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THOUGHTS ON WHY CERTAIN MARKETS ARE MORE SUSCEPTIBLE TO COLLUSION AND SOME POLICY SUGGESTIONS FOR DEALING WITH THEM

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-- Session IV --

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THOUGHTS ON WHY CERTAIN MARKETS ARE MORE SUSCEPTIBLE TO COLLUSION AND SOME POLICY SUGGESTIONS FOR DEALING WITH THEM[1]

-- Joseph E. Harrington, Jr. --

1. Introduction

1. It is useful to begin by clearly stating what I mean by collusion. From the economics perspective, collusion refers to when firms use particular strategies in order to sustain supracompetitive prices. We can refer to those strategies as the "collusive arrangement." By comparison, the typical legal perspective focuses on the communication (using that term quite broadly) by which firms coordinate on and sustain a collusive arrangement. Alternatively stated, collusion as viewed by economists is present when firms have mutual beliefs with regards to the use of certain strategies that result in supracompetitive prices. Collusion as viewed by the law is present when firms engaged in certain actions to achieve those mutual beliefs. As the focus of this paper is on unlawful collusion, the presumption is that firms have engaged in express communication in order to coordinate on a collusive arrangement though some jurisdictions do not require that communication to be express, while others require that the express communication actually succeeds in raising price.[2]

2. Section II provides a general description of the conditions under which we expect collusion to occur, while some empirical observations regarding which markets are most prone to have cartels are provided in Section III. An approach to structural screening based on induction is presented in Section IV with an application to cement cartels in Section V. Some policy recommendations are provided in Section VI.

2. Theoretically, When Do Firms Collude?

3. If firms are currently competing, what does it take for collusion to occur? There are three conditions that must be satisfied which I refer to as the stability, participation, and coordination conditions.

4. Any collusive arrangement requires firms to price higher than at a competitive outcome which means that a firm could increase its current profit by undercutting the collusive price and selling more. It is that short-run temptation to deviate that poses a challenge for almost any collusive arrangement. For all firms to behave as prescribed by the collusive outcome, each firm must realize that a departure is sufficiently likely to be detected and punished. For that to be the case, each firm must view the short-run gain in profit from cheating to be surpassed by the expected future loss associated with detection and punishment (such as a temporary price war or the indefinite breakdown of the cartel). Hence, the sustained setting of supracompetitive prices requires that there exist a self-enforcing collusive arrangement where, by self-enforcing, it is meant that each firm prefers to abide by it than to act differently. Various factors

[1] I want to thank Max Wei for his research assistance.

[2] For an extensive discussion of the distinction between the legal and economic perspectives to collusion, the reader is referred to Kaplow (2013).

influenced whether the stability condition is satisfied - that is, whether there exists a self-enforcing collusive arrangement - and a listing of many of those factors can be found in Motta (2004).

5. Thus far, I have described the *internal* stability condition which ensures that all firms that are part of the cartel abide by the collusive outcome. There is also the *external* stability condition which ensures that the collusive outcome is not upset by the expansion of supply by non-cartel members (when the cartel is not all-inclusive) or by the entry of new firms into the market. Entry barriers are critical to preventing a collusive arrangement from collapsing because the charging of a supracompetitive price can induce entry or the expansion of non-cartel supply (as occurred, for example, to the vitamin C cartel of the 1990s). I will refer to the stability condition as encompassing both these internal and external constraints. In sum, the stability condition is satisfied when there exists a self-enforcing (or stable) collusive arrangement that results in supracompetitive prices.

6. The focus of economic theory has been on characterizing the market conditions conducive to satisfying the stability condition. It is my sense, however, that many industries which could sustain a collusive arrangement, do not; and there are many instances of cartels which could have effectively operated prior to when the cartel was formed but did not. If my sense is right then it takes more than the existence of a self-enforcing collusive arrangement for firms to collude. This leads us to the second condition which is the participation condition. When there exists a stable collusive arrangement, when is it that firms want to replace competition with collusion? That is, when collusion is feasible, when is it desirable?

7. Though there is very little theoretical research on this question, let me offer a few, hopefully informed, remarks. A natural answer is that firms want to participate in a cartel when the incremental profit from doing so (relative to competition) is sufficiently great. Of course, positive incremental profit may be insufficient because of the prospect of detection and penalties. But even when the expected incremental profit is positive after taking into account expected penalties, managers may be hesitant to pursue it because of a reticence to engage in unlawful behavior or uncertainty as to whether other firms would participate (and attempting to collude can be unlawful as well). While higher incremental profit from colluding may make it more likely that firms will collude, it is not clear that positive incremental profit is sufficient to induce firms to collude.

8. Due to managerial incentive contracts and reputational concerns, it is also possible that a manager may be more inclined to collude when profit is low relative to some benchmark. Consider a setting in which firms' profits have significantly declined in comparison to levels realized in the immediate past or are low relative to historical profit levels in this market. If managers are compensated or evaluated (by the labor market) in terms of how they perform relative to such historical standards then they may feel under pressure to improve performance. This pressure could be self-imposed or coming from a manager's superior. Short of ways in which to raise profit, managers in these under-performing firms (or divisions) might find collusion the most promising alternative or perhaps the only alternative. Along these lines, one of the best documented triggering events for cartel formation is a significant decline in prices and profits which is typically attributed to a decline in demand (though could also be the result of a breakdown of tacit collusion), an example of which is the fine arts auction houses cartel. Especially for a market with homogeneous products, a demand decrease that creates excess capacity can significantly intensify price competition.

9. The decision to embark on a quest to collude may not solely be determined by economic forces. While it is reasonable to think that economic forces are necessary, they may not be sufficient. Whether firms choose to avail themselves of a collusive arrangement may also depend on, for the lack of a better expression, cultural factors. Cultural considerations can operate at the level of the organization, the market, and the country. At the level of the organization, corporate culture can influence the extent to which ethical

and legal considerations play a role in managerial decision-making. There is certainly variation in the extent to which an individual corporation participates in cartels with firms like Akzo Nobel and Archer Daniels Midland having been involved in many cartels. At the market level, past episodes of collusion in this or related markets could make managers more inclined to think that it is an option. In the market for turbine generators, firms were convicted in the late 1950s for engaging in explicit collusion and subsequently turned to tacit collusion in the early 1960s. The previous experience of circumventing intense price competition could well have been the basis for seeking out less egregiously unlawful forms of collusion.

10. Perhaps the cultural considerations that have the potential to play the biggest role are those that operate at the country level. For a country that, until recently, allowed firms to collude (that is, it was either lawful or was tolerated in the sense of not being prosecuted) or even encouraged firms to collude (in association with industrial policy), it is not difficult to imagine that managers may not perceive collusion as particularly unethical or harmful while still recognizing that it is now unlawful (and thus engaging in acts of deception to prevent its detection). It is also worth emphasizing that culture may not only affect whether a manager wants to collude but also whether he or she believes other managers want to collude. A firm will seek to collude only if it believes it is sufficiently likely that other firms will view the matter similarly. In sum, the participation condition is satisfied when enough firms in the market actually want to replace competition with collusion. Both economic and cultural factors play a role in determining whether that condition is satisfied.

11. Even if firms *can* collude (that is, the stability condition is satisfied) and *want* to collude (that is, the participation condition is satisfied), it does not immediately follow that firms *will* collude. Making a move from competition to collusion is not always straightforward or assured of success. In order to avoid engaging in a per se violation, firms may deploy non-express means of communication which are typically less effective in achieving their intended outcome. Firms may fail to change all firms' expectations that they are to coordinate their prices rather than compete in prices. Even when communication is effective, as is quite likely when firms engage in express communication, coordination can fail because of disagreement. There are many instances in which collusion collapses or a cartel member departs because of disagreement over the market allocation.[3] The coordination condition is satisfied when firms are willing and able to shift firms' expectations from that of competition to collusion.

12. Summing up, collusion occurs when: 1) there exists a stable collusive arrangement; 2) all (or sufficiently many) firms prefer to replace competition with one of those stable collusive arrangements; and 3) those firms are able to orchestrate a coordinated shift from competition to collusion. Thus, in asking for which types of markets is collusion most likely, we need to ask for which types of markets are these three conditions most likely to be satisfied. It is also worth asking which of these conditions is likely to be the binding constraint. Applying a very broad brush to this question, I'm inclined to say that if monitoring for compliance is not difficult (for example, there is high level of price transparency) then the participation condition is more likely to be binding than the stability condition. If instead monitoring is problematic then either the stability or participation conditions could be the binding constraint. If firms are engaging in non-express communication then the coordination condition and could be what makes the difference between success and failure when it comes to collusion. Clearly, a more thoughtful and systematic approach is needed to understand which condition is binding and how it depends on market conditions.

[3] For a recent documented episode in the German cement market, see Harrington, Hüschelrath, Laitenberger, and Smuda (2015).

3. Empirically, When Do Firms Collude?

13. Prior to addressing the empirical question of where cartels are most likely to appear, some methodological caveats are in order. The proper metric for answering this question is the probability that a market has a cartel. An empirical proxy for that probability is the historical frequency which equals, for a market type, the number of markets with cartels divided by the total number of markets. This then requires properly specifying the numerator - how many cartels there are - and the denominator - how many markets there are (and thus how many cartels there could be).

14. While the primary challenges will reside in measuring the numerator, there are problems even in specifying the denominator. To see why, let us think about addressing the question: Are cartels more common in chemical markets or cement markets? To do so would first require determining how many chemical markets there are and how many cement markets there are. Most chemical markets are global in the sense that a chemical manufacturer is a viable supplier to buyers throughout the world. In that case, the denominator is the number of global chemical markets in which case the empirical frequency of chemical cartels is, roughly speaking, the number of chemical cartels divided by the number of chemicals. Now consider measuring the empirical frequency of cement cartels. Due to high transportation costs relative to value, cement markets are local so, for any given cement product, there are many markets in the world. Given that there are many more cement markets then chemical markets, there should be many more cement cartels than chemical cartels (holding all else constant). Thus, one needs to properly specify the base number of markets in order to have the appropriate metric for comparing the frequency of cartels across products.

15. More problematic is properly specifying the numerator because there are several sources of biases associated with observing collusion. First, we only observe discovered cartels. This need not be a problem when it comes to assessing which markets are more prone to collusion *as long as the probability of discovery is the same across markets*. However, that is unlikely to be the case. If the likelihood of discovery is correlated with market traits then some markets may appear to have more cartels only because cartels are more easily discovered. The likelihood of discovery could depend on the price path in terms of level and volatility which can vary with the type of market. Discovery is more likely for non-all-inclusive cartels because of exclusionary practices (against non-cartel members) and that non-cartel members provide a competitive benchmark. Depending on the market, some collusive practices that are necessary for having a stable collusive arrangement - such as a customer allocation scheme - may also lend themselves to creating suspicions among customers. Understanding how market traits impact the form of collusive practices would then seem relevant for assessing the likelihood of discovery.

16. A second source of detection bias arises because explicit collusion is easier to detect than less explicit (but still unlawful) collusion. If firms can collude without overt communication then they will prefer to do so, and markets will vary in the extent to which they are able to do so. For example, perhaps collusion is more commonly observed in intermediate goods markets than in retail markets because of price transparency. In most retail markets, list prices are transaction prices so collusion may require minimal communication; for example, firms agree that one firm to act as a price leader. While in most intermediate goods markets, sellers offer discounts off of list prices which are not publicly observed. This monitoring challenge often requires the use of a market allocation scheme with sales monitoring (for example, Harrington and Skrzypacz, 2011). While there have been documented episodes of collusion in gasoline or petrol markets (for example, Clark and Houde, 2013), there could be many more undocumented episodes of collusion - ranging from the lawful to the unlawful - that involve far less communication and, therefore, a lower chance of detection.

17. Finally, there could be bias from observers having self-fulfilling beliefs. Competition authorities, plaintiff lawyers, and academic economists may believe cartels are more common in certain industries, so

they look for them there. Even if cartels are randomly allocated across markets, this process would lead us to falsely believe that cartels are more likely in certain markets. Given that screening of markets for cartels is a relatively new phenomenon, this source of bias is probably not a concern at present though, looking into the future, it could prove to be.

18. While a proper empirical analysis that takes into account the aforementioned challenges is yet to be done, let us put aside these concerns for the moment and turn to discussing where cartels are most common. To be clear, my objective is not to provide a systematic analysis of when cartels appear but rather to provide some remarks based on my own overall assessment and to analyze one market that has arguably seen the most cartels.

19. Reviewing the body of economic studies and surveys[4] as well as my exposure to public information regarding legal cases, the most striking regularity is that *cartels occur most frequently in markets for which buyers' decisions are heavily based on price*. Given that a firm can significantly increase its demand by pricing below rival firms when buyers' decisions are largely based on price, a firm is inclined to set a low price relative to rival firms. Of course, all firms have such an inclination and that ultimately drives price down to the vicinity of cost. Cognizant of this profit-threatening process, firms go to tremendous effort to avoid buyers making decisions largely based on price. Firms invest in differentiating their products by developing new product traits and new variants and, through advertising, accentuating the perception of differentiation. When product differentiation is difficult to create, a firm may try to distinguish itself with ancillary services and customer loyalty programs (the advent of which can be traced to frequent flier programs in the price-intensive airline industry). In short, firms strive to have buyers consider non-price dimensions when making their purchase decisions because it will soften price competition.

20. In some markets, however, it is difficult to engage in such activities. To begin, there are markets designed so that buyers' decisions are based only on price. That is the case with Nasdaq, where a buy (sell) order is mandated to go to the market maker offering the lowest ask (highest bid) price. In procurement auctions for a standardized product or service, the contract goes to the bidder with the lowest price. Even when the market design does not prohibit non-price dimensions from entering in the competitive process, some markets effectively end up in approximately the same place. In particular, many intermediate goods markets are characterized by suppliers offering essentially identical products to industrial buyers who are sophisticated and savvy and thus not swayed by advertising, have low search costs, are willing and able to bargain, and have high-powered incentives to get as low a price as other customers.

21. In these markets - whether it is a government procurement auction for building a road or manufacturers purchasing cardboard packaging - buyers almost exclusively base their decisions on price and, as a result, competition has a tendency to drive price down to cost. In those markets, there are basically two avenues through which firms can generate reasonably high price-cost margins. The first is to limit capacity. Even when products are identical, the lack of capacity to meet additional demand will deter firms from undercutting rivals' prices. But, at best, this is a temporary reprieve from low profits because a continued shortage of capacity will inevitably lead firms to expand capacity.[5] The second tactic is collusion: Firms avoid intense price competition by agreeing not to compete in price. If there is one regularity from the empirical documentation of cartels, it is that a disproportionately large number of cartels are either in markets or auctions in which buyers' decisions are almost exclusively based on price,

[4] In particular, Levenstein and Suslow (2001, 2006), Harrington (2006), and Marshall and Marx (2012).

[5] Relevant to this point, there are currently legal proceedings in the U.S. involving the airlines and steel industries because firms have engaged in "capacity discipline," which is the term espoused by the firms themselves at industry gatherings.

either because products are perceived to be homogeneous or due to market design. This regularity is reflected in the frequent presence of bidding rings in procurement auctions, the high proportion of cartels that occur in intermediate goods markets with commodities and, while cartels in retail markets are less common than in markets for intermediate goods, they seem to occur where products are largely undifferentiated (such as bread and gasoline).

4. An Inductive Approach to Structural Screening

22. Screening is the activity of using market data to identify possible episodes of collusions. There are two approaches to screening: structural and behavioral (Harrington, 2008). The structural approach identifies industry traits thought to be conducive to collusion or empirically associated with collusion. Factors generally considered to be consistent with collusion include reasonably high market concentration, homogeneous products, excess capacity, stable demand, among others. As part of structural screening, markets with more of these factors are viewed as being more likely to have a cartel. In contrast, the behavioral approach looks for evidence of collusion in the conduct of firms; specifically, firms' prices and quantities. Possible patterns to look for include low price variability, stable market shares, and a lack of strong correlation between price and cost, among others. While the structural approach is based on data that makes it more likely that a cartel *will form*, the behavioral approach uses data that may be evidence that a cartel *has formed*.

23. Standing by itself, I believe the behavioral approach is more promising than the structural approach, though the latter can be useful in conjunction with the former. I conjecture, though do not have evidence, that the structural approach is susceptible to producing too many false positives. For imagine the "ideal" market for collusion: two firms, identical products, high entry barriers, high level of price transparency, etc. Such a market is likely to produce a high score using a structural approach but, in many countries, I suspect that only a small fraction of such markets have cartels. The problem lies in that there are many omitted (unmeasured) factors that influence cartel formation. Thus, even if all quantifiable measures have created the "perfect storm" for collusion, a cartel may still not form.

24. By comparison, behavioral screening has two big advantages working in its favor. First, successful collusion must involve a change in the price-generating process; indeed, that is the reason that firms collude. In principle, it is then detectable, subject to data availability. Second, operating a cartel is difficult! Collusion imposes a unique set of challenges and constraints that manifests itself in terms of firm behavior. A close examination of most cartel episodes document the highly sophisticated structuring of the collusive arrangement in order to make it work (see, for example, Harrington (2006) and Marshall and Marx (2012)), and the departures and disruptions that occurred in spite of those efforts. All of this leaves a mark on observed firm conduct. In sum, colluding firms leave a trail and, even if cartelists are strategic, they will be unable to beat some behavioral screens because it is costly for them to do so (for examples, see Harrington (2008)).

25. Nevertheless, I am not one to dismiss any method that has some power and will now argue that an inductive approach could well enhance the efficacy of structural screening. To make this point, consider the structural screen developed in Grout and Sonderegger (2005) which used information from the United Kingdom's Office of Fair Trading over 1999-2003.[6] While one of the better studies, it also highlights some of the weaknesses from the structural approach. An observation is a Standard Industrial Classification (SIC) three-digit industry. They have a host of industry traits including industry sales, sales per firm, net capital expenditure per firm, R&D per firm, C3 concentration ratio, and market share volatility. Several

[6] The efforts of some competition authorities with regards to screening are reviewed in Laitenberger and Hüschelrath (2011), Petit (2012), and OECD (2013).

empirical specifications are used including an ordered logit model which produced estimates of how these factors correlate with the probability of having a cartel in a 3-digit SIC industry.

26. This study is well-executed but there are reasons for being pessimistic that such an analysis will prove useful in identifying markets that are likely to have cartels. While reasonably disaggregated by the standards of cross-sectional industry analyses, a 3-digit industry is generally far more aggregated than the typical cartelized market. With regards to structural factors, the analysis is constrained to considering only those factors for which there is data for all industries. As previously mentioned, omitted variables is a serious concern with a structural approach. While it is unreasonable to imagine having some variables (managerial incentive contracts, corporate culture, etc.), more detailed economic data for better defined markets is a possibility.

27. The execution of structural screening is based on the standard deductive approach in economics and more broadly in the social and physical sciences. Deduction involves laying out a general theory, providing evidence in support of that theory, and then assessing what it implies in a particular instance. In the case at hand, one uses theory to identify those factors that potentially matter with regards to collusion, correlate those factors with data on cartels, and use that analysis to produce predictions about the likelihood of collusion in particular markets. An alternative reasoning method is inductive which extrapolates from specific observations to make broad generalizations.

28. As a method of reasoning, deduction is more compelling than induction in that it is based on a systematic collection of facts and an underlying theory as to why those facts are relevant. Nevertheless, induction can be useful for generating hypotheses which, though they may be speculative, could nevertheless prove to be valid (in the sense that they are eventually supported by the data or provide predictions that are substantiated). While the weakness of induction is that it is based on a very limited sample (too limited to extract regularities), that weakness can also be a strength for one is not limited to considering only those structural factors for which data is available for a wide collection of markets. By focusing on a limited number of cases, an inductive approach can allow for a more complete set of economic variables and have them for an appropriately defined market, rather than being constrained to, for example, 3-digit SIC industries.

29. An inductive approach to screening involves three steps. First, find a market for which the rate of cartel formation is high. Second, describe the constellation of traits for that market. Third, identify other markets with that same (or almost same) collection of traits. Implicitly, the hypothesis is that because this market has a high rate of collusion then other markets with the same set of traits will also have a high rate of collusion.

30. The plan is to initiate the implementation of this approach using cement markets. In the next section, I first argue that cement is a market for which the rate of observed cartels is high in comparison to the universe of markets and then execute the second step by identifying those traits that describe cement markets. The third step, which is not executed in this paper, would be to find other markets with that same array of traits. To be clear, the underlying presumption with induction is: "Cement markets have these traits and cement markets frequently have cartels. Therefore, most markets with that set of traits frequently have cartels." This may or may not be empirically correct but it is a constructive way to develop new hypotheses. If we find that there is empirical support for this hypothesis, the next step is deductive: Develop a theory explaining it, derive testable hypotheses from that theory, and test the theory.[7]

[7] While induction might lead to a particular hypothesis regarding cartels, it does not suggest a proper test of the hypothesis. As the approach produces the hypothesis that markets with certain traits are likely to have cartels, one could look for markets with those traits and indeed find cartels there. But it may be the case that all markets have cartels (and not just those with that set of traits). This is also a problem with standard structural screening as long as a

5. The Case of Cement

A. Frequency of Cement Cartels

31. There are many markets with highly price-sensitive buyers for which cartels have been documented. The long list includes the markets for glass, concrete, shipping, gypsum, urethane, packaging, chemicals, vitamins, industrial gases, pipes & hoses, and on and on. Arguably, the market that has seen the most cartels is that of cement. A recent paper by Ivaldi, Jenny, and Khimich (2015) reviewed all 249 cartels prosecuted in 22 developing countries during 1995-2013. Encompassing more than 100 types of markets, Table 1 lists those that appeared most frequently. While petroleum products is at the top of the list, it is a fairly broad category. Among more narrowly defined products, cement led the way with eight out of the 22 countries having successfully prosecuted a cartel.

Table 1: Most Frequent Markets with Cartels (Ivaldi, Jenny, and Khimich, 2015)

Number of Countries	Market
9	Petroleum products
8	Cement, Poultry
6	Medical & health services, Public transportation, Shipping
5	Industrial and medical gases
4	Bakeries, Beer, Concrete products, Insurance,
	Liquified petroleum gas, Pharmaceuticals
3	Airlines, Fertilizers, Mobile phone services, Soft drinks, Sugar

32. From a more complete (but still not comprehensive) collection of sources, Table 2 lists countries with cement cartels for which the official decision occurred since 2000. It is also worth mentioning that the world's largest cement manufacturer, Lafarge, was involved in cartels in (at least) Brazil, India, Poland, Romania, South Africa, and the United Kingdom. The takeaway is that cement cartels are reasonably ubiquitous.

Table 2: List of Countries with Cement Cartels (Decisions Since 2000)*

Country	Duration	Decision
Argentina	1981-99	2005
Australia		2008
Austria	1998-2004	
Belgium	2000-03	
Brazil	2002-06	2006
Canada	15 years	2012
Colombia		2010
Egypt	2003-06/08	2008
France		2007
Germany	1991-2002	2003
Honduras		2010
Hungary	2005-07	2014
India	2000-09	2012
Indonesia		2010

competition authority only investigates markets with high scores (according to the structural screen). A proper test of a screen would require investigating markets with low scores, too. Evidence in support of a screen would be finding more cartels in markets with high scores and less cartels in markets with low scores.

Italy		2004
Pakistan	2003-08	2008
Philippines		2002
Poland	1998-2009	2009
Romania	2000-04	2005
South Africa	1995-2008	2012
Taiwan		2005
Turkey		2002, 2003, 2012
United Kingdom	2007-11	2014

*Sources: "Serial Offenders: Industries Prone to Endemic Collusion - Contribution from South Africa," OECD Global Forum on Competition, DAF/COMP/GF/WDZ (2015)23; Ivaldi, Jenny, and Khimich (2015); other sources.

B. Characteristics of Cement Markets[8]

33. Cement can broadly be defined as a substance that sets and hardens independently, and can bind other materials together. While, for example, the current European standard for common cement defines no less than 27 different cement types, cement is a standardized product so that, once controlling for the type, it is homogeneous across suppliers. Thus, like most markets with cartels, cement is a homogeneous product. Theoretically, it is ambiguous whether product homogeneity eases the stability condition because a more homogeneous product both increases the short-run gain to cheating and the foregone future loss from inducing cartel collapse.[9] However, it would seem that both the participation and coordination conditions are easier to satisfy. The low profit from competing when products are homogeneous will tend to result in a large incremental profit gain from cartel formation, while coordination is made easier since firms can charge a common price.

34. A second product trait is that cement has a relatively short shelf life of around 30-60 days which has the implication that inventories play a limited role. If, for example, demand unexpectedly and persistently declines, firms are unable to store excess supply for an extended length of time and thus would be inclined to unload it on the market at lower prices. This potentially significant decline in prices and profits under competition means a large incremental rise in profit from firms coordinating on keeping those supplies off of the market (or agreeing to transport it to more distant markets) and maintaining higher prices. Thus, a short shelf life could make it more likely that a demand decline causes the participation condition to be satisfied. The stability condition, by contrast, is likely to be more difficult to satisfy because collusion can be made more stable by firms being able to threaten increased supply out of inventories if a firm deviates from the collusive outcome. That type of punishment is less available to firms because of a short shelf life.

35. Turning to demand characteristics, cement is largely purchased by industrial buyers and its most common use is in the production of concrete which is widely used in the construction industry, either in the form of prefabricated units (such as panels, beams, and slabs) or "cast-in-place" concrete needed for the construction of building superstructures, roads, or dams. This has two notable implications: market demand for cement is highly price-inelastic and is subject to considerable variation over time. The share of cement in construction costs is around 2% (though is somewhat higher for certain construction projects such as bridges, tunnels, and prefabricated components). Because cement is a small fraction of the input cost of

[8] Some of the sources for this section are Rosenbaum and Sukharomana (2001), Mercado-Aldaba (2002), Salvo (2004, 2010), Shivani (2009), Zeidan and Resende (2009), Bejger (2011), and Harrington et al (2015).

[9] With less product differentiation, the short-run gain from undercutting the collusive price is higher because firm demand is more price-elastic, which makes collusion less stable; but the foregone profit from cheating is greater when it means returning to competition because competitive profit is lower, which makes collusion more stable. Theoretical analysis has shown that how these two effects net out depends on how product differentiation is modelled.

construction, even a reasonably large increase in the price of cement will have a small impact on the cost of construction and therefore a small impact on the demand for construction and subsequently the derived demand for cement. Estimates of the (absolute value of the) short-run price elasticity of demand for cement ranges from 0.14 to 0.55, so that a 10% rise in the price of cement would only lower the quantity sold by between 1.4 and 5.5%.[10] Highly price-inelastic demand is conducive to satisfying both the stability and participation conditions for collusion. A common price increase across cement suppliers is highly profitable and, furthermore, makes collusion more stable because firms that deviate risk forgoing those large profits in the future (that is, the punishment is very costly).

36. A second implication of the demand for cement being derived from the construction sector is that it is subject to a seasonal cycle in some countries and to the business cycle in all countries. In countries with reasonably dry summers and harsh winters, construction activity peaks in the summer months and experiences reduced activity in the winter months. While the seasonal cycle is predictable, the business cycle is not. The construction sector is an industry highly sensitive to the business cycle. The cyclicality and volatility of cement demand makes it more difficult for the stability condition to be satisfied.[11] Seasonality to demand makes collusion more difficult because a firm will have a strong incentive to deviate just after the peak of demand because demand is strong (which implies high sales and high current profit from undercutting the collusive price) but future demand is weak given that the cycle is heading into a trough (so the foregone future profit from causing a shift to competition is less).[12] At the same time, I would argue that cyclical demand - especially from the business cycle - could make it easier to satisfy the participation condition (conditional on satisfying the stability condition so that firms are able to collude). Cyclical demand is likely to create episodes of intense price competition when demand is weak and capacity is in ample supply and that could induce cartel formation.

37. Cement is a low-value commodity relative to weight which has the implication that transportation costs are a significant proportion of cost which results in geographically segmented markets. Transportation by trucks is the most frequent mode though, when available, transportation by rail or sea can be less expensive. In the absence of the latter options, this suggests that the relevant geographical markets are local. In the case of Brazil, almost 95% of consumed cement is produced within a 300-mile radius. The local nature of markets tends to make markets relatively concentrated which, at least theoretically, makes collusion more stable. It also makes it more costly for more distant non-cartel members to supply in response to higher prices, and that serves to stabilize collusion.

38. The production of cement is capital-intensive, energy-intensive, and uses a mature technology. The cement production process can be subdivided into three main steps: the preparation of the raw mixture, the production of the clinker, and the preparation of the cement. Cement producers tend to locate near the most important raw material source (which is typically lime). The production of the clinker through heating in a cement kiln is not only quite inflexible - in the sense that the costs per unit increase quickly with a higher rate of capacity utilization - but is also energy-intensive. In general, production characteristics suggest that high start-up costs are incurred with entry into the cement market, e.g., due to the necessary access to lime resources or the installation of production plants and mills.

[10] For Brazil, Salvo (2010) estimates 0.14-0.64 and Zeidan and Resende (2009) estimates 0.162-0.549, while Röller and Steen (2006) estimates 0.46 for Norway.

[11] On this point, Grout and Sonderegger (2005) finds that increased sales variability for a 3-digit SIC industry is associated with a lower frequency of cartels.

[12] This result is from Haltiwanger and Harrington (1991) though Fabra (2006) shows that it relies on capacity constraints not binding during the boom phase.

39. Production is energy-intensive, not only due to the operation of the kiln but also the grinding of raw material and clinker. Energy costs are estimated to be around 30-43% of manufacturing costs. Capital costs are about 20% of total manufacturing costs which results in reasonably high economies of scale. This has at least two implications pertinent to the conditions for collusion. First, given product homogeneity, if competition drives price down near marginal cost, price is likely to be below average cost. The prospect of incurring persistent losses is a likely rationale for cartelizing (and thereby satisfying the participation condition). The high capital costs also means that collusion is unlikely to induce greenfield entry though imports from more distant markets is a possible source of external instability.

40. As mentioned, the cement industry is mature and has experienced few technological improvements in recent times. The last major innovation took place in the 1970s when the "wet" process kiln system was replaced by the "dry" process which consumed less than half as much energy. This technological maturity could result in a certain stability of market shares (though capacity investment can upset that) which makes coordination easier as firms can allocate according to historical market shares which is common among cartels.[13] It also means collusion is more profitable because a firm cannot differentiate itself through a lower cost technology or an improved product (which, if they could, would tend to soften price competition). In addition to a mature technology serving to satisfy the participation condition, low asymmetry in costs could make agreement on a collusive outcome easier (thus satisfying the coordination condition) though there can still be considerable variation in firms' capacities which has been shown to make agreement more difficult for some cartels (especially if capacity utilization rates vary across firms).

41. While less of an intrinsic attribute to cement and more of a fact for some cement markets is the presence of excess capacity. This could well be due to demand variability. For example, if firms invest in capacity expansion when demand is strong then, when demand declines due to the business cycle, there is likely to be excess capacity. Or, as in the case of the German cement cartel, if demand growth expectations are not fulfilled then significant excess capacity can arise (Harrington et al, 2015). Excess capacity can result in satisfaction of the stability condition - as firms can expand supply as a punishment in response to cheating - and the participation condition - as prices and profits will be low with excess capacity and homogeneous products resulting in intense price competition.

42. To summarize the preceding discussion, cement markets are characterized by:

- Product homogeneity and short shelf life.
- Price-inelastic market demand from industrial buyers that is highly sensitive to seasonal and business cycles.
- High transportation costs resulting in local geographic markets.
- High capital costs resulting in concentrated markets and entry barriers.
- Capital-intensive mature production technology.
- Excess capacity (in some cement markets).

43. An inductive approach to screening would then entail finding markets with the same set of traits. Looking for this particular constellation of traits recognizes that it may be the interaction of these traits - not simply the aggregation of them - that makes collusion so common in cement markets. It may not just

[13] For examples, see Harrington et al (2015).

be homogeneous products or concentrated local markets or highly cyclical demand that make collusion more likely to emerge but rather those traits (and other ones) in conjunction. One place to start looking for product markets with similar traits is to consider other inputs into construction such as bricks, gypsum, gravel, concrete, roof tiles, and lumber.

6. Some Policy Recommendations

44. The primary objective of enforcement is to deter illegal behavior rather than detect and punish it. Deterrence avoids the social costs associated with such illegal behavior as well as the costs with discovering and prosecuting it. It is then natural to ask: Are competition authorities succeeding in deterring cartel formation? Is the intensified enforcement that has been experienced globally in the last 20 years paying off in terms of deterrence? While a comprehensive examination of that question is beyond the scope of this paper, suffice it to say that there is very little evidence of enhanced deterrence. This is not to say that there is evidence that the rate of cartel formation has *not* slowed but only that there is little evidence that it *has* slowed.

45. What we do know is that cartels continue to form, the recent global auto parts cartel may prove to be the largest cartel in the last few decades, and there is certainly no downward trend in the caseload of the Antitrust Division of the U.S. Department of Justice.[14] One could also ask whether the increase in penalties and possible increase in the probability of paying those penalties has resulted in making collusion unprofitable, on the whole. There is an active debate regarding whether penalties in some jurisdictions are too low - so that collusion remains profitable and there is under-deterrence of cartels - or too high - so that they are in excess of what is necessary to deter and may be creating social costs. For example, Connor and Lande (2012) argue there is under-deterrence. In the case of the EU, Allain, Boyer, Kotchoni, and Ponssard (2011) provides evidence against the under-deterrence claim, though Combe and Monnier (2011) offer a contrasting view. As an indirect measure that collusion is unlikely to be unprofitable (or at least not substantively unprofitable) is that there is little indication that senior managers in companies are putting in place measures to discourage and detect participation in cartels by their employees. The institution of antitrust compliance programs is a minimal response and falls far short of the efforts to which corporations go to avoid other illegal acts such as accounting fraud. In sum, there is little evidence that fewer cartels are forming or that collusion has, on the whole, become an unprofitable activity.

46. The implication I want to draw from that observation is that it is prudent to put more effort into discovering and convicting cartels. While both a higher probability of discovery and conviction and higher penalties ought to contribute to greater deterrence (by raising expected penalties), the former has the additional benefit of disabling cartels. If it proves to be the case that cartels are not being deterred then it is best that we strive to shut them down. Also relevant here is the oft-stated concern that leniency programs are heavily used by dying cartels which would mean that leniency programs are doing more to increase expected penalties (by aiding prosecution) than to closing down cartels as would be the case if it was inducing a member of an active cartel to come forward.[15] And there is evidence in the broader realm of crime that enhancing detection does more to deter than enhancing penalties: "Research to date generally indicates that increases in the certainty of punishments, as opposed to the severity of punishment, are more

[14] I do want to emphasize the empirical challenge of assessing the impact of policy on the cartel rate. It could well be that fewer cartels are forming and, at the same time, an increase in the rate at which cartels are discovered and prosecuted could result in the lack of a downward trend in caseload.

[15] Though it is shown in Harrington and Chang (2015) that, even if firms apply for leniency only upon cartel collapse, a leniency program can reduce average cartel duration by making the cartel less stable because the expected value from colluding is reduced.

likely to produce deterrent benefits."[16] In that light, my policy recommendations will largely focus on increasing detection though will conclude with a recommendation with respect to penalties for it is surely not my intent to suggest lightening up on the severity of punishments imposed on price-fixers.

47. Let me now turn to a few recommendations. In reiterating the analysis of the previous section, my first policy recommendation is to pursue structural screening based on an inductive approach: Look for structural traits consistent with those industries with the highest rate of cartel formation, such as cement, construction, and chemicals, and identify those markets with the same or almost-same constellation of traits. Such markets would be natural candidates for an examination of price and quantity data.

48. A related recommendation is to develop industry-specific behavioral screens for markets with the highest rates of cartel formation. To do so would involve looking for common patterns in prices and quantities in, say, cement cartels but also common collusive practices, such as basing point pricing or the use of sales quotas. Knowing the types of collusive practices used will lead to a richer and more precise set of predictions regarding firm conduct. Once those collusive markers are identified, competition authorities could educate buyers in those markets regarding what to look for with regards to sellers' prices and quantities. Such information is often provided at a general level in distributed material from competition authorities but here I am recommending, for example, to describe collusive markers specific to cement cartels and to inform cement buyers of those markers. It must always be remembered that buyers, in particular, industrial buyers, are the first line of defense against cartels. They have the best data and the strongest incentives for uncovering cartels. At the same time, a competition authority is better informed about what to look for and this market-specific knowledge can be communicated to buyers in those markets particularly prone to cartel formation.

49. In order to enhance the development of market-specific collusive markers, I recommend the creation of a global database on collusive practices and price and quantity patterns. Collecting multiple instances of cartels in, say, gasoline or shipping or asphalt or cement may allow us to identify commonalities in how they operate which could result in better market-specific screens. A necessary step for its implementation would be a common template for reporting the facts surrounding an episode of collusion. Such a template could be organized into: 1) market traits (e.g. concentration, product homogeneity); 2) cartel traits (e.g., is the cartel all-inclusive? which managerial levels were involved?); 3) collusive practices (e.g., market allocation, monitoring); 4) price and quantity patterns (e.g., low price volatility, stable market shares, gradually increasing price); and 5) cartel experience (e.g., what event might have induced cartel formation, cartel duration, how it was detected). My general sense is that there is a wealth of information in the minds and computers of competition authorities and it could be a major advance in our understanding of when and where cartels form, how they operate, and how they are detected by systematically centralizing this information so that it can be accessed for analysis.

50. While my next recommendation is not new, I would like to emphasize it in order to offer a counter-point to the U.S. Department of Justice's opposition to it. It is the use of whistleblower rewards to aid in detection. As with cartels in other markets, some cement cartels were originally reported by uninvolved employees of a firm that was eventually shown to be a member of a cartel. It was because a "disgruntled employee revealed to a newspaper that the cement companies were exchanging information and dividing their market shares"[17] that a cement cartel was discovered in Argentina, and it was a former employee of Votorantim Cimentos that reported a cement cartel in Brazil (Edwards (2012)). There are

[16] Wright (2010). That study also went on to state: "... half of all state prisoners were under the influence of drugs or alcohol at the time of their offense." Indeed, who knows how many cartels were formed over a three-martini lunch or a bottle of fine Bordeaux. ☺

[17] O'Farrell and de Pino (2009), p. 2.

other instances of cartels being reported by uninvolved employees, but also cases in which employees suspected something was awry but did not report; for example, the carbonless paper[18] and fine arts auction houses[19] cartels. Unless the employee is "disgruntled" or doesn't work for the company any more, there are strong disincentives for them to report their suspicions to anyone outside of the firm. In the spirit of the leniency program inducing involved employees to share what they know, it seems at least as compelling that we should offer large financial incentives to uninvolved employees to share what they suspect (and large enough means it is worth their while even if subsequently dismissed from the firm). At present, there are only three countries - Hungary, South Korea, and the United Kingdom - offering whistleblower rewards and only South Korea has rewards that are even remotely appropriate in size if one supposes that a whistleblower requires financial independence to implicate their employer in an unlawful activity.

51. The DOJ has expressed opposition to offering rewards to whistleblowers on the grounds of witness credibility: "The Antitrust Division's Deputy Assistant Attorney General for Criminal Enforcement ... stressed that jurors may not believe a witness who stands to benefit financially from successful enforcement action against those he implicated."[20] I believe this concern is unwarranted for several reasons. First, rewards are paid only upon conviction and the standards for conviction of price-fixing or bid-rigging are generally high which means that there is little hope for an employee to see any money from making fraudulent accusations. That may not be known to the general public but a competition authority can certainly express it to a prospective whistleblower. Second, a truly small percentage of cases actually go to trial in the U.S. Third, an investigation initiated by a whistleblower is likely to induce a leniency application (if indeed there is a cartel) in which case the primary evidence will come from the latter, not the former. There seems much to gain and little to lose from offering whistleblower rewards. Until there is clear evidence that we have won the fight against the cartels, we should continue to put in place policies that show promise.

52. My final recommendation pertains to serial offenders whether it means companies who colluded repeatedly in the same market or who colluded in more than one market. While it is common for fining guidelines to list recidivism as an "accentuating factor" that justifies fining these companies more, I advise against it.[21] Given there is a statutory maximum fine, fining recidivists *more* necessarily means fining first-time offenders *less* which means weaker penalties for first-time offenders.[22] A preferable fining policy is:

[18] "A Sappi employee admits that he had very strong suspicions that two fellow employees had been to meetings with competitors. He recollects that they would come back from trade association meetings with a very definite view on the price increases that were to be implemented and that they were relatively unconcerned by competitor reactions." *Official Journal of the European Union*, L 115/1, 21.4.2004, Case COMP/E-1/36.212 Carbonless paper, Decision of December 20, 2001.

[19] "Sotheby's submits that some of its personnel commented that they had a 'feeling' that the introduction of the fixed vendor's commission structure may have arisen out of some sort of understanding with Christie's. Such suspicions were supported by the fact that London had given strict instructions not to depart from the published commission structure and to monitor and report to senior management any discounts offered by Christie's in contravention of its published rates." Commission of the European Communities, 30.10.2002, Case COMP/E-2/37.784 Fine Arts Auction Houses.

[20] U.S. Government Accountability Office, "Stakeholder Views on Impact of 2004 Antitrust Reform Are Mixed, but Support Whistleblower Protection," July 2011; p. 38.

[21] In International Competition Network (2008), 20 out of 22 countries reported recidivism as an accentuating factor in the determination of corporate fines.

[22] However, some countries have a statutory maximum that is contingent on whether an offender is a recidivist. For example, Brazil allows a fine up to 20% of the previous year's turnover if it is a first offense but up to 40% if there was a previous offense. As collusion is almost always welfare-reducing, we should not be hesitant about setting the statutory maximum as high as we think firms can realistically pay. Whatever that maximum is, it ought to apply regardless of whether the offender is serial or not.

Fines are set at the maximum level allowed by the law with the exception that reductions will be provided when firms exhibit exceptional behavior in discontinuing collusion or cooperating with the investigation.

53. There should not then be accentuating factors, while mitigating factors are only those that create social gains by either reducing cartel duration - for example, offering a discount for immediately shutting down the cartel upon the start of the investigation - or increasing expected penalties by assisting in the prosecution - for example, firms plead guilty in exchange for a discount.

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