Levenstein, Margaret C.; Suslow, Valerie Y.

Working Paper

What Determines Cartel Success?

Working Paper, No. 2002-01

Provided in Cooperation with:
Department of Economics, University of Massachusetts

Suggested Citation: Levenstein, Margaret C.; Suslow, Valerie Y. (2002) : What Determines Cartel Success?, Working Paper, No. 2002-01, University of Massachusetts, Department of Economics, Amherst, MA

This Version is available at:
https://hdl.handle.net/10419/105725

What Determines Cartel Success?

Margaret C. Levenstein and Valerie Y. Suslow[1]

Section I: Introduction

"…[H]ow multitudinous are the devices by which industrialists have attempted to restrict international competition." (Great Britain Board of Trade 1944, p. v)

Although difficult at times to uncover, cartels are far from rare. Nussbaum estimates that international cartels controlled approximately 40% of world trade between 1929 and 1937 (1986, p. 134). As a result of the increased prosecution of international cartels during the 1990s, we have a new set of cartels that are ripe for study.[2] While it is generally agreed that cartels are not as pervasive in Western economies today, these contemporary cartels have certainly affected hundreds of millions of dollars of sales.[3]

Empirical research on cartels has a long history that both benefits and suffers from the variety of methodological approaches that have been used to examine cartels. This paper examines the evidence and results of these varied empirical studies of cartels and asks three sets of questions. First, how do we define and measure cartel success and failure? Second, what do we know about the difference between successful and unsuccessful cartels, between industries that are prone to collusion and industries where it is rare? Third, what methodological approaches are best designed to answer these questions? What can we learn from cross-section studies that examine cartels in many industries? What kinds of questions are better addressed through the industry-specific case studies that have been the focus of most recent research on cartels? How should students of cartels approach the study of these new cartels so as to provide the basis for a deeper understanding of the underlying dynamics of cartels and to inform anti-trust policy in the future?

Section II of the paper examines cross-sectional studies of cartels. It presents a set of stylized facts on cartel stability, duration, and profitability based on the findings of the cross-section literature. We compare the mean and variance of cartel length in cross-section studies. We find this comparison revealing, as it highlights the robustness of the extremes. That is, every data set gathered includes short-lived and long-lived cartels. This leads to a discussion of the determinants of cartel longevity and a comparison of the primary causes of cartel breakdowns or renegotiations across samples of cartel activity. Section III investigates a set of case studies of

[1] U of Massachusetts (mlevenstein@econs.umass.edu) and U of Michigan Business School (suslow@umich.edu)

[2] The Department of Justice has recently turned its attention and resources to prosecuting international cartels that have a significant effect on prices paid by U.S. consumers. During the 1990s the DOJ uncovered international cartels in a wide range of markets.

[3] Levenstein and Suslow (2001), provide a very rough estimate for the potential effects of recent international cartels on developing countries: "In 1997, the latest year for which we have trade data, developing countries imported $81.1 billion of goods from industries which had seen a price-fixing conspiracy during the 1990s. These imports represented 6.7% of imports and 1.2% of GDP in developing countries" (p. 2).

cartels, comparing the characteristics of these particular cases with the stylized facts presented in Section II. We then examine the same issues regarding the determinants of cartel success as discussed for cross-section studies, as well as additional insights that case studies provide. Section IV compares the characteristics of international cartels in the 1990s with those discussed above, and asks whether the stylized facts regarding industry characteristics hold for this particular set of cartels. We briefly discuss recent contributions examining the determinants of success of these cartels. We urge that future studies of these and other cartels learn from and build on earlier work on cartels. Concluding remarks are given in Section V.

Section II: Cross-Section Studies

There is considerable disagreement among economists and policymakers about how stable cartels are and how successful they are at increasing profits. Cartel behavior is usually clandestine, and cartel data sets (whether cross-section or single industry) are plagued with measurement error, unobservable variables, and sample bias. Thus, there are remarkably few rigorously established generalizations that we can make about cartel behavior or success. We know that cartels do occur, and we know that they do break down. There seem to be certain industries where cartels or cartel attempts appear to recur. Beyond this, our empirical generalizations are qualified and cautious.

Because the variables measured and the analytical methodologies employed are so dissimilar, one can compare the early cross-section work on cartels only in the broadest of terms. In order to assure that we are comparing apples to apples and oranges to oranges, we first discuss cross-sectional studies of U.S. cartels. Then we separately examine cross-sectional studies of international cartels.

One branch of the empirical cartel literature begins with Richard Posner's (1970) path breaking study of firms prosecuted for price-fixing by the Antitrust Division of the U.S. Department of Justice. His goal was to determine the shared characteristics of these price-fixing cases. Hay & Kelley (1974), Asch & Seneca (1975), and Fraas & Greer (1977) all take this approach. The advantage of this approach is that the legal cases themselves (especially those that were tried and not settled) produced a great deal of data. Posner, for example, assembles a sample of 989 horizontal conspiracy cases from 1890 to 1969.[4]

Table 1 summarizes the characteristics of collusion in each of the U.S. price-fixing samples. The mean number of firms ranges across the samples from 7.25 to 29.1, but the majority of price-fixing agreements involved fewer than 10 members (79% of Hay and Kelley's sample, 60% of Fraas and Greer's sample, and 64% of Posner's sample). Trade association involvement occurred primarily when the conspiracy consisted of a large number of firms (roughly one-third of the cases). The surprising absence from Table 1 of what most would consider basic factors influencing cartel success, such as demand elasticity and lumpiness or infrequency of orders, indicates how difficult it is to gather such data for broad cross-sections involving hundreds of firms in a variety of industries.

[4] Appendix A outlines the data sets used in each of these studies.

These early cross-section studies highlight several interesting cartel characteristics, but because of the likely bias in the data due to its peculiar selection criteria, later research moved to studying cartels outside of the United States, where antitrust laws were historically less stringent (certainly prior to World War II, and in many countries for decades after). International cartels have historically assumed that they were signing legal, but not enforceable contracts. Germany, where courts ruled that cartel contracts were enforceable, was the exception.[5] Although cartel member firms (or at least the non-U.S. firms) did not have to fear prosecution, they still had to solve privately the classic cartel incentive problem caused by conflicting individual and cooperative interests. Cartel members could communicate, seek information, and enforce penalties in an overt manner, but they could not rely on a third party to enforce the agreement.

Here we review five cross-section studies of international cartels: Eckbo (1976), Griffin (1989), Suslow (1991), Marquez (1994), and Dick (1996). The first four studies use samples of international cartels that begin before World War II; some remain active through the early 1980s. Andrew Dick's data set is comprised of Webb-Pomerene export cartels over the period 1918-65. We also discuss another survey of international cartels, the *Great Britain Board of Trade* study conducted by the British government after World War II. This monograph presents a great deal of interesting information, but not in a way that is easily quantifiable.[6]

1. Cartel Profitability

Most cartel scholars who work with cross-section data use duration to measure cartel success, well aware that duration is a highly imperfect proxy for performance.[7] Cartels can and do survive as de facto organizations without having a significant effect on price.[8] Data limitations force many to proxy cartel duration with the length of the formal agreement, which is itself problematic. Following the literature, much of this chapter's discussion of cartel success focuses on the determinants of cartel duration. Before we do so, however, we discuss the limited cross-section results on the profitability of international cartels.

Eckbo (1976) and Griffin (1989) both attempt to measure profits. Eckbo studies both the characteristics and the performance of international cartel agreements using an international cartel data set of 51 cartel agreements in 18 industries. The cartels in the sample date from late 1800s to the 1960s. Nineteen of the fifty-one cartel agreements are labeled "efficient," defined as able to "raise price 200% above the unit cost of production and distribution" (Eckbo 1976, p.

[5] German courts generally treated cartel contracts as enforceable agreements from 1870 until the end of World War II, when the occupation forces established U.S.-type anti-trust law.

[6] Each of these data sets are described more fully in Appendix A.

[7] The price-cost margin literature is much more sophisticated in its attempts to tie margins to industry and firm characteristics. See, for example, Domowitz, et al (1986). This is an interesting literature, but hard to map to cartel performance because we do not know whether there was a formal cartel in the industries that are found to have high price-cost margins. Another class of studies looks at the effect of antitrust prosecution on prices. For example, Sproul (1993) surveys 25 price-fixing cases between 1973-1984, and follows the price four years after the indictment. He finds a slight (7 percent) increase in prices for the entire sample. However, the evidence for those cases filed after 1976 (i.e., after the antitrust penalties were significantly increased), shows that price declines at first but then rises about 17 months after the indictment.

[8] For example, the British Government survey of cartel agreements reports that "[t]here is indeed, sufficient evidence to show that in some industries the agreements were not carried out or were carried out only in part" (1944, pp. xli-xlii).

26). Griffin (1989) computes the average Lerner Index for the 54 cartels in his sample. He finds an average Lerner Index of 0.31. The most "successful" cartel (the rubber cartel of 1923 to 1928) has an estimated Lerner Index of 0.80, while the least successful cartel (the wheat cartel from 1933 to 1934) still charged a price below cost so that its Lerner Index was –0.12. These results point to two important themes that we will come back to throughout the paper. First, cartel prices should, in principle, be compared to the prices that would obtain in the presence of competition. For example, in the depth of the Great Depression, an extremely successful cartel might still have charged a price below cost. Unfortunately, cartel studies rarely have enough information to take account of such issues. Second, as we will see in our discussion of duration, the overarching finding in the study of cartels is variation in outcome. Some cartels are very successful at increasing prices and profits, while others are dramatic failures.

2. Cartel Duration

Cartel duration may be more easily observed than excess cartel profits, but the interpretation of the observed pattern of cartel duration is more complicated than a novice might suppose. This is because one of the most clearly established patterns is that cartels form, endure for a period, appear to break down, and then re-form again. Thus the empiricist is faced with the question, did she observe two short-lived cartels? Or one long-lived cartel? Does this process of cartel breakdown and reformation represent cartel success or cartel failure? A variety of theoretical models have provided rationalizations of this phenomenon, but different explanations have very different implications for anti-trust policy.

Stigler (1964) argues that this pattern reflects fundamental cartel instability: the primary challenge to cartel success is the possibility of incumbent firms' cheating on the agreement. The repeated breakdown and re-formation of cartels reflects the occurrence of such cheating, suggesting that cartels are generally not able to meet this challenge and are, hence, not internally stable creatures.

In the hands of modern game theorists, Stigler's observations have been reincarnated with an entirely different policy implication.

> … collusive conduct may … result in a pattern … marked by recurrent episodes in which price and profit levels sharply decrease. …. Thus we reject the received view that performance of this type necessarily indicates an industry where firms are engaging in a sequence of abortive attempts to form a cartel. Since this opinion is often used … to deny the need for intervention to promote competition in such industries … our argument suggests the need to re-examine a widely held assumption about policy (Green and Porter 1984, p. 88).

Building on Stigler's intuition that the possibility of cheating is the major threat to cartel stability, Green and Porter (1984) show that price wars can themselves be the solution that the cartel needs to achieve stability. Cartel members refrain from cheating lest it push the industry into a price war. The observation of changing behavior on the part of cartel members is entirely consistent with a cartel being able to raise prices and profits above the competitive level. Periods

of low prices do not reflect the end of the cartel but are an information cost that arises from firms' inability to perfectly monitor one another's behavior.[9]

Rotemberg and Saloner (1986) present a different explanation of fluctuations in cartel behavior. Even when, as in their model, cartel members can observe one another's output decisions, so that there is no uncertainty about whether a competitor has cheated on a collusive agreement, successful collusion still requires that firms have an incentive not to cheat. A cartel's ability to raise price over the competitive level depends on the relative size of contemporary competitive profits and future cartel profits. For example an increase in current period demand increases the incentive to cheat on the cartel agreement, requiring an adjustment in the cartel price to prevent such cheating. Thus, even though cartel members never cheat and the cartel never breaks down, the cartel price fluctuates in response to shocks to demand. If this is the explanation of the observed cycling of cartel behavior, the best anti-trust policy may be expansionary macroeconomic policy.

Finally, Slade suggests that price wars may erupt as a result of learning or asymmetry. In this case, the empiricist's simplistic observation is correct: what looks like the end of a cartel is, in fact, a real breakdown in collusion. The breakdown is not caused by the cheating hypothesized by Stigler, but rather by permanent structural shifts that require renegotiation among cartel members (Slade 1989, May 1990).

The average cartel in these various studies lasted between 3.7 years and 7.5 years (Table 2) – which is either a very long time or a very short one depending on who is judging.[10, 11] The minimum reported estimate of 3.7 years, comes from Suslow (1991), who tries to link cartel dissolution to a specific event in the market which caused a restructuring of the cartel. [12] The standard deviation of cartel duration ranges from approximately 2.4 years (Eckbo's "Sample 1") to 6.3 years (Griffin). Examining individual cartels reinforces this picture of variety in cartel outcomes. The shortest cartel in Eckbo's "Sample 2" survived less than a year and the longest lasted 18 years.[13] In Griffin's sample, the minimum cartel duration is one year, and the maximum is 29 years, *both in the same market* – wheat. As shown in Table 2, roughly half of the cartels studied lasted less than five years, but a significant fraction (between 12 and 37

[9] Abreu, Pearce and Stacchetti (1986) extend Green and Porter's model by expanding the set of possible strategies beyond trigger strategies and allowing firms to choose the optimal strategy that maximizes expected profits. More generally, Green and Porter (1984) and Abreu, Pearce, and Stacchetti (1986) discuss specific ways of solving the imperfect monitoring version of the general Folk Theorem result. The Folk Theorem states that, with infinite repeated interaction and sufficiently low discount rates, there exists an equilibrium set of strategies that support any level of profits between zero and the joint profit maximizing level (Friedman 1971).

[10] The *Great Britain Board of Trade* study reports that the term of the typical cartel agreement varies considerably from cartel to cartel; most often it is from 3-5 years (British Government 1944, p. xiii).

[11] All of the international samples contain cartels that were abruptly ended by the start of World War II. Average duration can vary substantially within these samples, depending on whether all cartel episodes or only "uncensored" episodes are used to calculate the mean.

[12] Suslow (1991) defines distinct cartels within an industry if the cartel contract was restructured either after the exit of a key member or to incorporate a significant new member. A distinct cartel is not defined if a lesser country joined an agreement already in progress without prompting a change in the other cartel contract provisions. This method of dating cartel episodes yields duration estimates shorter than those specified in the actual written cartel contracts.

[13] There are several cartel episodes in Sample 2 that lasted less than a year, which leads Eckbo to code them as "0" in length. This is one reason for the relatively high standard deviation of 4.7 years in Eckbo's Sample 2.

percent) lasted more than ten years. It is difficult, then, to pigeonhole cartel longevity. Some cartels can barely get off the ground, while others last for decades.

And some do both. Table 3 presents duration statistics for a number of industries in which cartels appear repeatedly. Some cartels re-formed several times within a very short span of years, others went off and on over fifty years or more.[14] In some cases, such as the copper cartel, each period of cartelization appears to endure for longer than the previous one. This suggests a pattern of learning on the part of cartel members. In others, there is no obvious pattern: cartel episodes may be long or short, or very long or very short.

Table 3 demonstrates two other important issues in studying cartels. First, simply measuring duration is plagued with pitfalls because researchers can disagree on exactly where to place the beginning and end of a particular cartel episode. Eckbo and Griffin both study the sugar cartel with overlapping samples for roughly a thirty-year period. However, they disagree significantly on the precise timing of the many sugar cartels.

Second, the sugar industry experience illustrates an instance where firms repeatedly turned to cartels to try to increase profits, but apparently with little success, even in the short run. According to Eckbo, all of the sugar cartels were less than one year in duration, except for one ten-year spell. Why do firms keep trying to coordinate pricing when it not successful? It is possible that there is an empty core, i.e., the competitive equilibrium is not stable, leading to an incentive to form coalitions, but then these coalitions are themselves unstable. This could lead to a disequilibrium phenomenon of cycling in and out of collusion.[15] But it is also possible, as Green and Porter (1984) suggests, that these "breakdowns" are evidence of equilibrium price wars and should be treated as a single cartel of long duration. On the other hand, if Stigler is correct, and these cartels have failed, each should be counted as a distinct cartel. The empirical literature has yet to come to terms with this fundamental question.

3. Determinants of Cartel Profitability

Griffin (1989) and Eckbo (1976) provide the only systematic cross-section regressions relating cartel profitability to industry and cartel characteristics. They both find that cartel profits are increasing in industry concentration and cartel market share (Table 4) They also both conclude that homogeneity of firms within the cartel increases cartel success: Eckbo finds that "efficient" cartels tend to consist of firms with similar costs, while Griffin finds that cartels that are made up of a small number of similar sized firms are more able to raise price. Griffin creates a measure of internal cartel organization that attempts to capture the extent of control that the cartel has over member operations. Griffin finds that more centralized cartels are more effective at raising

[14] Similar studies have also been done for U.S. price-fixing samples. Bosch and Eckard (1991) present an estimate of the number of firms indicted multiple times by the DOJ. Over the period 1962-80, they estimate that 1300 firms were indicted for price fixing: "The proportion of recidivists (as much as 4 times) in our sample is roughly 14%" (p. 309, footnote 1).

[15] For more details of behavior in the sugar industry see Eichner, (1969), and Genesove and Mullin (1998, 2001); for a discussion of empty core models, how they compare to cartel models, and empirical tests, see Telser (1985), whose article discusses the existence of market equilibrium, Sjostrom (1989), who tests his theory with data from ocean shipping markets, and Pirrong (1992), who expands the empirical tests on ocean shipping by emphasizing the roles played by demand divisibility and discontinuities in marginal cost.

price.[16] He concludes, "For those searching for a magical equation by which to predict the monopoly power of the cartel, these results are disappointing …[P]robably of greater importance is that each cartel's monopoly power has been influenced by individual, cartel-specific effects, such as market conditions unique to that period, the personality attributes of key cartel organisers, and so forth" (Griffin 1989, p. 195). We will return to this theme below.

Although Griffin and Eckbo's work are the only extensive cross-section studies of cartel profitability, others provide related evidence. Asch and Seneca (1976) and Fraas and Greer (1977) attempt to distinguish statistically between industries prone to collusion and industries without cartels. Asch and Seneca find that poor profit performance is associated with collusion, although they are not sure why.[17] They try to associate this low-profit characteristic with other measurable characteristics. For example, they find that firms characterized by low profits and low rates of sales growth demonstrate a tendency towards collusive behavior. They also find that large, low-profit firms are clearly associated with collusive behavior to a much greater degree than small, high-profit firms.

Table 5 shows where these studies were able to identify statistically significant differences between collusive and non-collusive industries. A "+" sign in Table 5 indicates that this variable was positively and significantly associated with collusion, while a "-" sign indicates a negative and significant association. For example, Asch and Seneca find that large firms are more often convicted of collusion. On the other hand, industries with high entry barriers are less likely to be found in the collusive sample.

Regrettably, Table 5 has limited usefulness in advancing our knowledge of which factors make collusion possible or successful. That is because these studies do not tell us this. All we know is that these are the characteristics associated with price-fixing cases that were prosecuted. The disadvantage of working with these data is sample selection bias. As Posner notes, we cannot be sure whether these are samples of firms that are collusion-prone or prosecution-prone.[18] Asch and Seneca, for example, obtain the seemingly perverse result that low profit firms are more likely to collude. It is hard to know whether low profits spurred these firms to collusion, which is possible, or whether these were particularly unsuccessful price-fixing conspiracies – and therefore all the more obvious to anti-trust authorities.

Cross-section studies have had limited success at both measuring cartel profitability and estimating its determinants. The results that one can draw from the literature are sensible: firms in concentrated industries are more likely to collude and are more likely to raise prices by doing so. Cartels are more likely to form where members have similar interests and where cartels are able to control member behavior. Cartels with these features are also more likely to be

[16] Griffin does not elaborate on how he measures organization. He simply states that it "is a subjective measure assigned after reading the available descriptions of the effectiveness of the cartel structure" (Griffin 1989, p. 191).

[17] Asch and Seneca do not know whether the 50 randomly selected "non-colluding" firms were in fact not colluding, only that they were not prosecuted for price fixing.

[18] Posner's data show that a large proportion of the DOJ cases and an even larger proportion of FTC's cases are brought in industries with low concentration. One explanation is that "the methods used by the Department to detect and prove price fixing are such that marginal conspiracies in markets of low concentration are likely to be substantially over-represented in the Department's 'catch'…[C]onspiracies that have a large number of members...are most likely to generate the crucial evidence of agreement" (Posner, 1970, p. 410).

successful. But there is still enormous variation in industry conduct and in cartel success, even controlling for industry structure.

4. Determinants of Cartel Duration

There are a variety of reasons to expect that cartel duration is negatively related to the number of firms in the cartel and in the industry. A large number of firms creates coordination problems, increases the likelihood that there exists a firm willing to cheat, etc. The empirical results, however, are ambivalent on this question (Table 6). Posner and Dick actually find that cartel duration increases with the number of firms. Using his large sample of 989 Department of Justice cases, Posner finds that 52 percent of the cartels with 10 or fewer members persisted for 6 years or more. But duration was even longer for cartels with more than 10 firms; 64 percent lasted 6 years or more. Hay and Kelley do not have enough dispersion their much smaller sample to test for an effect of the number of firms on cartel duration. However, they do note that the majority of conspiracies lasting 10 or more years were in concentrated markets.

The empirical analysis of the equally intuitive presumption that industry concentration and high cartel market share increase the duration of a cartel is borne out in the international cross-sections. Dick, Marquez, and Suslow all find that cartel duration increases with the share of the market controlled by cartel members (Table 6). Hay and Kelley find that industry concentration is associated with increased cartel duration (Table 6).

Another important aspect of industry structure for cartel duration, highlighted by Stigler (1964) is the presence of large customers. Stigler hypothesized that large customers would increase the incentive for a cartel member to defect and, therefore, contribute to cartel instability. Dick tests this proposition for his Webb-Pomerene cartels and finds that cartels selling to relatively larger buyers tended to dissolve sooner (Dick 1996, p. 261). As shown in Table 6, other cross-section studies have not included downstream industry structure in their studies though this does seem like an issue for which a cross-sectional methodology could be useful.

As discussed above, demand fluctuations play an essential role in several different models of cartel stability, and most cross-sectional studies have included a demand-related variable. The particular measures vary from study to study depending on the particular model specified (and, of course, the actual data availability). To distinguish between the Green-Porter prediction that price wars will arise in response to unobserved negative demand shocks and the Rotemberg-Saloner prediction of "price wars during booms," Dick tests whether his sample of Webb-Pomerene cartels were more or less likely to collapse during downturns in export demand (Dick 1996, p. 271). [19] He finds that cartels were more likely to end during anticipated downturns, but that their stability was unrelated to unanticipated business cycle fluctuations.

Marquez focuses on the rate of growth of demand. He finds that an increase in demand growth has a negative effect on duration, but not a significant one. Comparing his results with others in the literature, Marquez conjectures that the effect of demand growth on cartel duration is dependent upon both the country composition of the sample and the sample period (Marquez 1994, p. 338). Suslow (1991) focuses instead on deviations from trend demand and finds that

[19] His measure of demand variability is the coefficient of variation of an index of quarterly export prices for one of four broad product categories during the cartel's life span.

demand uncertainty is the most important single variable in explaining cartel contract duration – more important than either the industry structure or cartel organization variables.

The British Government Study (1944) noted that cartel instability is a prominent feature in those industries susceptible to "violent" changes in economic conditions. More stable industries – such as matches, electric lamps, and quinine – saw steady cartel activity over long periods (British Government 1944, p. xxxii). This finding is consistent with the econometric results described above – demand instability appears to destabilize cartels.

Finally, most studies note that internal, organizational variables often seem important in determining the success and durability of any cartel. Despite the difficulty in capturing these organizational variables quantitatively, several studies have made useful inroads in this area. Suslow finds, for example, that variables measuring the existence of penalties, patents, and narrowness of product scope all have a positive, significant effect on duration. Also, the more experienced the cartel, and the more specialized and complex the governance structure (greater use of penalties and of central sales agencies, for example), the longer the cartel is likely to endure.[20] The British Government study comes to a similar finding regarding the importance of organizational variables. Cartel agreements were rarely renewed without substantial modification to the cartel organizational form or penalty structure (British Government 1944, p. xxxi).

Another way to approach the determinants of cartel duration is to examine the immediate cause of the cartel dissolution. Several of the international cross-section studies do systematically examine breakdowns. Eckbo categorizes cartel failures with a series of binary variables: Was the breakdown market related or political? If market related, was it due to external forces? If externally caused, was it an increase in non-member supply that strained cooperation to the breaking point? A tabulation of the results of his investigation is shown in Table 7. The main reason, as most theorists would suspect, is internal conflict or defection, accounting for 10 of the 23 breakdowns, or roughly 44 percent. The same holds true for the twenty-nine Sample 2 cartel episodes: 59 percent ended due to internal conflict. In Suslow's sample, it is also true that internal conflict and cheating ended a large majority of cartels, second only to the fact that many cartels in her sample were brought to an end by World War II.

As with Eckbo, Griffin also looks into the reasons for cartel "disintegration." He finds that for his sample of 54 cartels, 27 ended for primarily political reasons. New entry or the use of substitutes ranks second, with a count of 18. What Griffin calls "behavioral problems" or "opportunistic behavior" caused another 14 to fail. This category includes cheating and disagreement over market shares, encompassing both what we would classify as "monitoring" price wars and "bargaining" breakdowns. World War II brought 12 cartels to an end. Finally, technological change was decisive in ending 4 cartels (rubber, zinc, sulphur, and nitrate).

5. Summary of Results from Cross-Section Studies

We can make the following generalizations from the international cartel cross-section work, with a few specific comments on lessons we can extract from U.S. price-fixing cases:

[20] However, when a dummy variable is included in the regression analysis to capture pre-WWI cartel experience of 16 industries in the sample, Suslow (1991, p.23) finds no significant effect on post-WWI cartel episode duration.

- Cartels with greater market share and in more highly concentrated industries endure longer than those with lower market share and in less concentrated industries. In the U.S., price fixing is more frequent (or more frequently prosecuted) in industries with fewer firms or greater concentration.

- Faster growth in trend demand is associated with shorter cartels, as are business cycle downturns. In general, instability in the economic environment destabilizes cartels.

- Cartel organization and the history of the cartel are important, but difficult to measure. In the U.S., price fixing appears more frequently in homogeneous product markets, perhaps indirectly indicating that these cartels are easier to organize. Also, cartels in the U.S. often rely on trade associations to help with cartel organization when there are a large number of firms in the industry.

- Cartels reappear in some industries, and cartel duration tends to increase with industry experience with collusion.

- Other than WWII, cheating is the most common cause of breakdowns in international cartels.

Section III. Case Studies

We turn now to an examination of a set of recent case studies of cartels. This is, admittedly, a very unscientific sample. These studies were selected based on our own familiarity with the cases and, in some instances, prior knowledge that the authors looked at issues in which we were interested.[21] Most of these studies make more explicit use of the modern game theoretic literature than do the cross-sectional studies surveyed above. In this section we will compare the findings of these studies with cross-section results presented above. In particular, we examine the stylized facts regarding profitability and duration and discuss their implications for the determinants of profitability and duration.

Case studies can provide us with a richer information set about a particular industry and its experience with cartel agreements. The equilibrium outcome in game theoretic models of collusive behavior often turns on small differences in the information set that each player has and the conjectures each player makes about the other players' behavior. A firm that has participated in a series of cartel agreements over the years with the same set of industry players probably has definite priors about how they will react in response to changes in strategy. A case study may do a much better job of identifying these critical subtleties than the typical cross-section study. By studying the interaction of one set of firms in depth, we can learn more about expectations and beliefs and how these expectations are affected by past management strategies. The downside to the case study approach is that the generalizations necessary to develop policy are much more difficult to make. For example, consider a case study that convincingly demonstrates that a particular kind of vertical restraint was used to stabilize a particular cartel. What should we conclude? Such a finding means neither that such a restraint is always used for collusive purposes, and so should be prohibited by anti-trust authorities. Nor does it imply that such a restraint is necessary for cartel success, so that anti-trust authorities could restrict their attention

[21] See Appendix B for the list of cases.

to industries where such contracts were used. Case studies have provided useful comment on game theoretic models, but it has been much harder to move from case study analysis to policy recommendations. We attempt to bridge that gap here.

1. Cartel Profitability

Most modern case studies pay surprisingly little attention to evaluating the success of cartels. Perhaps we are just so happy to have the detailed data made possible by case studies that we are inclined to assume that the cartel is successful, and that we are learning from the case study about how successful cartels operate.[22] There are a few studies, though, that take the question seriously. The methodological questions can be separated broadly into three areas: use of price to measure success, comparison of good times against price wars to measure success, and, as always, using duration as a proxy for success. Here we survey the findings of studies taking these different approaches, and we point out the common pitfalls.

Because quite a few cartels were formed following a decline in price (either because of entry, market integration, technological change, or a decline in demand), cartel prices and profits might well be lower, or at least not higher than, those that prevailed in the pre-cartel period. A fall in profits after the formation of a cartel does not necessarily mean that the cartel was not successful. Profits might be higher than would have been the case *in the absence of the cartel*.

With this caution in mind, Table 8 reports changes in prices and profits in our sample of sixteen cartel case studies.[23] Virtually every cartel case study surveyed here reports that the cartel was able to raise prices immediately following cartel formation. Most case studies do not compare cartel prices with the competitive price (or any other counterfactual price). In the bromine and ocean shipping cases, the cartels were reportedly able to raise price to the joint profit-maximizing level. In the case of German steel, cartel prices were lower than the joint maximizing price, but still significantly above the competitive price. In cases where the cartel was regional or national, the cartel price may be compared to the world price. In two such cases, cement and oil, national cartels were able to raise prices above the world price. Thus, there is ample evidence of price increases, but this evidence is often fragmentary. In many cases, it is not the right kind of evidence to determine conclusively whether the cartel raised prices and profits above what they would have otherwise been.

It is also important, when evaluating the success of a cartel, to look at more than just the price the cartel charges during "collusive" periods. As many of these industries have periods of price wars or other breakdowns in collusion, the success of the cartel must be measured in terms of overall profitability, not just the profitability of periods in which high prices are charged, no matter how briefly. For example, during the 1930s, U.S. breweries cooperated to raise prices, probably increasing prices to levels that were actually *higher* than the joint-profit-maximizing

[22] Of course, there are also studies that deny that what they are studying *is* a cartel. Firms may get together and fix prices, but, it is argued, the economic result is not to restrict output and raise prices relative to what would occur in the absence of such cooperation (Leach 1994; Pirrong 1992; Sjostrom 1989). (Why rational, profit-maximizing firms who cooperate in setting prices would refrain from trying to increase profits is a bit of a mystery, but one that is beyond the scope of this paper.) This paper does not address these largely normative questions; we presume that firms are using whatever means are at their disposal to raise profits.

[23] The sources for these case studies are reported in Appendix B.

price in order to assuage prohibitionists concerns (which remained influential immediately following Repeal). But these high prices were not sustainable. McGahan (1995) found that the industry had price wars in each of the three years in which it attempted to collude.

2. Cartel Duration

The issues that arose in measuring cartel duration in cross-section studies do not disappear when one turns to case studies. The difference is only that the economists' choices become more visible to the reader. For example, conflict over the terms of a cartel agreement may lead to a price war. Such price wars, termed "bargaining price wars" by Levenstein (1996) in her examination of the bromine cartel, can in principle, through careful case study, be distinguished from those that represent a "punishment phase" (à la Green-Porter) of an ongoing cartel. Gupta (1997) also finds evidence of bargaining price wars for the tea industry cartels in 1931 and 1932.[24]

It is also important not to equate formal duration with success. There are cases in which the formal structure of the cartel is maintained, but declining market share undermines the cartel's ability to raise price above the competitive level. This was the case, for example, in the mercury industry (MacKie-Mason and Pindyck 1987). The industry apparently managed a very successful cartel from 1928 to 1950; in 1950 collusion broke down in a dispute regarding a large Italian sale to the U.S. government stockpile. The cartel was re-established in 1954 and prices rose to very profitable levels. But high prices induced entry, and after 1965 the cartel's share of world output declined. The cartel continued its formal existence but had little impact on prices. Another attempt at cartelization was made in 1975, including countries representing 60-80% of world production, but the "new cartel was unsuccessful" (MacKie-Mason and Pindyck 1987, p. 197).[25]

Table 9 presents duration statistics from sixteen cartel case studies. Comparing Table 2 and Table 9, we find that cartel longevity for this set of sixteen industries, with fifty cartel episodes among them, is longer than was the average duration for the cross-section studies discussed above. The mean duration is 17.2 years (median of 8 years), rather than the roughly 4 to 8 year average found in cross-sections. The variance in cartel longevity for the cases reported in Table 9 also far exceeds that for the cartels studied in cross-sections, which was itself sizeable. Cartel duration ranges from less than one year (in the case of several cartels that barely or never got off the ground) to 100 years between the formation of the DeBeers diamond cartel and its first breakdown. The standard deviation of cartel duration of this admittedly non-random sample is a whopping 18.3 years. One suspects that this variance reflects scholars' tendency to select industries for case study that have either a long history of cartel activity or an interesting history of on-again off-again cartel episodes. In any case, the lesson learned once again is that cartels cannot be categorized as "short" or "long" – they are both.[26]

[24] These "bargaining price wars" are similar to what Slade (May 1990) calls "asymmetric information price wars."
[25] Note that MacKie-Mason and Pindyck (1987) appear to measure success by examining price trends. Falling prices, which continued after the formation of the new cartel, may have reflected the failure of the cartel. But demand was also declining. Falling prices therefore might still reflect a successful cartel, when measured against the (counter-factual) prices that would have prevailed absent a cartel.
[26] It also reinforces the point made above that there are inherent sample selection problems in cartel studies.

There is substantial variation in the duration of cartels both within a single industry and across industries. That two of the most stable cartels in this set are both South African – the DeBeers diamond cartel and the South African cement cartel – highlights the importance of particular cultural and institutional environments. But we also find very stable cartels in the United States, such as the parcel post (Railroad Express) cartel that was in force for much of the nineteenth century. Both ocean shippers and mercury producers have also managed to sustain long lasting cartels.

The least stable cartel in this group is the one that has received the most attention of late, the nineteenth century railroad cartel known as the Joint Executive Committee (JEC). The JEC data, studied by Ulen (1979), Porter (1983), and others, show fairly conclusively that switches in conduct occurred in the late nineteenth century railroad industry.[27] Even in the notoriously unstable railroad industry, the JEC looks short-lived. The longer periods of railroad cooperation reported in Table 9 are all from southern railroads. The northern railroads did not manage to sustain cooperation for more than two or three years, before the establishment of the Interstate Commerce Commission (ICC), except in cases where there was another large, outside player, such as Standard Oil.

In this set of case studies there are several cartels that got off to a rocky start and then managed to sustain collusion for longer periods. This was the case for the railroad-oil, tea, potash, and sugar cartels. It appears that the participants learned about each other and about organizational features that would help to support collusion in their industry. It seems likely that this kind of early history of failure characterizes many successful cartels. In many cases, these early failed attempts may have left little or no historical record. This kind of learning appears to continue in many of the European cartels; the post – World War I steel and potash cartels, for example, display more complex organizational structures than did their pre-war predecessors. In contrast, the change in institutional and economic environment seems to have limited the usefulness of pre-World War I or National Industrial Recovery Act (NIRA) cartel experience for many U.S. industries. Alexander (1994) convincingly argues that in many industries firms did learn to cooperate during the NIRA period in ways that improved their ability to limit price cooperation even after explicit collusion was prohibited. This does not show up in our table because the new form of cooperation was generally not a formal cartel.[28]

Of course, in other industries, early failures never lead to successful collusion. It is important, as a matter of anti-trust policy, that we learn to distinguish failed attempts that pave the way for future collusion from failed attempts that reflect the inherent difficulty of sustaining collusion in a particular industry. One can speculate that there are a large number of industries that followed the pattern of the Canadian oil industry, in which the failure to sustain collusion led to consolidation of the industry (Grant and Thille, 2001). This has certainly been asserted about the attempts to control prices in the U.S. trusts of the late nineteenth and early twentieth centuries. Similarly, the repeated failure of railroads to sustain collusion is often offered as an explanation for the creation of the ICC. With state power, the ICC could accomplish for the railroads what they could not accomplish with voluntary accords (MacAvoy 1965, Kolko 1965).

[27] See Slade, May 1990, pp. 531-32 for a complete discussion.
[28] See Levenstein (1996) and Genesove and Mullin (1999) for further discussions of learning about cartel design.

Case studies that examine failed attempts to form cartels add enormously to our understanding of the basic cartel problem. A close examination of the reasons for failure would illuminate our understanding of why cartels appear where they do and the extent to which successful cartels are idiosyncratic in nature or endemic to certain industries. Because successful cartels are more likely (despite the cartels' best efforts) to leave records than are failed cartels, and because success is more appealing as a subject of study, most studies focus on successful cartels. There is also a certain reluctance to label a cartel a failure, even when it might be more informative to do so. One important exception is MacAvoy's (1965) study of nineteenth century railroad cartels. He argued strongly that these cartels *failed* because of the impossibility of preventing cheating by member firms. This point has been lost in the literature on the JEC, which has tried to discern the characteristics of a successful cartel from the JEC experience.

There are a few other treatments of cartel failure, in addition to MacAvoy's work. Alexander's (1997) study of the 1930s pasta industry is an interesting case. She argues that cost heterogeneity was sufficient to make it impossible for macaroni producers to collude, even during the NIRA, when many other U.S. industries were able to collude in the new, more sympathetic legal environment. The optimal collusive price was very different for large firms with low costs than it was for smaller firms with higher costs.

Levenstein (1995) examines repeated attempts by U.S. salt producers to collude during the nineteenth century. Salt producers created the very first known price-fixing cartel in the U.S. They employed a wide variety of legal and extra-legal mechanisms to fix prices, limit output, and provide exclusive access to geographic markets. Each of these collusive arrangements collapsed within a year or two at the most. Levenstein argues that, despite much hard and creative work on the part of the manufacturers, as well as some state regulators, there were not sufficient barriers to entry to allow for sustainable collusion. Clay and Troesken (2002) come to a similar conclusion regarding attempts to control the markets for distilled alcohol during the late nineteenth century: barriers to entry were simply too low to allow colluding firms to maintain market share as they increased price.

3. Determinants of Cartel Profitability and Duration

a. Concentration

Virtually all studies of collusion include some measure of concentration. Concentration has been shown to be consistently and positively related to collusive success. Concentration may reflect barriers to entry. But to the extent that concentration exhibits its own, independent effect on collusive success (as opposed to simply picking up the effect of barriers), it is probably because it is easier to design an agreement with fewer participants. Studies that find a positive relationship between collusion and concentration include Hay and Kelley (1974) and Eckbo (1976) (Table 1). [29] Most of the cartels included in our case study sample were in relatively

[29] The structure-conduct-performance and price-cost margin literature have found a consistent relationship between concentration and profits and/or markups across industries, but we restrict ourselves here to the literature on cartels. Rosenbaum and Manns (1994) for example, in their price-cost margin study of Fortune 500 corporations from 1974-77, find that stable market concentration is the only variable that consistently makes conjectures more collusive. This stability may reflect the increased ease of coordination among a small number of firms in industries that are highly concentrated and/or whose membership does not fluctuate. The stability of industry membership, however,

concentrated industries (see Table 10). The exceptions are usually legal cartels, often with active state involvement.

Some argue that the number of *decision-makers* is more important than the number of firms (Cyert, *et al*, 1995). If the firm decentralizes pricing authority, then there is less price discipline and price wars are more likely to break out. For example, in the famous electrical equipment conspiracy, Richard Austin Smith says that the 1950s "decentralization plan" (where the head of each unit was given marketing and pricing authority) lead to the breakdown of the cartel (Smith 1963). The number of participants in our set of case studies ranges from 2 to several hundred, as shown in Table 10. But in each case where there were more than a dozen or so firms, industry associations or even national governments played a key role in organizing and implementing the agreement.

b. Cheating

Table 11 catalogs the causes of cartel "failures" as reported in our sample of case studies. The most common cause of breakdown noted in Table 11 was entry; entry disrupted collusion at some point in over a third of the industries studied and was the primary cause of cartel disruption in a third of the individual episodes studied.[30] That is larger than the figures given in Table 7 for cross-section studies, although it is close to Griffin's 33% figure. Non-market forces, such as the outbreak of WWI or WWII (15% of the cartels) and Department of Justice action (a little over 10%) account for about a quarter of the dissolutions in the group.

Trailing far behind are three cartel episodes, or less than 10% of the case study sample episodes, that ended due to cheating. One interesting case regarding industry-specific demand fluctuations is the electrical equipment cartel. There was more cheating in the turbine agreement than in other electrical equipment products, because of the lumpiness of demand. This is consistent with Stigler's comment on the importance of large customers. Where the defector can quickly capture a large share of the market with a small defection, defections are more likely. This seems to have been the case in turbines, though it does not seem that it was sufficient to undermine the cartel altogether.

In many industries, authors asserted that cheating was simply not a problem for the cartel. Bargaining problems were much more likely to undermine collusion than was secret cheating. About one quarter of the cartel episodes ended because of bargaining problems. Bargaining issues affected virtually every industry studied. Finding a point on the contract curve, and hoping that that point remains an equilibrium, is often the biggest challenge for firms attempting to collude. Successful cartels have developed organizational designs that allow the agreement to accommodate fluctuations in the external environment without requiring costly renegotiations. Secret cheating undermines cartels in some industries, but if collusion is really to be successful, the firms in the industry will probably have to make such a significant investment in the collusive organization and in the development of organizational skills that cheating becomes a

---

also suggests that there are barriers to entry that allow the cartel to flourish. What these barriers are may well vary from one industry to another.

[30] Baker (1995) argues that new entry is particularly important in cartelized industries because incumbent firms are less likely to adopt new innovations than are new entrants. Thus entry is induced not only by high cartel profits but also by the incumbents' neglect of potentially profitable innovations.

secondary issue. Industries that continue to suffer from cheating after making such formal agreements are often industries that cannot really sustain collusion. Of course, the story of the modern industrial organization literature is that firms do not actually cheat; their competitors cannot discern that due to noise in the economic environment. The costliness of many of the hypothesized punishments is such that successful colluders would rather invest in mechanisms to assure that cheating is observable, and therefore prevent it, than to implement costly punishments because of *ex-post* uncertainty.

c. Customers and the Nature of Demand

The case study literature also reflects the surprisingly complex relationship between customers and supplier cartels. Table 12 summarizes the role of customers in the sample of case studies surveyed. In five of these industries, customers engaged in explicit strategic behavior to try to break the cartel that charged them high prices. In some cases (e.g., bromine and potash) customers attempted to enter the industry, vertically integrating to get around the cartel. In other cases, customers attempted to encourage defections by telling suppliers that others already had (as in the rayon industry) or by contracting with defectors, as predicted by Stigler (Eswaran 1997, Levenstein 2000). Recent research on the potash cartel suggests that fertilizer manufacturers organized a national merger *in order to* undermine the potash cartel that supplied them with an essential raw material (Levenstein 2000). Some customers also looked to legal remedies, even before the Sherman Act offered triple damages, as when crude oil producers had the corporate charter of an early railroad cartel revoked (Granitz and Klein 1996). In virtually every case, large customers happily took advantage of price wars to stock up on supplies (Levenstein 1996). For example, grain brokers actually stored their goods in Chicago waiting for the next breakdown in the JEC railroad cartel (Ulen 1979).

But as seems so often to be the case in studying cartels, large customers are bad for cartel stability – unless they aren't. There are other cases, sometimes in the same industries as those described above, in which customers were intimately involved in stabilizing a cartel, providing information and punishment mechanisms not otherwise available and sharing, indirectly, in cartel rents (Granitz and Klein 1996, Levenstein July 1993). Barbezat (1994) argues that steel users preferred the stability assured by the German steel cartel to the chaos of the competitive market. In many of these cases, the preferred treatment received by the cooperating customer gave them a significant advantage relative to their own competitors: better to pay somewhat higher input prices, and rid oneself of competitors who would have to pay even higher prices; better to *pay* higher input prices than *charge* competitive ones.

As demand is more elastic, the potential for increasing profits decreases and so does the incentive to create a cartel (Pindyck 1979). Where tested, this fairly intuitive result is borne out in the cross-sectional studies discussed above. Eckbo (1976) finds that cartels are able to raise price substantially only if demand is sufficiently inelastic and there are few short-term substitutes (p. 42). There are numerical estimates of demand elasticities for only four of the sixteen industries included in our informal sample of case studies (Table 13); in most cases measured demand is inelastic. In five other cases, demand for the product is described as "inelastic." The one industry included that clearly had very elastic demand (the brewing industry, with an elasticity of –10), also had a remarkably unsuccessful cartel, with price wars occurring in every year of the study. The prices charged by that particular cartel may have, in fact, been higher than

optimal, moving demand out to a very elastic range, because the cartel was operating in the immediate post-Prohibition era and there was significant political pressure to keep the price of alcoholic beverages high.

The longstanding presumption in the cartel literature has been that cyclical downturns undermine cartels. This was the case in the tin and steel cartels that fell apart during the depression of the early 1890s (Lamoreaux 1985). Table 14 summarizes the evidence on cyclicality and cartel stability that could be culled from our sample of case studies. The table asks whether a particular cartel ever came together or fell apart in response to demand fluctuations. Many studies report that a cartel came together during a period of falling prices, but this is not always, or even usually, associated with falling demand (either for the particular product or in aggregate). Instead, it often signifies entry or the integration of previously distinct markets. The limited information in this table reflects the limited contribution of case study research, up to this point, in informing our understanding of the relationship between cyclicality and cartel stability. The only case that was ended by an observable demand shock is that of the international steel cartel. In other cases, bargaining issues may arise as a result of a decline in demand. Similarly, it may be that cases that we have coded as cheating were adversely affected by demand shocks.

What is most striking about this is how little relevance macroeconomic fluctuations seem to have one way or the other. This is consistent with the Green-Porter/Abreu, et al literature, which implies that firms will respond to unobserved fluctuations in demand, but not to observed fluctuations. From the point of view of the cartel, macroeconomic fluctuations are close to common knowledge; it is idiosyncratic demand that may not be observed. It is also consistent, however, with our comments on expensive, disruptive punishments. Successful cartels do not break apart, but rather develop machinery of some sort that allows them to weather cyclical fluctuations. Cartels that are disrupted by observed cyclical fluctuations may be fairly fragile to begin with.

d. Cartel Organization

Cross-sectional studies have a difficult time testing the importance of organizational issues, because, even if it is possible to get data on cartel organizations for a large number of industries, that data has to be drastically simplified in order to be made use of in such a study. Case studies offer more promise in this area, though most do not address the question directly. One exception is MacKie-Mason and Pindyck (1987); they argue that organizational issues were *not* important in determining cartel success. External conditions, not organizational issues, undermined the sulfur and mercury cartels; more generally, they argue that if sufficient profits are available, organizational means will be found. But they do not examine the internal records of the cartels involved, so it is difficult to know whether a different cartel organization could have created barriers to entry or sustained demand, so that the cartel could have enjoyed continued success. One example of a cartel that has managed to do exactly that is the diamond cartel (Spar1994).

Baker and Faulkner (1993) argue that organizational structure did matter for the success of the electrical equipment cartel of the 1950s: collusion was easier for standardized products in which the management of the cartel could be fairly decentralized. It was much more difficult for customized products that required frequent contact among colluding firms. But this case highlights the difficulty of treating organization as an exogenous variable. The same firms with

essentially the same managers used very different organizations, but that was because of differences in the homogeneity of their products. Thus one suspects that standardization and the smoothness of demand were the real determinants of cartel stability, more so than organization per se.

The expectations that participants have about competitors' propensity to cooperate can make all the difference in whether collusion is successful or not. These expectations may be influenced by previous interaction or interaction in other markets. These may also be influenced by culture, either cultural bonds that make negotiations easier or cultural differences that must be overcome. The large number of international cartels, historically and more recently, suggests that firms have managed, at least in some cases, to overcome such barriers in the search for higher profits. But while a wide range of literatures, from the oldest cartel studies to modern supergame models of collusion, highlight the importance of such issues, they have rarely been systematically studied. They are not explicitly included in any of the cross-sectional studies discussed in Section II, above.

Case studies have the potential to provide a forum for further examining such expectation issues, but moving from casual description to testing is rare and difficult. Spar (1994) examines how the internal organization of competitors can affect their capacity for external cooperation. At the core are the dual problems of commitment and credibility. She argues that these are critical determinants of cartel success. Her study describes the historical background in which individualist diamond miners were forced to develop cooperative solutions to a variety of problems and argues that this created the context for successful collusion in the industry. Studies of the rayon industry note that there was a "culture of collusion" among firms in the industry that facilitated cooperation (Gallet and Schroeter 1995, Markham 1952). Similarly, the 1930s steel industry benefited from the experience of the Gary dinners of the 1890s (Baker 1989). Alexander's (1994) piece does perhaps the best job of moving the analysis forward by examining how the opportunity to cooperate during the National Industrial Recovery Act increased the potential for implicit collusion after its overturning by the Supreme Court. Something had changed that allowed firms to move to a more profitable equilibrium as a result of that experience.[31]

Section IV: Cartels in the 1990s

In this section we discuss the duration and success of a set of more recent and less well-studied cartels: international cartels during the 1990s. It is impossible to gauge the true number of international cartels in existence in the 1990s. However, we do know that the U.S. Department of Justice and the European Commission have recently investigated and prosecuted, or are currently investigating, at least forty different international price-fixing conspiracies that were in force at some point in the past decade. The surge in U.S. prosecutions of international cartels stems primarily from the revision and expansion of the Antitrust Division's corporate amnesty program in 1993. The number of corporations coming forward and seeking amnesty rose from

[31] Polodny and Scott Morton (1999) provides an excellent example of how to directly examine the role of cultural bonds in sustaining a cartel. The question they address is how the response of the cartel to a new entrant depends on cultural bonds, but it is a very similar question to the one raised here. See Cooper and Haltiwanger (1993) for a non-cartel example of firms using the NIRA to move an industry to a more profitable equilibrium.

roughly one corporation per year to one per month.[32] On the heels of this increased enforcement by the U.S., the European Union, as well as some non-European countries, have strengthened their anti-cartel laws and stepped up their enforcement.[33]

The United States and the European Commission have successfully prosecuted thirty-five international cartels for fixing prices during the 1990s (Table 15).[34] This sample, like its intellectual antecedents discussed in Section II, may be biased as a result of its dependency on prosecution as a sample selection criterion. The producers in these cartels come almost exclusively from industrialized, OECD countries. Many of these conspiracies appear to have had primarily U.S. or EU effects, but some of the larger cartels clearly had an effect on markets worldwide (Levenstein and Suslow 2001).

1. Cartel Profitability

We have very little evidence on the excess profits earned as a result of these episodes of cartelization. For fifteen of the thirty-five cartels we have anecdotal evidence of price increases during the cartel periods, mostly from the trade press.[35] The reported price increases range from 10 percent to 100 percent, with a median cartel price increase of approximately 25 percent. One can also see from Table 15 that the typical market was highly concentrated. Although the concentration figures are hard to summarize, since they differ according to geographic region (U.S., Europe, or world) and the number of firms, a very rough calculation shows that the median market concentration, ranging from a two- to a ten-firm concentration ratio, is 83 percent.

The graphite electrodes cartel fits the pattern of a highly concentrated industry that allegedly raised prices significantly over a five-year period. Graphite electrodes are large carbon columns used by electric arc furnaces or "mini-mills" in the making of steel. These mini-mills use graphite electrodes to generate the enormous heat necessary to melt scrap metal and convert it back into a marketable steel product. UCAR International of the United States and SGL Carbon Corporation of Germany dominate the market, with a combined world market share of about two-thirds. Roughly five firms make up the bulk of the remaining market share. In the United States, graphite electrode prices increased over fifty percent during the cartel period, May 1992

[32] Bingaman (1996, p. 8). See also Adler and Laing (1997), who state, for example, that "In 1991, only 1 percent of corporate defendants were foreign and no foreign individuals were charged that year. From July 1996 to January 1997, 20 percent of all corporations and 27 percent of all individuals charged were foreigners" (p. 1).

[33] See, for example. Reynolds, Michael, "EU Briefings," *International Financial Law Review*, London, January 1, 1999, vol. 18, no. 1, pp. 48+. The article announces the decision within the European Commission to create a new unit to fight cartel activity. See Evenett and Suslow (2000) and Evenett, Levenstein, and Suslow (2001) for further discussion of this sample of 1990s cartels.

[34] In order to be included in this sample, a cartel must satisfy the following conditions: 1) it must involve more than one producer; 2) it must include firms from more than one country; and 3) it must have attempted to set prices or divide up markets.

[35] Of course, evidence of increased cartel prices must be interpreted with care because some portion of the increase may reflect other factors such as rising raw materials costs or increases in demand. The information in Table 15 is purely descriptive and does not purport to control for other relevant factors that may have affected prices during the conspiracy period. Also, we do not know what the competitive price would have been "but for" the cartel.

through February 1997.[36] In Canada, where the industry consists of only two firms with a combined market share of over 90 percent, prices rose by more than 90 percent over 1992-97.[37]

The most precise estimates of cartel overcharges for a recent international cartel come from the economists who worked on the first lysine cartel case – a federal class-action suit in 1996. The lysine conspiracy was precipitated by Archer Daniels' Midland's large-scale entry into the industry in 1991. Lysine prices plummeted. After securing roughly one-third global market share, ADM signaled that it was willing to behave cooperatively.[38] There were 25 cartel meetings between 1992 and 1995. In 1995 the Department of Justice was investigating the lysine case but had not yet filed formal charges. However, lysine customers brought a number of private civil suits, which were consolidated into a federal class-action suit in 1996. The defendant companies settled for $45 million.

The government's expert, John Connor, estimates that the cartel overcharged U.S. customers between $65 million and $134 million.[39] The reasons for such a wide range in this estimate are by now familiar ones. As we argued earlier, it is quite tricky to determine whether cartels are stable or recurring and the exact time frame during which a cartel was successfully operating. In addition, there are always competing explanations for price increases, which may have occurred regardless of any cartel activity. In the lysine case, the primary competing explanation was seasonality of demand. Connor estimates that one-fourth of the 1992 price increase could be attributed to seasonality.[40]

The timing of the dates of the lysine cartel was problematic, and there was considerable disagreement between the economic experts on each side. Connor writes that there was "[d]isagreement about the dates of the conspiracy-effects period, the but-for price, and the type of industry conduct absent collusion…"[41] Connor uses marginal cost (estimated from what he identifies as "highly competitive" periods) as the competitive price. White, on the other hand, argues that the lysine industry, absent cooperation, would not have operated as a perfectly competitive industry. It was a four-firm oligopoly that would have likely been able to engage in some form of implicit coordination if there had been no explicit meetings.[42]

Recognition of this possibility, White argues, causes us to "enter the world of oligopoly speculation."[43] Perhaps ADM would have operated as a dominant firm. Or, perhaps the firms would have adopted Cournot behavior. White then identifies a shorter, 17-19 month, period as the best estimate of the true (i.e., effective) conspiracy period. He concludes that "[t]hough the

[36] "Government's Sentencing Memorandum and Government's Motion for a Guidelines Downward Departure (U.S.S.G. §5K1.1)" U.S. Department of Justice, Filed October 19, 1999 (2001), p. 2.
[37] "Foreign Corporation Fined $12.5 million for Price Fixing," Industry Canada, Competition Bureau, News Release, July 20, 2000.
[38] Connor (2001), pp. 8-9.
[39] Connor (2001), p. 20.
[40] Connor (2001), p. 10.
[41] Connor (2001), p. 15.
[42] White (2001), pp. 27-28. From a pro-active policy perspective, the relevant question is what is necessary to achieve a competitive price that assures an efficient allocation of producers' resources and individual consumption decisions. Thus, for our purposes, the marginal cost price is the relevant comparison.
[43] White (2001), p. 28.

conspiracy surely did have harmful effects on the purchasers of lysine, those effects were less extensive and less severe than was claimed."[44]

2. Cartel Duration

The story on duration is quite the same as with other samples of cartel activity we have examined thus far. The average duration of the sample of 1990s cartels listed in Table 15 is approximately 5.4 years, with a standard deviation of 4.7. There are short-lived cartels, such as aluminum phosphide, where the price-fixing effort lasted only from January to November of 1990. In this case, one of the major producers refused to cooperate to raise prices and the conspiracy quickly collapsed. Other short-lived cartels include plastic dinnerware, sodium gluconate, and thermal fax paper. On the other hand, as with previous cartel samples, there is evidence of long-lived cartel activity as well: cartonboard (1986-1991), graphite electrodes (1992-1997), maltol (1989-1995), and sorbates (1979-1997), to name just a few.

3. Determinants of Cartel Profitability and Duration

Careful study of the characteristics of the industries cartelized during the 1990s has yet to be done. In most cases, however, the industries are highly concentrated with a few very large multi-national firms that compete with one another in many geographical and product markets. In the few cases where the industry is not highly concentrated, such as shipping, industry associations have played a critical role in organizing and maintaining the cartel.

There is no systematic study to date of whether these cartels used different mechanisms of organization, communication, and penalties than did their predecessors. There have been claims that "international cartels use increasingly sophisticated techniques and technology to coordinate their activities…"[45] Much more research needs to be done to verify this statement and interpret the details. On the surface, the methods of organization and operation give the impression of remarkable similarity to those used historically. For example, most of these cartels held meetings in hotel rooms around the world. Despite new technologies of communication, the executives seem to have decided that true cartel negotiations – covering quotas, exchange of information, and threats of punishments – had to be done face-to-face. Another similar characteristic is that markets were often divided geographically, much as they were in the international cartels active prior to World War II. James Griffin, Deputy Assistant Attorney General, Antitrust Division, makes this point when introducing the information contained on a series of covert tapes made by the Federal Bureau of Investigation of the lysine cartel meetings:

> "While the lysine tapes are extraordinary in the sense that they give us an insider's view of the inner workings of an international cartel, the cartel itself is far from extraordinary. The objectives of the lysine cartel and the methods the conspirators used are common among the international cartels that we have detected in the last few years. At their core, international cartels have essentially the same purpose – to increase profits among the conspirators by carving up world markets – and they operate pursuant to the same methods – fixing prices, rigging bids, allocating

[44] White (2001), p. 30.
[45] Bingaman (1996), p. 1.

territories and customers, and allocating sales volumes among the conspirator firms on a worldwide basis."[46]

Another well-documented example comes from the citric acid case, where firms in the industry fixed prices from approximately July 1991 to June 1995.[47] The structure put in place by the citric acid cartel members was quite elaborate. The senior executives responsible for determining the broad outline of the cartel agreement were nicknamed "the masters." The lower-level executives responsible for the day-to-day workings of the cartel were "the sherpas." They shared monthly sales figures and took stock at the end of the year of each company's total sales. A company selling more than its quota was required the next year to purchase citric acid from a cartel member that was under quota.[48] This type of elaborate structure is no different in philosophy from the intricate structure developed by, for example, the electrical equipment manufacturers in the United States in the 1950s (famous for its "phases of the moon" bidding scheme).

It is predictable that if firms attempt to fix prices and maintain cartel profitability, they must block entry into the industry. Even a cursory study of recent international cartels shows that these firms have used and will use all available means to create barriers to entry. The U.S. citric acid producers tried twice to employ the government to help protect the domestic industry from Chinese imports. First, in 1995, *while the cartel was still intact*, producers lobbied the Office of the U.S. Trade Representative to include citric acid on the list of various Chinese imports to be hit with a high tariff. A last-minute agreement prevented the sanctions from being imposed.[49] The second anti-dumping allegation was brought in 1999. The International Trade Commission dismissed the case in February of 2000, after deciding that there was no material injury.[50]

The graphite electrodes conspiracy also displays familiar structural characteristics, organizational mechanisms, and strategic behavior. First, the global market is highly concentrated, with two major global firms holding the bulk of the market. Second, barriers to entry are high – it takes roughly four years to build a new plant, and, according to industry sources, there has been no new entry since 1950.[51] The cartel members agreed, among other things, to divide the world market share and designate a price leader in each region, reduce exports to members' home markets, restrict capacity, exchange sales and customer information, and issue price announcements and price quotations in accordance with the agreement.[52] According to reports in the press, the cartel investigation began after a complaint from a steel manufacturer.[53] This is

[46] Griffin, James M., Deputy Assistant Attorney General, Antitrust Division, U.S. Department of Justice, "An Inside Look At A Cartel At Work: Common Characteristics of International Cartels," Speech given to the American Bar Association, Section of Antitrust Law, 48th Annual Spring Meeting, April 6, 2000, p. 2.
[47] "Justice Department's Ongoing Probe Into the Food and Feed Additives Yields Second Largest Fine Ever," U.S. Department of Justice Press Release, January 29, 1997.
[48] Kurt Eichenwald "U.S. Wins A Round Against Cartel," *New York Times*, January 30, 1997.
[49] Cheryl Cullinan Lewis, "Citric Acid," *Purchasing*, May 4, 1995.
[50] Clay Boswell, "Pucker Up: A Taste for Tartness Drives Acidulants," *Chemical Marketing Reporter*, May 29, 2000.
[51] Levenstein and Suslow (2001), p. 33.
[52] A listing of the charges is given in "Government's Sentencing Memorandum and Government's Motion for a Guidelines Downward Departure (U.S.S.G. §5K1.1)" U.S. Department of Justice, Filed October 19, 1999.
[53] Adam Jones, "Blowing the Whistle - American-Style," *The Times*, February 24, 2000.

one of the few cases where the presence of a large customer does appear to have destabilized a modern cartel, albeit through a different mechanism than Stigler hypothesized.

Contrary to Stigler, this sample of international cartels suggests that successful collusion is possible in industries with large customers (see Table 15). Many of these cartels sold intermediate goods to large, concentrated industries. For example, citric acid producers sold to Mars, Coca-Cola, and Proctor and Gamble while the vitamin cartel was selling to Kellogg, Quaker Oats, and Tyson. In fact, slightly less than half of the price-fixing cases in Table 15 (where we could find relevant information) had large corporate customers whose purchasing offices presumably had both knowledge and bargaining power on their side when ordering inputs. These firms may have used their bargaining power to lower their input prices, but they seem not to have used their resources to break up these cartels. Of these 35 anti-trust cases, four were initiated by customers filing civil suits, but in each case the customers were small firms or individuals. Triple damages were not enough to catch the attention of the legal staffs of these large corporate purchasers *prior* to government action. They have, however, been willing to demand compensation for damages *after* the government had broken up the cartel; there were seven civil suits filed against cartels with large customers after the government filed suit.

This indicates that the impact of large customers on cartel stability may be more complex than Stigler suggests. Some of these downstream industries may have been sufficiently oligopolistic themselves that it was possible for them to pass along higher input prices to consumers, decreasing any incentive they might otherwise have to disrupt the upstream cartel. Thus customer size, in and of itself, may destabilize the upstream cartel, but customer concentration may have the opposite effect.

Section V. Conclusion

What determines cartel success? Part of the difficulty in studying cartel success is that it depends on a wide variety of variables, and these variables are often not independent of one another. These include traditional structural variables, such as the variance in and concentration of demand, the structure and homogeneity of costs, and the rate of technological change. Cartel success also depends on organizational factors, such as the distribution of power within the cartel, its voting structure, the sophistication of mechanisms for detecting and deterring cheating, and the ability of the cartel itself to create barriers to entry. Cartel success depends as well on factors that are exogenous to the particular industry, such as government regulation and anti-trust enforcement. Finally, cartel success depends on such idiosyncratic and history-dependent determinants as how quickly the organization learns about cartel design, the start-up costs of creating the cartel, and the reputation of cartel members. It is easy to see that none of these variables functions independently. Start-up costs are lower and punishment devices more sophisticated in a more accommodating legal environment than one with vigorous anti-trust enforcement. Cartels can easily create barriers to entry in some industries, but fail repeatedly to do so in others, despite similar organizational and managerial skills.

What is the best way to study cartels? If the best answer to the question "What determines cartel success?" is that it is primarily exogenous factors, such as anti-trust enforcement, or demand and cost parameters, then cross-sectional studies should be informative. If, on the other hand, idiosyncratic determinants such as managerial strategy and cartel design are the predominant

factors influencing cartel success, then industry-specific studies are necessary. Case studies may also help to illuminate the ways that individual cartels have influenced "exogenous" variables such as anti-trust policy or market demand (for example, by lobbying or advertising).

There is an important complementarity between case study and cross-sectional analysis of cartels. As we have argued, it is crucial to distinguish successful from unsuccessful cartels. Case study analysis is necessary to determine the level of success (or lack thereof) of any individual cartel. But with a sufficient number of such studies upon which to draw, cross-sectional analysis could improve our understanding of the determinants of successful collusion beyond what is ever possible when examining one, by definition idiosyncratic, case at a time.

When we recognize that both external and internal factors and the relationship between them matter for cartel stability, we can see that despite the flowering of the empirical cartel literature in recent years, there is much fruitful work still to be done.

References

Abreu, D., D. Pearce, and E. Stacchetti. "Optimal Cartel Equilibria With Imperfect Monitoring." *Journal of Economic Theory*, 1986, 39, pp. 251-69.

Adler, Howard Jr. and Laing, David J. "The Explosion of International Criminal Antitrust Enforcement." *Business Crimes Bulletin: Compliance & Litigation*, March 1997, 4(2).

Alexander, Barbara. "The Impact of the National Industrial Recovery Act on Cartel Formation and Maintenance Costs." *Review of Economics and Statistics*, 1994, 76(2), pp. 245-54.

---. "Failed Cooperation in Heterogeneous Industries Under the National Recovery Administration." *Journal of Economic History*, 1997, 57(2), pp. 322-344.

Asch, Peter, and Seneca, Joseph J. "Characteristics of Collusive Firms." *Journal of Industrial Economics*, 1975, 23(3), pp. 223-37.

Baker, Jonathan B. "Identifying Cartel Policing Under Uncertainty: The U.S. Steel Industry, 1933-1939." *Journal of Law and Economics*, 1989, 32, pp. S47-S76.

---. "Fringe Firms and Incentives to Innovate." *Antitrust Law Journal*, 1995, 63(2), pp. 621-641.

Baker, Wayne E. and Faulkner, Robert R. "The Social Organization of Conspiracy: Illegal Networks in the Heavy Electrical Equipment Industry." *American Sociological Review*, 1993, 58, pp. 837-60.

Barbezat, Daniel. "Competition and Rivalry in the International Steel Cartel, 1926-1932." *Journal of Economic History*, 1989, 49(2), pp. 435-447.

---. "International Cooperation and Domestic Cartel Control: The International Steel Cartel, 1926-1938." *Journal of Economic History*, 1990, 50(2), pp. 436-438.

---. "Structural Rigidity and the Severity of the German Depression: The AVI and the German Steel Cartels 1925-1932." *Explorations in Economic History*, 1994, 31(4), pp. 479-500.

Berry, Steven, and Briggs, Hugh. "A Non-Parametric Test of a First-Order Markov Process for Regimes in a Non-Cooperatively Collusive Industry." *Economics Letters*, 1988, 27(1), pp. 73-77.

Bingaman, Anne K. Assistant Attorney General, Antitrust Division. "Opening Markets and Protecting Competition for America's Businesses and Consumers: Goals and Achievements of the Antitrust Division, U.S. Department of Justice, Fiscal Year 1993 through March 1996." March 27, 1996.

Bosch, Jean-Claude and Woodrow, Eckard E. Jr. "The Profitability of Price Fixing: Evidence from Stock Market Reaction to Federal Indictments." *Review of Economics and*

Statistics, May 1991, 73(2), pp. 309-317.

Briggs, Hugh. "Optimal Cartel Trigger Strategies and the Number of Firms." *Review of Industrial Organization*, August 1996, 11(4), pp. 551-61.

Clay, Karen and Werner Troesken, "Strategic Behavior and Market Structure in Whiskey Distilling, 1887-1895." *Journal of Economic History*, forthcoming.

Connor, John M. " 'Our Customers Are Our Enemies': The Lysine Cartel of 1992-1995." *Review of Industrial Organization*, 2001, 18(1), pp. 5-21.

Cooper, Russell and Haltiwanger, John C. "Automobiles And The National Industrial Recovery Act - Evidence On Industry Complementarities." *Quarterly Journal Of Economics*, 1993, 108(4), pp. 1043-1071.

Cyert, Richard, Praveen Kumar, and Jeff Williams. "Impact of Organizational Structure on Oligopolistic Pricing." *Journal of Economic Behavior and Organization*, 1995, 26, pp. 1-15.

Dick, Andrew R. "When Are Cartels Stable Contracts?" *Journal of Law and Economics*, 1996, 39(1), pp. 241-83.

Domowitz, Ian., Glenn Hubbard and Bruce Peterson. "Business Cycles and the Relationship between Concentration and Price-cost Margins?" *RAND Journal of Economics*, 1986, 17(1), pp. 1-17.

Eckbo, Paul L. *The Future of World Oil*. Cambridge: Ballinger Publishing, 1976.

Eichner, Alfred S. *The Emergence of Oligopoly: Sugar Refining as a Case Study*. Baltimore: Johns Hopkins University Press, 1969.

Ellison, Glenn. "Theories of Cartel Stability and the Joint Executive Committee." *Rand Journal of Economics*, 1994, 25(1), pp. 37-57.

Eswaran, Mukesh. "Cartel Unity over the Business Cycle." *Canadian Journal of Economics*, 1997, 30(3), pp. 644-72.

Evenett, Simon J., Margaret C. Levenstein, and Valerie Y. Suslow. "International Cartel Enforcement: Lessons from the 1990s." *The World Economy*, September 2001, 24(9), pp. 1221-1245.

Evenett, Simon J. and Valerie Y. Suslow. "Preconditions on Private Restraints on Market Access and International Cartels." *Journal of International Economics Law* , December 2000, 3(4), pp. 593-631.

Fourie, F. C. and Smith, A. "The South African Cement Cartel: An Economic Evaluation." *South African Journal of Economics* 62, 2 (1994).

Fraas, Arthur G. and Greer, Douglas. "Market Structure and Price Collusion: An Empirical Analysis." *Journal of Industrial Economics*, 1977, 26(1), pp. 21-44.

Friedman, James W. "A Non-cooperative Equilibrium for Supergames." *Review of Economic Studies*, 1971, 38, pp. 1-12.

Gallet, Craig A. "Cyclical Fluctuations and Coordination in the US Steel Industry." *Applied Economics*, 1997, 29(3), pp. 279-85.

Gallet, Craig A. and Schroeter, John R. "The Effects of the Business Cycle on Oligopoly Coordination: Evidence from the U.S. Rayon Industry." *Review of Industrial Organization*, 1995, 10, pp. 181-196.

Genesove, David, and Mullin, Wallace P. "Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914." *Rand Journal of Economics*, 1998, 29(2), pp. 355-77.

-----. "The Sugar Industry Learns to Organize Information Exchange," in Naomi Lamoreaux, Daniel Raff, and Peter Temin, eds., *Learning by Doing in Firms, Markets, and Countries*. Chicago: University of Chicago Press, 1999, pp. 103-138.

-----. "Rules, Communication, and Collusion: Narrative Evidence from the Sugar Institute Case." *American Economic Review* , June 2001, 91(3), pp. 379-398.

Grant, Hugh and Thille, Henry. "Tariffs, Strategy, and Structure: Competition and Collusion in the Ontario Petroleum Industry, 1870-1880." *Journal of Economic History*, June 2001, 61(2), pp. 390-413.

Granitz, Elizabeth and Klein, Benjamin. "Monopolization by 'Raising Rivals' Costs': The Standard Oil Case." *Journal of Law and Economics*, April 1996, 39(1), pp. 1-47.

Great Britain Board of Trade. "Survey of International Cartels and Internal Cartels, 1944 and 1946." London: Central Library, Department of Industry, 1976.

Green, Edward J. and Porter, Robert H. "Noncooperative Collusion Under Imperfect Price Information." *Econometrica*, January 1984, 52(1), pp. 87-100.

Griffin, James M. "Previous Cartel Experience: Any Lesson for OPEC?" in Lawrence R. Klein and Jamie Marquez, eds., *Economics in Theory and Practice: An Eclectic Approach*. Dordrecht: Kluwer Academic Publishers, 1989, pp. 179-206.

Grossman, Peter. "The Dynamics of a Stable Cartel: The Railroad Express, 1851-1913." *Economic Inquiry*, 1996, 34, pp. 220-36.

Gupta, Bishnupriya. "Collusion in the Indian Tea Industry in the Great Depression: An Analysis of Panel Data." *Explorations in Economic History*, 1997, 34, pp. 155-173.

---. "The International Tea Cartel in the Great Depression." *Journal of Economic History*, March 2001.

Hay, George A., and Kelley, Daniel. "An Empirical Survey of Price Fixing Conspiracies." *Journal of Law and Economics*, 1974, 17, pp. 13-38.

Hudson, Henry. "The Southern Railway and Steamship Association." *Quarterly Journal of Economics*, 1890, 5, pp. 70-94.

Hughes, James W. and Barbezat, Daniel P. "Basing-Point Pricing and the *Stahlwerksverband*: An Examination of the 'New Competitive School.'" *Journal of Economic History*, 1996, 56(1), pp. 215-222.

Kolko, Gabriel. *Railroads and Regulation, 1877-1916*. Princeton: Princeton University Press, 1965.

Lamoreaux, Naomi. *The Great Merger Movement in American Business, 1895-1904*. Cambridge: Cambridge University Press, 1985.

Leach, D. F. "The South African Cement Cartel: A Critique of Fourie and Smith." *South African Journal of Economics*, 1994, 62, pp. 254-79.

Levenstein, Margaret. "Vertical Restraints in the Bromine Cartel: The Role of Distributors in Facilitating Collusion." National Bureau of Economic Research (Cambridge, MA) Historical Working Paper No. 49, July 1993.

---. "Price Wars and the Stability of Collusion: A Study of the Pre-World War I Bromine Industry." National Bureau of Economic Research (Cambridge, MA) Historical Working Paper No. 50, September 1993.

---. "Mass Production Conquers the Pool: Firm Organization and the Nature of Competition in the Nineteenth Century." *Journal of Economic History*, 1995, 55(3), pp. 575-611.

---. "Do Price Wars Facilitate Collusion? A Study of the Bromine Cartel Before World War I." *Explorations in Economic History*, 1996, 33, pp. 1107-37.

---. "Price Wars and the Stability of Collusion: A Study of the Pre-World War I Bromine Industry." *Journal of Industrial Economics*, 1997, 45(2), pp. 117-38.

---. *Accounting for Growth: Information Systems and the Creation of the Large Corporation*. Stanford: Stanford University Press, 1998.

---. "Strategic Consumer Behavior and Cartel Stability: The Potash Industry, 1870-1914." Ann Arbor, Michigan: Mimeo, 2000.

Levenstein, Margaret C. and Suslow, Valerie Y. "Private International Cartels and Their Effects on Developing Countries." Background paper prepared for the World Bank's *World Development Report 2001*, December 2001.

MacAvoy, Paul W. *The Economic Effects of Regulation: The Trunk-Line Railroad Cartels and the Interstate Commerce Commission Before 1900*. Cambridge, MA.: The MIT Press,

1965.

MacKie-Mason, Jeffrey K. and Robert S. Pindyck. "Cartel Theory and Cartel Experience in International Minerals Markets." in R. Gordon, Jacoby, and Zimmerman eds., *Energy: Markets and Regulation*. Cambridge, MA.: MIT Press, 1987, pp. 187-214.

Markham, Jesse W. *Competition in the Rayon Industry*. Cambridge, MA: Harvard University Press, 1952.

Marquez, Jaime. "Life Expectancy of International Cartels: An Empirical Analysis." *Review of Industrial Organization*, 1994, 9(3), pp. 331-41.

McGahan, Anita M. "Cooperation in Prices and Capacities: Trade Associations in Brewing After Repeal." *Journal of Law and Economics*, October 1995, 38, pp. 521-557.

Nussbaum, Helga. "International Cartels and Multinational Enterprises." in Alice Teichova, Maurice Levy-Leboyer, and Helga Nussbaum, eds., *Multinational Enterprises in Historical Perspective.* New York: Cambridge University Press, 1986, pp. 131-45.

Pindyck, Robert S. "The Cartelization of World Commodity Markets." *American Economic Review*, 1979, 69(2), pp. 154-58.

Pirrong, Stephen C. "An Application of Core Theory to the Analysis of Ocean Shipping Markets." *Journal of Law & Economics*, 1992, 35(1), pp. 89-131.

Polodny, Joel M. and Scott Morton, Fiona M. "Social Status, Entry and Predation: The Case of British Shipping Cartels 1879-1929." *Journal of Industrial Economics*, March 1999, 47(1), pp. 41-67.

Porter, Robert H. "A Study of Cartel Stability: The Joint Executive Committee, 1880- 1886." *Bell Journal of Economics*, Autumn 1983, 14(2), pp. 301-14.

---. "On the Incidence and Duration of Price Wars." *Journal of Industrial Economics*, 1985, 32(4), pp. 415-426.

Posner, Richard A. "A Statistical Study of Antitrust Enforcement." *Journal of Law and Economics*, 1970, 13(2), pp. 365-419.

Rosenbaum, David and Manns, Leslie. "Cooperation V. Rivalry and Factors Facilitating Collusion." *Review of Industrial Organization*, 1994, 9(6), pp. 823-38.

Rotemberg, Julio J. and Saloner, G. "A Supergame-Theoretic Model of Price Wars During Booms." *American Economic Review*, 1986, 76, pp. 390-407.

Schroter, Harm G. "The International Potash Syndicate." in Dominique Barjot, ed., *International Cartels Revisited, 1880-1980*. Caen, France: Editions-diffusion du Lys, n.d., 1994.

Scott Morton, Fiona. "Entry and Predation: British Shipping Cartels 1879-1929." *Journal of*

Economics and Management Strategy, 1997, 6(1) , pp. 679-724.

Sjostrom, William. "Collusion in Ocean Shipping: A Test of Monopoly and Empty Core Models." *Journal of Political Economy*, 1989, 97(5), pp. 1160-79.

Slade, Margaret. "Price Wars in Price-Setting Supergames." *Economica*, 1989, 56, pp. 295-310.

---. "Strategic Pricing Models and Interpretation of Price War Data." *European Economic Review*, May 1990, 34(2-3), pp. 524-37.

---. "Cheating on Collusive Agreements." *International Journal of Industrial Organization*, December 1990, 8(4), pp. 519-533.

Smith, Richard Austin. *Corporations in Crisis*. Garden City, N.Y.: Doubleday, 1963.

Spar, Debora L. *The Cooperative Edge: The Internal Politics of International Cartels*. Ithaca, N.Y.: Cornell University Press, 1994.

Sproul, Michael F. "Antitrust and Prices." *Journal of Political Economy*, 1964, 101(4), pp. 741-754.

Stigler, George. "A Theory of Oligopoly." *Journal of Political Economy*, 1964, 72, pp. 44-61.

Suslow, Valerie. "Cartel Contract Duration: Empirical Evidence From International Cartels." Mimeo, 1991.

Teece, David J., David Sunding, and Elaine Mosakowski. "Natural Resource Cartels." in Allen V. Kneese and James L. Sweeney, eds., *Handbook of Natural Resource and Energy Economics*. Vol. 3. Amsterdam: North Holland, 1993, pp. 1131-66.

Telser, Lester G. "Cooperation, Competition, and Efficiency." *Journal of Law & Economics*, May 1985, 28(2), pp. 271-95.

Ulen, Thomas S. "Cartels and Regulation: Late Nineteenth Century Railroad Collusion and the Creation of the Interstate Commerce Commission." Ph.D. Dissertation, Stanford University: Stanford, Calif., 1979.

White, Lawrence J. "Lysine and Price Fixing: How Long? How Severe?" *Review of Industrial Organization*, 2001, 18(1), pp. 23-31.

TABLE 1

COMPARISON OF CARTEL CHARACTERISTICS:
U.S. CROSS-SECTION STUDIES

	Author		
	Hay & Kelley	***Fraas & Greer***	***Posner***
Number of Observations	65	606	989
Sample	DOJ convictions for covert horizontal price fixing between 1963 and 1972	DOJ convictions for price fixing between 1910 and 1972	DOJ horizontal conspiracies, 1890-1969
Unit of Observation	Cartel	Cartel	Cartel
	Cartel Characteristics		
Mean Number of Firms in Conspiracy	7.25[a]	16.7	29.1[b]
Median Number of Firms in Conspiracy	7	8	Between 6 and 10
Fewer than 10 cartel members	79%	60%	64%
Average C-4 Ratio	77%		"large proportion … in industries not normally regarded as highly concentrated"
Trade Association Involvement	29%	36%	44%
Product Homogeneity	"High"		
Ratio of Fixed to Marginal Cost	"No pattern"		

	Hay & Kelley	***Fraas & Greer***	***Posner***
Social structure	"Dominant individuals" can facilitate cooperation		
Bid rigging	29%	19%	14%
Patent		10%	10%
Government customer	14%		At least 7%
Market allocation[c]	35%	26%	26%
Single sales agent		3%	6%
Terms & conditions of sales set	14%	5%	14%
Disciplinary or coercive practices; exclusion	5%	12%	
Policing; fines; audits			4%

Notes:

[a] Excluding four cases with 50 or more conspirators.

[b] The mean number of firms for all horizontal conspiracies in Posner's sample is 29.1, but the average falls to 19.9 if one omits the cases brought between 1920 and 1934. The average number of conspirators that Posner reports for those years is as follows: 1920-24: 53; 1926-29: 95; 1930-34: 56.

[c] Market allocation includes use of production quotas, division of markets, division of territories, allocation of customers.

TABLE 2

CARTEL DURATION: U.S. AND INTERNATIONAL CROSS-SECTION STUDIES

	Eckbo – Sample 1 [a]	***Eckbo – Sample 2*** [a]	***Griffin/ Marquez***	***Suslow***	***Posner***	***Dick***
Average Duration (years)	3.8[c]	4.6[c]	7.3	3.7[e]	7.5[f]	5.3[g]
Standard Deviation of Duration	2.4	4.7	6.3	3.0		
Duration Range	1 –18	0 – 18[d]	1 – 29	1 – 13		
% less than 5 years	60%	57%	43%	40%		39%
% 10 or more years	12%	18%	32%	37%		24%

Notes:

[a] Eckbo splits his sample into two sub-samples, depending on data availability. In Sample 1, Eckbo is able to measure seventeen dimensions of cartel and market characteristics. For Sample 2, he can measure only five dimensions. There seems to be a mistake in Eckbo's Table 3-3 on p. 37. Included in that table is an iodine cartel lasting sixty-one years. However, the averages he presents later regarding cartel length are correct only if the iodine cartel is taken out of the calculations. (Also, it would make the number of observations 52 rather than 51.) The calculations in the above table for Sample 2 do not include the iodine cartel.

[b] Marquez uses Griffin's sample, omitting two cartel episodes (Griffin has 54 episodes and Marquez has 52). The means and standard deviations reported in the two papers are therefore extremely similar, but not identical.

[c] Eckbo defines "efficient" cartels as those able to "raise price 200% above the unit cost of production and distribution" (Eckbo 1976, p. 26). Average duration for efficient Sample 1 cartels is 5 years, for inefficient Sample 1 cartels it is 3.1 years. For Sample 2 cartels, the efficient episodes lasted 8 years on average while the inefficient episodes lasted only 2.7.

[d] There are several cartel episodes in Sample 2 that lasted less than a year, which Eckbo codes as "0" in length.

[e] The mean duration of all cartel episodes is 8.3 years with a standard deviation of 6.2 years. The mean duration of the 28 uncensored cartel episodes is 3.7 years with a standard deviation of 3 years.

[f] The average duration statistics are given in Posner's Table 25 only for cases from 1950-69.

[g] Dick states that "the median Webb-Pomerene cartel remained active for approximately 5.3 years" (p. 251). In footnote 28 on p. 251 he says that the "average cartel survived at least until year 5 with a 51.7 percent probability and at least until year 6 with a 45.8 percent probability. I assume a uniform distribution of cartel exists between these two duration to interpolate a median duration of 5.3 years." The median duration of non-censored episodes is 5.3 years. Dick also reports that the median life span among cartels organized as common sales agencies was roughly 4.5 years, compared to 7.4 years for cartels (for example, joint advertising export cartels) whose members shipped individually (p. 256). We suspect that this might be because the non-sales agency "cartels" were not actually colluding to fix prices and therefore did not face the same threats to their stability.

TABLE 3

EPISODIC CARTELS:
EXAMPLES FROM INTERNATIONAL CARTEL CROSS-SECTION STUDIES

Industry	***Length of Cartel Episodes*** ***(years)***							***Author***
Aluminum	5 [1901]	2 [1906]	2 [1912]	3 [1923]	4 [1929]	5 [1931]		Eckbo
Coffee	1 [1957]	1 [1958]	3 [1959]					Eckbo
Copper	2 [1888]	4 [1918]	6 [1926]	4 [1935]	19 [1968]			Griffin
Steel	4 [1926]	0.5 [1930]	0.17 [1931]	6 [1933]				Eckbo
Sugar	2 [1926]	4 [1931]	2 [1937]	2 [1959]	5 [1968]	3 [1974]	3 [1978]	Griffin
Sugar	0 [1864]	10 [1902]	0 [1929]	0 [1942]	0 [1953]	0 [1956]	0 [1958]	Eckbo
Sulfur	3 [1907]	10 [1922]	5 [1934]	11 [1947]				Griffin
Tin	2 [1929]	3 [1931]	2 [1935]					Eckbo

Notes:

The beginning dates of each cartel episode are shown in superscript.

TABLE 4

DETERMINANTS OF CARTEL SUCCESS:
INTERNATIONAL CROSS-SECTION STUDIES

	Eckbo – Sample 1	***Eckbo – Sample 2***	***Griffin***
Number of Observations	23	28[a]	22 industries 54 episodes
Dependent Variable	Efficient / Inefficient 9 / 14	Efficient / Inefficient 10 / 18	Lerner Index Avg =0.3, Range=(-0.1, 0.8)
Independent Variable	*Sample Mean*	*Sample Mean*	*Sign of Regression Coefficient*
Cartel Concentration/ Herfindahl	0.9 / 0.36 (1 = C4 > 50%)	1.6 / 0.55 (2 = C4 > 75%, 1 = C4 ∈ (50%, 75%))	
Cartel Market Share	0.9 / 1.14 1 if (50%, 75%), 2 if > 75%	2 / 1.2	Positive*
Demand Elasticity	0.22 / 0.06 (1 = elastic)		Positive
Social structure/ Organization			Positive* (index from 1-10)
Cartel Heterogeneity (Cost or size)	0.9 / 0.58 (1 = high cost member produces at a cost no larger than 50% above low-cost member)		Negative
Government involved	0.12/ 0.58 (1 = yes)		

	Eckbo – Sample 1	***Eckbo – Sample 2***	***Griffin***
Short-term substitution	0.22 / 0.43 (1 = short-term substitutes exist)		
Long-term substitution	0.77 / 0.43 (1 = long-term substitutes exist)		

Notes:

* = statistically significant as reported by author.

[a] See Appendix A for details on the size of Eckbo's Sample 2.

TABLE 5

DETERMINANTS OF CARTEL SUCCESS:
U.S. CROSS-SECTION STUDIES

	Fraas & Greer	***Asch & Seneca***[a]
Sample	606 DOJ convictions for price fixing between 1910 and 1972 and 1569 random manufacturing industries	51 convicted price-fixers and 50 randomly selected "non-colluders"
	Relationship Between Collusion and Industry Characteristics	
Number of Firms	-	insignificant
Profit Rate		-
Rate of Demand Growth		-
Firm Size		+
Producer Goods		+
Variability of Profits		+
Market Share		+
Advertising Intensity		-
Entry Barriers		-
Concentration		+
Patents	-	
International market	-	
Lumpiness of orders	-	

TABLE 6

DETERMINANTS OF DURATION:
U.S. AND INTERNATIONAL CARTEL STUDIES

Author	***Dick***	***Marquez***	***Suslow***	***Posner***	***Hay & Kelley***
Number of Observations	93 industries 111 episodes	22 industries 52 episodes	45 industries 71 episodes	989 DOJ cases	62 DOJ cases
Dependent Variable[a]	Conditional probability of continued survival	Duration	Conditional probability of continued survival	Duration	Duration
Independent Variable					
Number of Firms or Number of Countries	Positive*		Negative	Positive[c]	Insignificant[d]
Industry Concentration					Positive[e]
Cartel Market Share	Positive*	Positive*	Positive		
Cartel Concentration		Positive*[,b]			
Patent Involved			Positive*		
Government Involved			Negative		
Market Allocation			Negative*[,f]		
Joint Sales Agency	Positive		Negative		
Penalties			Positive*		
Buyer size	Negative*				
Demand Instability	Negative*				
Rate of demand growth		Negative	Negative*		
Business Cycle	Negative		Negative*		

Author	*Dick*	*Marquez*	*Suslow*	*Posner*	*Hay & Kelley*
Anticipated Cycle	Negative*				
Unanticipated Cycle	Insignificant		Negative*		
Experience	Positive*		Positive		
Age in Single Episode	Positive*[g]				
Cross-market Linkages	Positive*				
Period of Activity Before WWII		Negative*[h]			
Ended in 1939		Negative			
Interest Rate		Negative			

Notes:

* = statistically significant as reported by author.

[a] The actual dependent variable used in both Dick (1996) and Suslow (1991) is the conditional probability of failure. The dependent variable listed here is "conditional probability of continued *survival*" for ease of comparison with those studies using "duration" as their dependent variable. For example, Dick reports a negative coefficient for cartel market share: as market share increases there is a lower conditional probability of failure or a *longer* expected cartel duration. Although the coefficient reported in his paper is negative, we list the sign as "Positive," directly indicating an increase in cartel duration.

[b] Cartel concentration is measured as the Herfindahl index using each cartel member's share of cartel output to capture "the concentration of economic power within the cartel" (Griffin 1989, p. 186).

[c] Posner compared number of conspirators with length of time between inception of conspiracy and filing of complaint. He found that of 79 cases with 10 or fewer firms, 52% persisted for 6 years or more. Of the 28 cases involving more than 10 firms, 64% persisted 6 years or more.

[d] "Since most of the cases had ten or fewer conspirators the dispersion of observations was not great enough to allow any significant pattern to emerge" (Hay and Kelley 1974, p. 26).

[e] "…the preponderance of conspiracies lasting ten or more years were in markets with high degrees of concentration" (Hay and Kelley 1974, p. 26).

[f] Negative correlation if the cartel set production quotas. Other measures (exclusive territories, export quotas) were positive but insignificant.

[g] Cartel in 10^{th} year had 38-48% higher probability of dissolving than cartel in 5^{th} year.

[h] Current cartel averaged three years shorter if cartel existed prior to WWII.

TABLE 7

CAUSES OF CARTEL BREAKDOWNS: INTERNATIONAL CARTEL STUDIES

Causes of Cartel Breakdown		Eckbo – Sample 1	Eckbo – Sample 2	Griffin[a]	Suslow
Cheating and Disagreement		43.5%	58.6%	33.3%	23.9%
External Shock		30.4%		50.0%[b]	42.3%
Entry and Substitution[b]		26.1%	41.4%	33.3%	15.5%
	Entry	13.0%[c]		25.9%	15.5%
	Substitution	8.7%[c]		9.3%	
Technological Change				9.3%	
Antitrust Indictment					18.3%
TOTAL # EPISODES		23	29[d]	54	71

Notes:

[a] This is based on both Griffin's discussion on pp. 198-99 and the information in his Table 4 (pp. 200-201).

[b] The sum of entry and substitution does not always add to the total because of under-classification in the case of Eckbo and double counting in the case of Griffin. Eckbo categorizes six episodes, or 26.1% of the 23 observations in Sample 1, as breaking down due to either entry or substitution. Of the six, 3 were due to entry, 2 to substitution, and 1 is unclassified. Two of Griffin's cartels ended as a result of both substitution and entry.

[c] This over-states the significance of external shocks as we classify them in this paper. Griffin groups together wars, antitrust and other governmental actions, and cartel reorganizations. We cannot separately categorize the cartel reorganizations in his sample, but some of them may more properly be classified as asymmetric information or bargaining problems, which may or may not have resulted from an external shock.

[d] See Appendix A for a discussion of the size of Eckbo's Sample 2.

TABLE 8

CARTEL PRICES AND PROFITABILITY: SELECTED CASE STUDIES

Industry	*Price and Profitability Trends*
Beer	Possibly above the monopoly level, due to political pressure to keep price high
Bromine	Close to joint-profit maximizing level in some periods; other collusive periods barely above Cournot price level
Cement	10 percent above world price
Diamonds	Prices nearly doubled after initial formation of cartel
Electrical Equipment	
Mercury	Prices higher in first incarnation (1928-1950) than second (1954-1972)
Ocean Shipping	Close to joint-profit maximizing level
Oil	Prices sometimes approached import price (New York price plus tariff)
Parcel Post	
Potash	Prices rose following agreements; in 1910, prices were double "average cost"
Railroad	
Railroad-Oil	
Rayon	
Steel	Less than joint profit maximizing price, but one-third higher than world price
Sugar	Prices rose after cartel formation
Tea	Prices rose 80 percent in 1933 after cartel was re-established

See Appendix B for list of sources.

TABLE 9

CARTEL DURATION: SELECTED CASE STUDIES

Industry	*First year of cartel* [a]	*Average length of cooperation in industry*	*Number of distinct episodes of cooperation* [b]	*Maximum length of cooperation*	*Minimum length of cooperation*
Beer	1933	9 years	1	9 years	9 years
Bromine	1885	6.25	4	10	3
Cement	1922	40	1	40	40
Diamonds	1870s	60	2	100	20
Electrical Equipment	1950	8	1	8	8
Mercury	1928	25	2	28	22
Ocean shipping	1870s	51	3	54	50
Oil	1871	2	3	3	1
Parcel Post	1851	28.5	2	40	17
Potash	1877	9.4	8	20	1
Railroad	1875	3.8	6	8	1
Railroad-Oil	1871	7	5	30	0
Rayon	1932	8	1	8	8
Steel	1926	7.25	4	13	4
Sugar	1887	6.75	4	10	2
Tea	1929	3.5	2	6	1

Notes:

[a] The first year of the cartel is not necessarily the first year in which collusion was attempted or achieved in the industry. It is simply the first year in the cartel case studies surveyed here.

[b] These indicate the number of distinct cartels, whose existence we can clearly date by drawing on the case studies surveyed here. In these industries, there are clearly a larger number of agreements in distinct product markets and distinct regions than is suggested by this table.

See Appendix B for list of sources.

TABLE 10

CONCENTRATION AND NUMBER OF FIRMS:
SELECTED CASE STUDIES

Industry	***Number of Participants***	***Concentration***
Beer	550 - 780	C1 = 4%
Bromine	7 - 15	
Cement	4	C3 = 95%
Diamonds		C1 declined from nearly 100% in 1880 to 80% in 1994
Electrical Equipment	40	
Mercury	2 countries; only 1 or 2 mines in each country	C2 = 80%
Ocean shipping	2-8	C2 = 50% in one South African market
Oil	19-50	
Parcel Post	5	C5 nearly 100%
Potash	3-30	
Railroad	3-15	
Railroad-Oil	3-4	C3 = 75%
Rayon	2	C2 = 50%
Steel	4-8 (countries and/or firms)	US: C4=60%; C1=35%
Sugar	8-19	C1 declined from 92% to 25%; C3 = 60% in 1927
Tea	349 (3 countries)	C4 > 20%

See Appendix B for list of sources.

TABLE 11
CAUSES OF CARTEL BREAKDOWN:
SELECTED CASE STUDIES

Industry	***Entry and Cartel's Reaction[a]***			***Secret Cheating***	***War or Anti-Trust Prosecution***	***Technological Change***	***Other Bargaining Problems***
	Entry Occurred	*Disrupted Cartel*	*Accom-modated by Cartel*				
Beer				Yes	Yes		
Bromine	Yes	No	Yes	Little	Yes	Yes	Yes
Cement	No						
Diamonds	Yes	No	Yes	No			Yes
Electrical Equipment				Yes, for turbines	Yes		
Mercury	Yes	Yes	Yes	Yes			
Ocean shipping	Yes	Yes	Yes	No			Yes
Oil	Yes	Yes	Yes	No			
Parcel Post	Attempted	Yes			Yes		Yes
Potash	Yes	No	Yes	No	Yes		Yes
Railroad	Yes	Yes	Yes	Yes	Yes		
Railroad-Oil	Yes	Yes	Yes	No	Yes	Yes	Yes
Rayon					Yes		
Steel				In U.S.	Yes		
Sugar	Yes	Yes	Yes	Yes	Yes	No	Yes
Tea	Yes		Yes	Yes	Yes		Yes

Notes:

[a] Entry indicates whether there was *any entry* during the period covered by the case study. "Disrupted cartel" indicates that there were instances in which the cartel responded to entry with punitive or predatory behavior. Entry which was followed by an invitation to join the cartel, but in which the firms could not reach a new distribution of quotas or rents, is classified as a *bargaining problem*, not an entry problem per se. "Accommodated" indicates that there were instances in which a new entrant was invited to join the cartel without a disruption in cooperative pricing. For the other columns, a "yes" indicates that such an event disrupted the cartel, not simply that it occurred. For example, there was technological change in the oil industry during the period of study, but that technological change did not disrupt collusion.

See Appendix B for list of sources.

TABLE 12

HOW DOES DOWNSTREAM STRUCTURE AFFECT CARTEL STABILITY?: SELECTED CASE STUDIES

Industry	***Customer Size***	***Customer Concentration***	***Customer participation in cartel***	***Did customers try to destabilize cartel?***
Beer	Small	Low	No	No
Bromine	Medium	High	Yes	Downstream pharmaceutical firms tried to integrate backward into bromine
Cement	Small	Low	Vertical Integration	
Diamonds	Medium	Low	Yes	
Electrical Equipment	Varied	Low	No	
Mercury				
Ocean shipping	Varied	Low	No	Yes, in tramp shipping & other geographic routes
Oil			No	
Parcel Post	Varied	Low	No	
Potash	Increased over time	Increased over time	No	Yes, attempted vertical integration, attempted to induce cheating
Railroad	Varied	Low	No	Strategic shipping by customers
Railroad-Oil	Large	High	Yes	Yes, crude producers had cartel charter revoked
Rayon			No	Customers spread rumors of cheating, to induce it
Steel	Large		Yes, in some cases	Large customers bargained for lower prices than small customers received
Sugar	Varied		No	No
Tea			No	No

See Appendix B for list of sources.

TABLE 13

DEMAND ELASTICITY ESTIMATES:
SELECTED CASE STUDIES

Industry	***Elasticity Estimate***
Beer	-10.3
Bromine	-0.38 to – 3
Cement	Inelastic
Diamonds	Very inelastic
Electrical Equipment	
Mercury	-0.07 to –0.21
Ocean shipping	
Oil	Assumed to be inelastic
Parcel Post	
Potash	
Railroad	
Railroad-Oil	
Rayon	Elastic
Steel	Inelastic in long run; short run elasticity high
Sugar	Relatively inelastic
Tea	Low, especially at higher incomes (-0.32)

See Appendix B for list of sources.

TABLE 14

HOW DOES DEMAND AFFECT THE FORMATION & ENDURANCE OF CARTELS?: SELECTED CASE STUDIES

Industry	***Formed during downturn***	***Formed during upturn***	***Broke up during downturn (observed?)***	***Broke up during upturn (observed?)***	***Industry cyclicality***
Beer	Yes	No	Price war punishments in response to unobserved shocks		Counter-cyclical
Bromine	No	No	No	No	Low
Cement					High
Diamonds					
Electrical Equipment	No				Varied across products
Mercury	No				
Ocean shipping	No				
Oil	No				High
Parcel Post	No				
Potash	No				
Railroad	No				High
Railroad-Oil	No				High
Rayon	Yes			Yes	
Steel	Yes		Yes		High
Sugar	Yes				Counter-cyclical
Tea	Yes				Counter-cyclical

See Appendix B for list of sources.

TABLE 15

INTERNATIONAL PRICE-FIXING
RECENT U.S. DOJ AND EC ACTIONS

Industry	*Duration[a] (years)*	*Measure of Market Concentration[b]*	*Measure of Price Increase[c]*	*Large customers?[d]*
Aluminum Phosphide	< 1	U.S.: C4 = 90	48%	No
Bromine Products	3	World: C3 = 76	N/A	?
Cable-Stayed Bridges	1	N/A	N/A	No
Carbon Cathode Block	2	N/A	N/A	?
Cartonboard	5	Europe: C-Cartel= 80	20-26%	No
Cement	11	Europe: C6 = 50 Britain: C3 = 90 France: C4 = 90	N/A	?
Citric Acid	4	U.S.: C4 = 100 Europe: C5= 100	1) 21-24% markup over marginal cost 2) 50% price increase	Yes
Ferrosilicon Products	2	U.S.: Six major producers	N/A	Yes
Ferry Operators (Adriatic Sea)	7	N/A	N/A	No
Ferry Operators (Cross-Channel Freight)	< 1	C2 = 72 for cross-channel passenger market; same two firms were indicted in the cross-channel freight cartel	10%	?
Fine Arts	6	C2 = 95	0 – 20%	?
Graphite Electrodes	5	World: C2 = 67; U.S.: C5 = 94 Canada: C2 = 90	U.S.: 50% - 60% Canada: 90%	Yes
Isostatic Graphite	5	World: 6 major firms	N/A	Yes
Laminated Plastic Tubes	9	U.S.: C3 = 95	N/A	?

Industry	*Duration*[a] *(years)*	*Measure of Market Concentration*[b]	*Measure of Price Increase*[c]	*Large customers?*[d]
Lysine	3	World: C3 = 95% in late 1980's (ADM began production in 1991 and by 1996 had 47% world market share) Mexico: C2 = 90	World: 41% U.S.: 67%: Estimated "overcharges" vary from $45 million up to $134 million Canada: 50%	Yes
Maltol	6	World: C2 = 80-90	N/A	Yes
Marine Construction Services	4	N/A	N/A	Yes
Marine Transportation Services	5	N/A	N/A	?
Plastic Dinnerware	1	U.S.: C2 > 90	N/A	Yes
Shipping (Central West African)	20	Shipping conference held more than 90% market share	N/A	?
Shipping (Far Eastern)	4	Shipping conference held 80% share between northern Europe and the Far East	N/A	?
Shipping (France-Central & West African)	17	C4 = 90	34-39%	?
Shipping (North Atlantic)	2	1994: Cartel members had joint market share over 60% 1995: Shipping conference held between 70-80% of the trans North-Atlantic container market	Damages Estimate, 1995: Announced price increases in 1995 "would have meant an additional cost to shippers of US$65 to $75 million, when compared with 1994 prices" Damages Estimate, 1994-98: Trans-Atlantic Conference Agreement (TACA) cost European industry $1.8 billion in extra shipping costs between 1994 and 1998	?
Sodium Erythorbate	2	C2 = 90	N/A	Yes
Sodium Gluconate	2	Cartel members were world's major producers	N/A	Yes
Sorbates	17	N/A	14%	Yes
Stainless Steel	1	World: C4 = 52	100%	?

Industry	*Duration*[a] *(years)*	*Measure of Market Concentration*[b]	*Measure of Price Increase*[c]	*Large customers?*[d]
Steel Beam	6	Europe: C10 = 66	N/A	?
Steel Heating Pipes	4	Western Europe: C6 = 91	10-20%	No
Steel Tube, Seamless	5	EC cartel share = 19%	N/A	?
Sugar	4	Great Britain: C2 = 90	N/A	Yes
Tampico Fiber	5	Cartel members had "overwhelming" share of the U.S. market	N/A	No
Thermal Fax Paper	1	U.S.: C3 = 40-45	10%	Yes
Vitamins	9	World: C3 = 75 for bulk vitamins	U.S.: 20% Canada: 30%	Yes
Wastewater Construction	8	Five large multinational construction companies	One estimate of the markup in the bid for one contract was "at least $26.5 million"	Yes

Notes:

The information presented in Table 15 on individual cartels was gathered from various industry and government sources including: 1) The US Department of Justice (www.usdoj.gov/atr); 2) The European Court of Justice (http://europa.eu.int/cj); 3) Industry and business newspapers and trade magazines, such as *American Metal Market, Chemical Marketing Reporter, EU Business, European Business Week, International Cement Magazine, News Line, Oil and Gas Journal, Rocks and Mineral Market, Wall Street Journal*.

[a] Duration is based on approximate conspiracy dates alleged in the government's suit against the cartel. Indictments of different firms may list different conspiracy dates, which are not reflected in this table.

[b] All concentration figures are approximate. Wherever possible concentration measures date to the period of the cartel. In other instances the figures date to the period immediately prior to or after the cartel. Detailed references are available from the authors.

[c] All price increase measures are approximate. Information is extremely sparse. The price increase information usually refers to a selected period within the cartel years; it is not normally an indicator of the average price increase over the entire life of the cartel. Detailed references are available from the authors.

[d] This is a rough indicator of whether the cartel sold to large firms. We had no specific sales cutoff. The indicator reflects solely whether the cartel sold to what we would be familiar with as a sizeable company. Detailed references are available from the authors.

APPENDIX A

Description of Data Sets Used in Cross-Section Cartel Studies

Asch and Seneca (1975): 101 large U.S. manufacturing corporations, 1958 – 1967.

Dick (1996): 93 industries with 111 Webb-Pomerene (U.S.) export cartels, 1918 – 1965.

Eckbo (1976): 51 international cartels in 18 industries, 1819 – 1964. (Sample 1 contains 23 cartels measured on 17 dimensions, Sample 2 has 29 cartels measured on 5 dimensions. There is a discrepancy between the text and the tables describing Sample 2. Table 3-3 which lists the characteristics of the Sample 2 cartels has an entry for an Iodine cartel, bringing the total number of cartel episodes listed to 29. In the text and in Table 3-5, however, Eckbo says that there are only 28 cartel episodes.)

Fraas and Greer (1977): 606 cases of U.S. price fixing, 1910 – 1972.

Great Britain Board of Trade (1944): 125 products surveyed (primarily manufacturing), pre-World War II.

Griffin (1989): 54 international cartels in 22 industries, 1888 – 1984.

Hay and Kelley (1974): Cases of U.S. price fixing, 1963 –1972. The article's appendix lists 110 cases, but Hay and Kelley were not able to measure all of the desired industry characteristics for each case. Of the 62 cases in their Table 2, for example, concentration ratios are available for 50 cases.

Marquez (1994): 52 international cartels in 22 industries, 1888 – 1984. (Marquez uses Griffin's cartel sample, but excludes Copper V (i.e., the fifth cartel episode in copper) and Magnesium II. Marquez does comment on the omission.)

Posner (1970): 1551 U.S. antitrust cases, 989 involving horizontal conspiracy, 1890 – 1969.

Suslow (1991): 71 international manufacturing and commodity cartels episodes are distinguished for 45 industries, 1920 – 1939.

APPENDIX B

SOURCES FOR SELECTED CASE STUDIES

Industry	Source
Beer	McGahan 1995.
Bromine	Levenstein 1995, 1996, 1997, 1998.
Cement	Leach 1994; Fourie and Smith 1994.
Diamonds	Spar1994.
Electrical Equipment	Baker and Faulkner 1993.
Mercury	MacKie-Mason and Pindyck 1987; Teece, Sunding and Mosakowski 1993.
Ocean shipping	Pirrong 1992; Polodny and Scott Morton 1999; Scott Morton 1997; Sjostrom 1989
Oil	Grant and Thille 2001.
Parcel Post	Grossman 1996.
Potash	Levenstein 2000, Schroter 1993.
Railroad	Ellison 1994;Berry and Briggs 1988; Briggs, 1996; Hudson, 1890; Porter 1983, 1985
Railroad-Oil	Granitz and Klein 1996.
Rayon	Eswaran 1997; Gallet and Schroeter 1995
Steel	Baker 1989; Barbezat 1989, 1990, 1994; Gallet 1997; Hughes and Barbezat 1996.
Sugar	Genesove and Mullin 1998, 1999.
Tea	Gupta 1997, 2001.