resistance for Cartel versus Merger," Working Paper, Duke University, available at https://faculty.fuqua.duke.edu/~marx/bio/papers/CartelvMerger2013WorkingPaper_UniformCosts.pdf.

Lamoreaux, Naomi (1985), *The Great Merger Movement in American Business, 1895–1904*, Cambridge, UK: Cambridge University Press.

Lebrun, Bernard (1996), "Existence of an Equilibrium in First Price Auctions," *Economic Theory* 7: 421–443.

Lebrun, Bernard (1999), "First Price Auctions in the Asymmetric N Bidder Case," *International Economic Review* 40: 125–142.

Levenstein, Margaret C. and Valerie Y. Suslow (2006), "What Determines Cartel Success?," *Journal of Economic Literature* 44(1): 43–95.

Marshall, Robert C., Leslie M. Marx, and Matthew E. Raiff (2008), "Cartel Price Announcements: The Vitamins Industry," *International Journal of Industrial Organization* 26: 762–802.

Marx, Leslie M. and Jun Zhou (2014), "The Dynamics of Mergers among (Ex)Co-Conspirators in the Shadow of Cartel Enforcement," Available at SSRN: http://ssrn.com/abstract=2410948.

Mookherjee, Dilip (2006), "Decentralization, Hierarchies, and Incentives: A Mechanism Design Perspective," *Journal of Economic Literature* 44(2): 367–390.

Nocke, Volker and Lucy White (2007), "Do Vertical Mergers Facilitate Upstream Collusion?," *American Economic Review* 97(4): 1321–1339.

Persson, Lars (2004), "Predation and Mergers: Is Merger Law Counterproductive," *European Economic Review* 48: 239–258.

Porter, Patrick G. (1969), "Origins of the American Tobacco Company," *The Business History Review* 43(1): 59–76.

Ripley, William Z. (1916), ed. *Trusts, Pools and Corporations*, New York: Ginn & Company.

Rotemberg, Julio J. and Garth Saloner, (1986), "A Supergame-Theoretic Model of Price Wars During Booms," *American Economic Review* 76: 390–407.

Sharkey, William W. (1973), "A Study of Markets Involving Increasing Returns and Uncertain Demand," Ph.D. Dissertation, Univ. of Chicago.

Snyder, Christopher M. (1996), "A Dynamic Theory of Countervailing Power," *RAND Journal of Economics* 27(4): 747–769.

Spector, David (2003), "Horizontal Mergers, Entry, and Efficiency Defences," *International Journal of Industrial Organization* 21(10): 1591–1600.

Stigler, George J. (1950), "Monopoly and Oligopoly by Merger," *American Economic Review Proceedings* 40: 23–34.

Stigler, George J. (1964), "A Theory of Oligopoly," *Journal of Political Economy* 72: 44–61.

Thorelli, Hans (1954), *The Federal Antitrust Policy*, Baltimore: The Johns Hopkins Press.

U.S. Census Office (1902), *Abstract of the Twelfth Census of the United States 1900*, Washington, DC: Government Printing Office.

U.S. Department of Commerce (1914), *The Lumber Industry: Part IV, Conditions in Production and Wholesale Distribution Including Wholesale Prices,* Washington, DC: Government Printing Office.

Vickrey, William (1961), "Counterspeculation, Auctions, and Competitive Sealed Tenders," *Journal of Finance* 16(1): 8–37.

Waehrer, Keith (1999), "Asymmetric Private Values Auctions with Application to Joint Bidding and Mergers," *International Journal of Industrial Organization* 17: 437–452.

Waehrer, Keith and Martin K. Perry (2003), "The Effects of Mergers in Open-Auction Markets," *RAND Journal of Economics* 34(2): 287–304.

Weeks, Lyman Horace (1916), *A History of Paper-Manufacturing in the United States, 1690–1916,* New York: The Lockwood Trade Journal Company.

Werden, Gregory J. and Luke M. Froeb (1998), "The Entry-Inducing Effects of Horizontal Mergers: An Exploratory Analysis," *Journal of Industrial Economics* 46(4): 525–543.

Whitney, Simon (1958), *Antitrust Policies Vol.* 1 *and Vol.* 2, New York: The Twentieth Century Fund.

Williamson, Oliver E. (1985), *The Economic Institutions of Capitalism*, New York: The Free Press.