DRAFT

The Empirics of Private Restraints and International Trade:

What Can Policymakers Learn from the Economic Literature?

A Report Prepared for the International Competition Policy Advisory Committee, U.S. Department of Justice

Simon J. Evenett[*]
Rutgers University, The Brookings Institution, and CEPR

Valerie Y. Suslow[+]
University of Michigan Business School

September 23, 1999

[*]email address: evenett@fas-econ.rutgers.edu
[+]email address: suslow@umich.edu

Table of Contents

Executive Summary (pages 4-8)

Empirical Evidence on Private Practices and Market Access (pages 9-25)

I. Introduction

II. Market Access, Trade Liberalization, and the Growth of International Commerce since 1970

III. Assessing Allegations of Market-Closing Foreign Private Practices

IV. Assessing Measures of the Effects of Foreign Private Practices on Market Assess

- A. Case Study Evidence on Private Practices
- B. Estimating the Effects of Private Practices on Trade Flows: A Proxy Variable Approach
- C. Detecting Anomalous Trade Patterns
- D. Summary

V. Using a Bounds Approach to Filter Allegations of Harmful Foreign Private Practices

VI. Concluding Remarks

Empirical Evidence on International Cartels (pages 26-69)

I. Introduction

II. Theories of Cartel Behavior

- A. Static Oligopoly Games
  - 1. External Cartel Problem: Substitution and Entry
  - 2. Internal Cartel Problem #1: Organizing and Sharing Production
- B. Dynamic Oligopoly Games
  - 3. Internal Cartel Problem #2: Detecting Cheating
  - 4. Internal Cartel Problem #3: Deterring Cheating

C. Recent Game Theory Contributions

III. Evidence from Cross-Section Studies

A. Cartel Duration
1. Are Cartels Short- or Long-Lived?
2. Do Cartels Have One or Many Episodes?
3. What Determines Cartel Duration?
4. Reasons for Cartel "Failure" or "Renegotiation"

B. Cartel Performance
1. Do Cartels Raise Prices? Are Cartels Profitable?

IV. Evidence from Case Studies

A. Duration
B. Price Wars
C. Rate of Time Preference
D. Joint Sales Agencies and Product Differentiation
E. Multi-market Contact

V. Anecdotal Evidence from Recent International Price-Fixing Cases

A. Duration
B. Cartel Activity Over the Century
C. A Resurgence of International Cartels?

VI. Using a Bounds Approach to Filter Allegations about International Cartels

A. Barriers to Entry
B. Time Horizon
C. Extent of Repeated Interaction
D. Volatility of Demand
E. Number of Players (Included and Excluded)
F. Ability to Punish

VII. Concluding Remarks

References (pages 70-77)

Tables (pages 78-93)

Appendix: Description of Data Sets Used in Cross-section Cartel Studies (pages 94-95)

Executive Summary

The ongoing debate on the merits of taking state action against private firms, whose practices have allegedly restricted market access, has made little reference to the policy implications of economic analyses of those practices. This disconnect between economic research and policymaking in one critical overlap between trade and competition policy is troubling, especially as these matters are receiving greater attention in the run up to the launch of the next multilateral trade round.

In this report we examine what are the policy implications of the empirical literature on private restraints and market access in general, and on international cartels in particular. Although our focus is on empirical findings this is not to downplay the important role that conceptual frameworks play in structuring analyses and formulating explicit hypotheses. The following questions are addressed: Does the economic literature shed light on the prevalence and effects of such private practices and cartels? What evidence or procedures can be reliably used to detect the existence of a market access restricting private practices and cartels? Are there satisfactory methods for quantifying the effects of such private practices and cartels? If not, are there alternative means to filter allegations of private practices or cartel-like behavior?

To answer these questions we draw from a long-standing and rich empirical literature on national and international cartels. The empirical literature on private practices and market access is much younger, with the debate over how closed are Japan's markets providing the primary impetus for a stream of statistical studies. On the prevalence of international cartels and private restraints we argue that:

- There is insufficient evidence to support the position that international cartels and market-access restricting private practices are a widespread phenomenon in today's international trading system. Assessing the prevalence of private practices is

particularly difficult as parties to those practices typically have strong incentives to hide their implicit or explicit agreements from antitrust officials, legal practitioners, and researchers. To those who are convinced that cartels and private practices plague the international trading system, policymakers may want to ask "how could you know?"

- Nor is there sufficient evidence to support the view that private practices or international cartels are irrelevant (see, for example, the list of recent allegations about cartel behavior in Table 6.)

With respect to the detection of private restraints and cartels, our principal findings are:

- That firms do not publish agreements to restrict market access or to cartelize a market is not surprising (especially if it enhances the probability of them becoming targets of actions by the U.S. or other governments.) Being unable to observe such agreements creates all sorts of difficulties in detecting such private restraints and cartels, which policymakers should bear in mind when interpreting evidence that is presented to them. Researchers and legal practitioners have frequently used the existence of "anomalies" in pricing data and trade data to infer the existence of such restraints or cartels. Unfortunately, there are competing explanations for almost every observed market outcome, including those outcomes thought to be anomalous. And since some of those explanations are benign (ie. the outcomes result from the normal competitive process between firms), inferences drawn on market outcomes alone are likely to be unreliable and open to challenge. For example, observing a price war between firms could signal the breakdown of an international cartel; but it might also indicate that a "punishment phase" has been entered into to reprimand a cartel member or members who are suspected of deviating from the cartel agreement.

- That many explanations can account for observing over long periods of time no (or low) U.S. exports to a given foreign market, or persistent international differences in prices for the same good, calls into doubt the value of undertaking a wide-ranging U.S. government study of the prevalence of private restraints based only on trade

flows and price gaps[1]. A study based solely on such data would not be able to identify those markets where foreign private restraints operate.

Of course, demonstrating that a foreign private practice or cartel exists does not imply that those private actions have had detrimentally effects on U.S. firms. We now turn our attention to attempts to quantify those effects, and our principal findings are:

- The multiple (theoretical) explanations for most observed market outcomes, and the inability to observe the specifics of agreements between private firms, are the principal hurdles facing any attempt to quantify the effects of cartels and private practices. Few empirical studies rigorously consider more than one explanation for the market outcomes under investigation, leaving the reader with little sense that the proposed explanation best accounts for the behavior in the market (or markets) in question. Furthermore, the statistical techniques that attempt to take into account unobserved business practices often cannot disentangle the effects on U.S. firms of unobserved objectionable foreign private practices, unobserved benign foreign practices, and other unobserved characteristics of the firms, market, or industry; calling into question the interpretation of any estimates that follow from these techniques.

- Given the vigorous market for corporate control in the U.S., the primary motivation of U.S. firms is almost certainly to maximize their stream of profits over time. In which case the correct measure of the damage done by foreign private practices and cartels is the reduction in the U.S. firm or firms' profitability, and not estimates of the reduction in their sales or exports--as is commonly reported in the literature. When assessing which, if any, allegations made by U.S. firms about foreign private practices or cartels to pursue, policymakers should demand that complainants supply estimates of the reduction of profitability caused by those foreign practices. These estimates, and assumptions and calculations underlying them, should also be open to scrutiny.

- In general, when presented with any quantitative estimates policymakers should keep in the mind the following questions: What is the causal relationship underlying the

[1] Wolff (1999) makes just such a proposal in a speech at the OECD. See also Wolff, Howell, and Magnus (1998).

statistical approach used to generate the estimates? And what is the evidence that this causal relationship better accounts for the outcomes in the market under investigation than any other causal relationship? Policymakers should demand answers to these questions before considering an allegation about foreign private actions. In sum, policy responses should be devised on the basis of lines of causality that best characterize the market in question (and their associated quantitative estimates), and not on the unquestioned estimates provided by U.S. export interests.

These findings suggest just how difficult it will be to implement a mechanism to investigate allegations about the detrimental effects of international cartels and market-restricting private actions. These difficulties will be faced at the national and multilateral level. Given the stakes for U.S. policymakers are so high (in terms of antagonizing trading partners and inviting similar treatment to be metered out against U.S. firms accused of restricting access to the U.S. market), it is quite worrying that proposals for rigorous investigative procedures against foreign private practices, advanced by certain U.S. legal practitioners[2], give so little attention to the specifics of how an investigation should be conducted. Instead, energies seems to have been devoted the more straightforward task of proposing market access "rights" and "warranties" and to devising even-more stringent punishment provisions.

Recognizing both the theoretical indeterminacy of the economic literature, and the absence of any empirical rules of thumb upon which to base an investigation into alleged effects of foreign private practices and international cartels, several scholars have taken a different tack. These scholars have noted that the preconditions for the successful operation of such practices or cartels are often observable. This has led to a number of constructive proposals, the essence of which are to employ filters to eliminate allegations where those observable preconditions are not met.

The key components of such a filter are as follows: when a policymaker receives an allegation about a certain foreign practice, their first step is to draw upon the economic models of that practice. The second step is to use those models to locate the set of observable preconditions under which the private practice might be harmful to U.S. exporters. The third step is to use information about the foreign firms, product characteristics, and industry conditions to check whether those preconditions have been

[2] See Wolff, Howell, and Magnus (1998).

met. If not, the allegation is dismissed. Otherwise, a full investigation of the effects of the alleged practice is initiated.

Such filters have three advantages. First, these filters are grounded in not one but a class of economic models. These filters are therefore not beholden to any one theory or school of thought. Secondly, these filters are deliberately designed to facilitate empirical implementation, by focusing attention on the observable preconditions for harmful effects to occur. This is in contrast to the difficulties (noted above) associated with estimating the effects of an alleged foreign private practice or cartel. Thirdly, to the extent that these filters enable policymakers to dismiss some allegations, the government resources that would have been used in a full investigation are saved.

We explore at length what those observable preconditions are in the case of international cartels, and point to references when similar preconditions can be located for other agreements between private firms. We also describe how such a filter has been already employed to considerable effect in analyzing one class of investigations under U.S. trade law.

Empirical Evidence on Private Practices and Market Access

I. Introduction

Even though U.S. exports have grown much faster than U.S. national income since the beginning of the 1970s, there are concerns in some quarters that certain foreign markets remain closed to U.S. exports. Some commentators and prominent U.S. firms point to foreign regulatory policies and other policies "inside the border," as well as the practices of foreign firms, as being responsible for impaired market access. These claims have provoked a debate over what is market access, what determines market access, and perhaps most contentious of all, what is the appropriate policy response for U.S. officials to allegations of deliberately closed foreign markets.

Our objective here is to survey and evaluate those strands of the economics literature purporting to measure market access, with a particular focus on the role of private practices. This literature is diverse to say the least, and constraints on space necessitate selectivity. We have drawn from prominent studies and approaches in the literature. To guide our evaluation of the literature we have broken down the market access issue into five related but distinct questions (see section III).

Our principal finding is that the existing measures of market access cannot adequately differentiate between the numerous explanations, some of which are benign, for disappointing U.S. export performance. Furthermore, they provide little guide to policymakers as to which foreign private practices (if any) need to be remedied. In addition, these measures are unlikely to accurately monitor foreign firms' compliance with any agreement to cease engaging in a certain practice. The unsatisfactory state of these empirical measures is due to the fact that few determinants of market access are observable, and cannot be taken into account of in econometric analyses. For example, foreign firms engaged in an illegal market-blocking practice are unlikely to make those

arrangements public, and therefore remain unobserved by the researcher. These findings are discussed in section IV below.

Although this empirical literature is in a sorry state, one should not be unduly pessimistic. As a result of the debate over the merits of this literature we have a much better sense of what the relevant questions are; of the limitations of certain commonly-employed evidence on impaired market access; and of the many different factors which determine U.S. firms' performance in overseas markets. Taking these lessons on board should lead policymakers to become much more skeptical of claims made by U.S. firms about impaired foreign market access. We do not subscribe to the view that foreign private practices never impede U.S. exports. Rather, our review of the literature supports the position that before the U.S. government takes action against foreign firms, policymakers need to be convinced that the other major determinants of trade flows cannot plausibly account for any specific instance of miserable U.S. export performance.

Finally, we also propose an approach to help policymakers filter out less compelling claims that foreign private practices have impeded market access. For a given private practice the central idea is to employ the relevant economic models to locate the observable preconditions necessary for that practice to impair the market access over a sustained period of time. (These observed preconditions could include product characteristics and characteristics of the industry or market in question, such as barriers to entry.) Policymakers would then check whether these preconditions are found in the foreign market where the private practice is said to operate. If not, the allegation against the foreign firms should be dismissed. In essence, this approach uses the economic literature to "bound" the circumstances under which private practices impair market access. We explore this approach in section V and discuss one study where the use of such a filter generated striking results.

II. Market Access, Trade Liberalization, and the Growth of International Commerce since 1970

The last three decades have seen a substantial expansion in the flows across national borders of goods, services, investments and commercially-related migration. The share of national income spent on imports has surged in many OECD nations[3]. The growth of investment flows and, more recently, service transactions have been even more impressive[4]. Coinciding with this surge in global commerce have been distinct changes in the international specialization of production. Developing and transition economies now produce and export manufacturing goods of increasing technological sophistication[5]. And corporations in industrial countries have increasingly "sliced up the value chain[6]," moving distinct stages in production processes to different geographic locations, including overseas[7].

A selective account of the role that multilateral trade liberalization has played in fostering these changes in the global economy provides the context in which the following discussion on foreign market access is grounded. As we shall see, failure to appreciate this context has led to inappropriate presumptions, and perhaps incorrect conclusions about the causes and consequences of access to overseas markets.

Repeated rounds of multilateral trade liberalization, according to Krugman (1995) amongst others, are responsible in large part for the enhanced ability of firms to export to foreign markets. While a comprehensive review of the scope of these agreements is beyond the scope of this paper[8], one aspect of these agreements bears repeating: they have nurtured a rules-based global trading system, with member states accepting constraints initially on border measures and then other policies, in return for other member states doing likewise. As Jackson (1998) has argued, one of the principal benefits of these agreements is the reduction in uncertainty faced by exporters, importers

[3] A comparison of the growth of these national import shares in OECD nations since 1970 can be found in Djankov, Evenett and Yeung (1999).
[4] An overview of these developments can be found in OECD (1998) and World Bank (1999).
[5] Lall (1998) reports on the major trends.
[6] A phrase first coined by Michael Porter in the 1970s, and recently popularized in Krugman (1995).
[7] The developments are reviewed from a global perspective by Feenstra (1998), Graham (1996) and Vernon (1998), and from a U.S. perspective by Whitman (1999).

and foreign investors, knowing that government signatories are less inclined toward, and somewhat constrained in, taking arbitrary and discriminatory measures.

What is also noteworthy is that these multilateral trade agreements do not specify market shares, import levels, or prices that importing and domestic firms must transact at. It is hard to believe that private sector agents could read such agreements and come away with the impression that any such outcomes-based market access guarantees were an integral component. Yet the following passage, taken from the Coalition for Open Trade (1997), comes dangerously close to suggesting that the process of bargaining, and the content of these agreements, contain such guarantees.

> "At the core of the 'trade-and-competition' conundrum is the failure of bargained-for market access to materialize as planned and promised. Governments come together in trade negotiations; they exchange and implement concessions; and then it remains impossible to sell across the border. The cause need not be classic 'restraints of trade'; it could be any kind of private behavior, including criminal activity, that has the effect of keeping imports at bay. The point is that the expected sales--or rather the expected ability to sell--does not materialize[9]."

Even though the multilateral agreements contain no guarantees of ex-post market outcomes, this quotation does raise an interesting question: in the absence of government-inspired border barriers, what other factors can account for a continued inability of domestic firms to sell in a foreign market? Identifying which (if any) of them apply in a given situation is central to tackling the market access question. The following six factors have received much attention[10]:

- International transportation and insurance costs can make it unprofitable for a firm to supply an overseas market. The evolution of these costs over time has recently received renewed attention by trade economists (see in particular Hummels 1998a, b, and 1999). These studies have found an interesting divergence between falling air transportation costs and rising sea transportation costs (Hummels 1999). This suggests that bulkier goods may find any benefits from trade liberalization are offset by rising international transportation costs.

[8] For such a review see Hoekman and Kostecki (1995).
[9] Coalition for Open Trade (1997), page 33.
[10] The following factors can also account for persistent international differences in the prices of tradeable goods.

- Changes in industry productivity levels and changes in national endowments of capital, skilled and unskilled labor, and resources can alter the direction and amount of trade. For example, the adoption of common technologies (such as computers), the transfer of technology across national borders, and the increasingly similar business school educations of managers, will contract cost differences between domestic firms and their overseas competitors. In the case where foreign firms "catch up" with the better production and managerial practices of their U.S. rivals, this convergence in costs will (partially, and possibly fully) offset the benefits conveyed on those U.S. rivals by the reduction of trade impediments to the foreign market. Djankov, Evenett and Yeung (1999) show that growing similarities in the production technologies available to domestic and foreign firms have partially offset the growing tendency towards the international specialization of production in 21 OECD nations since 1970[11]. Therefore, these so-called supply side changes can account for a U.S. firm's inability to sell in foreign markets, even when a foreign government has lowered its trade barriers in full compliance with a multilateral, regional, or bilateral trade agreements.

Graham and Lawrence (1996) identify four further factors that can impede the entry of a U.S. firm into a foreign market--even though trade liberalization may have occurred.

- "[S]ome constraints on contestability are inherent in particular forms of market-based competition and are inevitably present in certain kinds of production and marketing activities. These include the advantages that accrue to first entrants as a result of economies of scale (fixed costs), advantages due to superior knowledge of incumbents (e.g. learning by doing) and advantages due to market niches with particular consumer loyalty[12]." The characteristics of a product are particularly important in this regard. Most economic analyses focus (for reasons of tractability) solely on markets where goods alone are transacted, and typically it is assumed that the benefit of the good to the buyer is known at the time of the purchase. However, the quality of many services, and of many goods that are bundled with services, are often unknown at the time of purchase, and the quality is only revealed later when the good or service is consumed or

[11] Using a different empirical strategy Redding (1999) reports similar findings.
[12] Graham and Richardson (1996), page 6. According to Graham and Richardson, a market with low or no barriers to entry by new sellers is said to be contestable.

used. Devising incentive schemes to induce firms to supply high quality services (which are typically more costly to produce than low quality services) have resulted in a number of important insights. Of particular relevance here is the finding that reputation, acquired by incumbent firms who have track records for supplying high quality products, can act as an effective barrier to entry to new firms who claim that they can supply even higher quality products but have no (or limited) track record to prove it. These so-called "informational barriers to entry" have been analyzed in the international trade context by Bagwell (1991), building on the insights of industrial organization economists.

- "[O]ther important constraints on international market contestability reflect history and experience that are not readily changed. For example, there might exist strong incumbency advantages to domestic firms deriving from long familiarity with local culture, customs, tastes, language and legal systems.[13]"

- "[M]any services and some goods [are] essentially non-tradable, and therefore potential entry by foreign firms via foreign direct investment becomes a prerequisite for international contestability[14]." Therefore, removal of tariffs, quotas, and other border measures, without any change in government policy towards foreign investment in a given market, may result in no change in the ability of foreign firms to supply that market.

- "[B]arriers which result from the anticompetitive and collusive strategic actions of private firms[15]."

That (at least) six factors can explain why imports need not rise after trade liberalization has three important implications. First, U.S. policymakers and firms need to assess the importance of each of these factors when forming their expectations about the effects of trade reform in a given foreign market. More realistic expectations about the effects of multilateral trade liberalization might go some way to reducing the post-liberalization frustration at the continued inability of some firms to sell in overseas markets.

[13] Graham and Richardson (1996), page 6.
[14] Graham and Richardson (1996), page 6.
[15] Graham and Richardson (1996), page 6. An overview of the economic theory underlying firm behavior that might result in private restraints is found in Viscusi, Vernon, and Harrington (1995). Furthermore, see the interesting analysis of the European Union's enforcement of private restraints contained in Neven, Papandropoulos, and Seabright (1998).

Second, since there are at least six explanations (the six factors outlined above, plus combinations of them) that can account for a U.S. firm's inability to sell in a foreign market, evaluating the relevance of competing explanations should be central to any policy analysis. It is not enough to argue that private practices have impeded market access. Persuasive evidence should be presented that other explanations are irrelevant or of secondary importance. This requires identifying the preconditions for each explanation to hold, specification of the mechanisms at work, and a clear statement of the predictions for all the relevant observed market outcomes such as price, quantity, market concentration, and firm entry and exit.

Third, differences in the relevance of these six factors across markets, countries and time ought to cast doubt on any claims that observed import levels should be similar or respond similarly to a given trade reform. This suggests that looking for anomalies in trading patterns, or in the response to trade reform, is misguided as it is unclear what a "normal" or "typical" trading pattern is.

III. Assessing Allegations of Market-Closing Foreign Private Practices

The following five distinct but related questions distinguish between central elements of the market access issue. These questions will help place the empirical measures of market access, which we review in the next section, within the context of a discussion on assessing allegations of market-closing foreign private practices. This set of questions should not be seen as constituting a multi-step decision rule for policymakers, although the answers to these questions should surely play a role in their deliberations. Furthermore, these questions could be asked of any alleged case of foreign private practices, and of the existing studies of the effects of foreign private practices on the performance of U.S. exporters.[16] As we shall see in the next section those studies often provide answers of differing quality to only a subset of the following questions.

- [Characterization Question] *What is the nature of the alleged foreign private practice(s)?*

[16] Here we conceive of U.S. export performance broadly to include not only the quantity sold, but also the price charged, the range of products that the U.S. firm can sell, including after-sales service.

This question focuses attention on the type of the alleged private practice, and the firms who are thought to be parties to that practice. Where possible, supporting evidence should go beyond evidence of broader associations between firms within the same or different markets, and point to specific practices of foreign firms. As we will see in section IV, the relationship between many Japanese firms in the same business group may involve a number of potentially interrelated and distinct business practices. These practices may have different effects on market access, and some may be more or less objectionable than others.

This characterization of the private practice is to be distinguished from the following three questions about the effects of those practices.

- [Export Performance Question] *Taking account of all of the other determinants of a U.S. exporter's performance, how would the removal of the alleged foreign private practice alter that performance?*

The essential point is to disentangle the effects of the alleged private practices from the other determinants of a U.S. exporter's performance. This question is essentially a counterfactual one, requiring a conceptual framework that can predict firm and market outcomes in the absence of the alleged private practice but where all of the other determinants of market access remain. In sum, any proposed response to this question that does not take account of, or in the language of econometricians "control for", the determinants of market access which are unrelated to private practices should be treated with suspicion.

- [Damage Question] *Taking account of all of the other determinants of a U.S. exporter's profitability, how much higher would those profits be in the absence of the alleged foreign private practice?*

Although one could subsume this question under the last one, we have distinguished between them because economic analyses typically take a firm's primary motivation to be the maximization of its stream of profits over time. This question therefore highlights the actual damage done to the U.S. firm (or firms) by the foreign private practice, rather than the effect on intermediate variables like sales, which can be one means to the desired end (of higher profits.) Furthermore, it does not follow that a foreign private practice which has substantially reduced a U.S. exporter's sales has also substantially reduced that firm's

profitability. In order to expand sales abroad exporters often have to lower prices, cutting profit margins. This is not simply a theoretical conjecture: one of the most striking findings of studies of the effects of sales by new entrants in concentrated market structures is that, by the time three to five firms have entered the market, the pricing behavior of all firms converges quickly to competitive levels and profits fall toward zero[17]. U.S. policymakers and aggrieved U.S. firms should not expect the profit margins that prevailed under the private practices to remain if foreign market access is improved and U.S. exports expand.

- [Welfare Defense Question] *What would be the effect of removing the private practice on the welfare of the foreign nation where that practice operates?*

This question amounts to asking whether the removal of the practice will enhance the foreign nation's consumers welfare[18] without harming that nation's producers; or whether the removal of the practice will improve the total profitability of that nation's producers[19] without reducing the welfare of foreign consumers. If the removal of the practice reduces the foreign nation's welfare, then there is presumably a foreign defense for retaining the practice. Indeed, the greater the reduction in foreign welfare caused by the removal of the practice the greater is the likely opposition to any U.S. pressure to remove that practice.

- [Policy Response Question] *What, if any, should be the response of the United States to the finding that foreign private practices have impaired U.S. export performance or profitability?*

It is important to differentiate between this question and its four predecessors. All too often protagonists jump from evidence which purports to show that private practices exist or have deleterious effects to a conclusion that the U.S. should respond in some (typically vague) manner. Of course, the answers to the previous four questions ought to have some bearing on the appropriate policy response. For example, U.S. officials may not want to expend many resources and political capital on a foreign private practice that only marginally reduces the profits of U.S. exporters.

[17] The most-often cited study of this phenomenon is Breshanan and Reiss (1991).
[18] Typically lower prices for existing goods or the introduction of higher quality goods are thought to enhance consumer welfare. Formally economists use the notion of consumer surplus, which captures the difference between what consumers are willing to pay for a good and what they actually pay, to assess consumer welfare.
[19] Including those firms who are not parties to the private restraint.

Now we turn to a discussion of what light (if any) the major strands of the empirical literature can shed on these five critical questions.

IV. Assessing Measures of the Effects of Foreign Private Practices on Market Access

This section reviews the merits of the two principal approaches to measuring the effects of private practices on market access. In fact, it would be more accurate to say that these approaches estimate the effect of such practices on international trade flows, and so attempt to tackle the Export Performance Question outlined above. However, before we proceed any further the prevalence of case studies and anecdotal evidence in the writings of (primarily) political scientists, foreign policy analysts and legal practitioners calls for a brief digression on their merits, too.

A. Case Study Evidence on Private Practices

In the absence of direct evidence of agreements between foreign firms to restrain market access, the unsatisfactory export performance of U.S. firms (or performance of U.S. affiliates abroad) is often presented as evidence of market-closing foreign private practices. For example, the draft report of the International Trade and Antitrust Task Force of the American Bar Association[20] quotes four qualitative allegations from an American Electronics Association submission to the Office of the United States Trade Representative in 1991, one of which is reproduced below,

> "One U.S. company sought to sell an electronic component to three large Japanese industrial companies which accounted for more than 90 percent of purchases of that component in Japan. After seven years of effort, after technical approval by all three Japanese companies, after being recommended to top management as the superior (compared to Japanese competitors) component by the staffs of two of the three companies, and after having been told repeatedly by purchasing staff that its prices were 'fully competitive' or 'more than competitive,' the U.S. company never made a single sale."

[20] On *Private Anticompetitive Practices and Market Access Barriers,* 1999.

To be fair, other allegations of private practices have presented a richer set of qualitative evidence[21], but the starting point is typically a low level (or no) sales by a U.S. exporter or exporters in some foreign market. However, as the discussion in section II made clear, low levels of sales or import penetration can be accounted for by a large number of potential explanations. Although qualitative evidence could rule out some of these competing explanations,[22] the evidence presented is typically insufficient to rule out all those competing explanations which are unrelated to private practices. Therefore, all that can be claimed is that the evidence fails to reject several explanations for poor U.S. export performance, including private practices.

B. Using Proxy Variables to Estimate the Effects of Private Practices on Trade Flows

Allegations based on qualitative evidence have also been combined with econometric estimates of the effects of private practices. The leading example of this approach is probably Lawrence's (1993) overview of his previous research into the Japanese trading regime, with its particular focus on the effects of the *Keiretsu*. Lawrence examines whether horizontal and vertical arrangements between business groups, two types of business groups known as *Keiretsu*, can account for lower import penetration ratios and higher exports in those Japanese manufacturing industries where such arrangements are more prevalent. In addition to describing how firms in the same *Keiretsu* often pool risk, share information, and own stock in each other's firms, Lawrence notes that

> "close links between assemblers and suppliers economize on transaction costs, enhance the transfer of technology and increase the incentives to make [relationship-] specific investments." (Lawrence 1993, p.12)

These arrangements are said to increase efficiency and shelter firms within a business group from the fear of takeovers, and some claim that the latter enables them to take a longer term view of investment projects and research and development.

[21] See for example Grindley, Salant and Waverman (1999) and Eastman Kodak Co. (1995).
[22] For example, a detailed account of the characteristics of the good in question could rule out concerns that purchasers do not know the quality of the good at the time of purchase, and so eliminate those explanations for low imports based on "informational barriers to entry."

Lawrence then reports on an earlier study of his (Lawrence, 1991) which examined the following hypotheses:

> "if *Keiretsu* operate to make Japanese firms more efficient, then industries or firms where *Keiretsu* are prominent should have lower imports and higher exports. However, if such industries or firms only operate by excluding others from selling in Japan…they will be associated with lower imports but have no impact on exports." (Lawrence 1993, p.13)

In an attempt to control for some of the other determinants of import and export levels, he included as explanatory variables other industry characteristics (such as relative use of capital and labor, tariffs, transportation costs, and the concentration of industry sales). In his econometric analysis of the variation in imports across Japanese industries, Lawrence found that the presence of horizontal and vertical *Keiretsu* arrangements reduced imports by as much as 50 percent. In a similar analysis of Japanese exports Lawrence found weaker evidence that *Keiretsu* comprising vertical relationships between firms were associated with higher export levels, consistent with the view that such arrangements were efficiency enhancing. No such effect was found in *Keiretsu* comprising horizontal relationships.

What should we make of this type of study? It should be acknowledged up front that by attempting to quantify the effects of private business practices and by taking into account some other plausible explanations for an industry's level of imports and exports, this type of study is a marked improvement over the case study approach. However, interpreting the results is not as straightforward as one might initially think. As Lawrence himself notes, the principal problem arises from using the extent of *Keiretsu* membership in an industry as an explanatory variable. This variable does not identify which aspects of the *Keiretsu* business structure are responsible for his findings. That is, this approach cannot reveal which private business practices are responsible for his findings. Worse still, certain unobjectionable business practices could account for these findings. *Keiretsu* arrangements could actually lead to greater competition within Japanese markets, which keeps imports low on competitive grounds alone. In fact, Weinstein and Yafel (1992) report that firms in *Keiretsu* earn much smaller profit margins than do other firms. The key point to take away from this discussion is that, in the absence of directly observing private business practices, the use of variables to proxy for those practices creates substantial problems when interpreting the empirical results, and so detracts from the utility of this approach to policymakers.

C. Detecting Anomalous Trade Patterns

The suspicion that informal barriers and private practices are responsible for Japan having an unusually low levels of imports, compared to other industrial nations, led to the development of another approach to measuring market access or blockage. At the heart of this approach is the following counterfactual: if other industrial nations had Japan's supply side characteristics would their predicted import levels exceed the actual import levels observed in Japan? If so, then non-supply side factors--and in this approach those factors are presumed to be informal impediments to trade such as private practices--are said to account for Japan's unusually low level of imports.

One advantage of this approach is that the supply-side determinants of trade flows are explicitly taken into account. Although data on those supply-side determinants are needed to implement this approach, measures of private practices are not. Therefore, this approach does not have to resort to using proxy variables for those private practices which are not observed by the researcher.

Using a theory of trade in differentiated products Lawrence (1987) found that in 1980 Japanese manufacturing industries imported on average 40 percent less than other nations' would have if they had Japan's supply side characteristics too. His offers the following interpretation of these findings:

> "Japanese manufactured good imports have been significantly reduced by unusual trade barriers and preferences…" (Lawrence 1987, p. 538.)

Lawrence's findings provoked a spirited debate about the merits of this approach[23]. The first point of contention was the choice of economic model used to predict the other nations' import levels if they had Japanese supply side characteristics. Saxonhouse (1989) revisited Lawrence's original analysis using a different theoretical model, and found that Japan's trade patterns where no different (statistically speaking) from those predicted for other industrial countries.

[23] The two leading protagonists, Robert Z. Lawrence and Gary Saxonhouse, have summarized this perspectives on this debate in Lawrence (1993) and Saxonhouse (1993) respectively.

The second point of contention revolves around the interpretation of any discrepancy between Japan's actual imports and the predicted or counterfactual levels of imports. Even if this discrepancy were entirely accounted for by hidden trade barriers, the private practices of Japanese firms, and Japanese consumers' preference for domestically produced goods, no light is shed on the relative importance of each of these three factors. In addition, this approach cannot discriminate among those private practices, pointing out those practices that are more harmful to U.S. exporters' performance. Finally, errors in the measurement of international trade flows and supply side factors and the omission of other determinants of trade flows (which are correlated with the supply side factors) are just two of many statistical concerns that can bias the econometric estimates, and therefore the counterfactual import levels predicted by those estimates.

At first, not needing direct measures of private practices, or proxy variables for those practices, appeared to give this approach an edge over the approach outlined in the previous sub-section. However, by failing to separate out the effects of different private practices there is no way policymakers can infer which (if any) practices are more damaging to U.S. export interests--which was, after all, the principal drawback of the proxy approach also! At best the approach described in this sub-section points out where the combined effect of a number of non-supply side factors has produced a trade flow of untypical or unusual magnitude.

D. Summary

This section has shown just how difficult it is to reliably estimate the effect of private practices on U.S. export performance. It should not be surprising that foreign firms who are engaged in private practices that affect imports, especially those practices that are illegal, are reluctant to publish details of their inter-firm agreements. The inability of researchers to observe those agreements has forced them to develop the two approaches described above, the inferences from which have been disputed. Worse still, as foreign practices can differ in their consequences, the inability to observe those different practices and to incorporate those observations into the statistical analysis implies that

these approaches offer no guide to which foreign practices (if any) are the most in need of policymakers' attention.

As we argued in section III before contemplating measures against foreign firms, discerning the effects of a foreign private practice on U.S. export performance ought to be part of any serious official investigation. However, the above evaluation suggests that the information required to satisfactorily estimate the effects of those private practices is well beyond that available to most researchers, and probably to most U.S. exporters too. This suggests that policymakers should be extremely skeptical of any estimates supplied to them. Furthermore, it suggests that if policymakers wish to estimate these effects themselves, then it is quite likely that the resources needed to collect the relevant information are considerable. Given these difficulties in conducting an investigation into the effects of a foreign private practice, it is worth asking whether any other empirical evidence could justify dismissing an allegation at a more preliminary stage before a costly investigation is launched~~?~~. We now turn to this question.

V. Using a Bounds Approach to Filter Allegations About Foreign Private Practices

In this section we outline an empirically-implementable filter which could weed out less compelling allegations about foreign private practice, so avoiding the need for full investigation. And we describe one study where such a filter eliminated a large number of accusations of a certain foreign trade practice.

The key components of this filter are as follows: when a policymaker receives an allegation about a certain foreign practice, their first step is to draw upon those economic models of that practice. The second step is to use those models to locate the set of observable preconditions under which the private practice might be harmful to U.S. exporters. The third step is to use information about the foreign firms, product characteristics, and industry conditions to check whether those preconditions have been met. If not, the allegation is dismissed. Otherwise, a full investigation of the effects of the alleged practice is initiated.

This filter has two advantages. First, the filter is grounded in not one but a class of economic models. The filter is therefore not beholden to any one theory or school of thought. Secondly, the filter is deliberately designed to facilitate empirical implementation. Rather than estimate the effects of a foreign private practice on U.S. export interests, this filter focuses attention on the observable preconditions for harmful effects to occur.

What is particularly interesting is that several analysts, in the fields of international trade and industrial organization, have (independently) began to advocate filters of this type. In our discussion of cartels we described how Sutton (1995) argued that existing economic theories provided "bounds" on the circumstances under which welfare-reducing collusion can be sustained. Neven, Papandropoulous, and Seabright (1998, Ch.2) advocate a three-part rule for evaluating allegations of vertical restraints, the first two of which examine whether the preconditions for harmful effects exist--and is thus similar in spirit to the filter outlined above. Their rule leaves to the end an investigation of whether there are substantial effects on third parties of vertical restraints.

Finally, such a filter has been devised and implemented empirically by Shin (1998) in her examination of

> "whether foreign firms subject to [U.S.] antidumping orders in the 1980s could have been motivated by predatory intent." (Shin 1998, p. 81)

While the antidumping laws are not the focus of this study, it is Shin's approach, rather than the area of application, that is of interest here. Shin described her procedure as examining whether

> "the structural characteristics of the industries represented by this sample [of antidumping orders issued by the U.S. in the 1980s] are examined to determine if predation could have been a successful strategy in those industries." (Shin 1998, p.86)

She employed economic theories of predatory pricing to guide her choice of these "structural characteristics." What is striking is that in only 39 of the 161 cases were the preconditions for successful predation met[24]. These findings suggest that such filters can have substantial discriminatory power, helping to eliminate those allegations with little

[24] This, of course, does not imply that predation was the motive for dumping in those 39 cases, and Shin notes that further analysis would be needed to reach that conclusion.

merit, and therefore foregoing the need for a lengthy and undoubtedly controversial investigation of the effects of the alleged foreign private practice.

VI. Concluding Remarks

Earlier we proposed five questions that should be at the heart of any investigation into whether the U.S. should take action against foreign private practices that have allegedly impaired market access for American firms. As three of these five questions involved estimating the effects of these practices, we examined the reliability of leading empirical approaches to measuring market access. Unfortunately, the paucity of information on foreign private practices available to researchers calls into question the inferences that can be drawn from these measures. However all is not lost. Typically, some of the key preconditions for those practices to have harmful effects are observable. If so policymakers can employ a filter to check if those preconditions have been met in a given case, before pursuing the more challenging task of quantifying the practice's harmful effects.

Empirical Evidence on International Cartels

I. Introduction[25]

Although difficult at times to uncover, cartels are far from rare. Cartels have historically been particularly common in international trade where they were less likely to come under antitrust scrutiny. It has been estimated that approximately 40% of world trade was controlled by international cartels between 1929 and 1937 (Nussbaum).[26] Whether there is a new wave of cartel activity is a question that has arisen in several recent publications. Guerrin and Kyriazis (1993) claim that cartels "continue to flourish and prosper." (p. 269) Litvak and Maule (1975) argue that cartels or "cartel-like" behavior is reappearing, although the form may be different. (p. 61) Finally, the World Trade Organization raised the issue in its 1997 Annual Report: "While the extent of cartel activities is intrinsically difficult to assess …there are some indications that a growing proportion of cartel agreements are international in scope." (p. 40)

What determines whether or not a cartel is feasible in an industry? What determines its success? Its stability? Answers to these questions would put us in a much better position to formulate antitrust policy and enforcement strategy.

Unfortunately, both theoretical and empirical work on cartel behavior suggests that it is impossible to say definitively where collusion will and will not take place. Our inability to make such a determination does not simply reflect our ignorance of cartel operations or secrecy on the part of cartels. The existence and success of collusion is not sufficiently

[25] This paper contains significant excerpts from Levenstein and Suslow "What Determines Cartel Success?" *How Cartels Endure and How They Fail: Studies of Industrial Collusion*, Peter Grossman, ed., forthcoming 2000.

[26] There are a variety of estimates, but all are within this range. In addition, there are some scholars who report on the actual number of cartels: Notz (1929) estimated 114 international cartels in existence prior to World War I; Mirow and Maurer (1982) cite a similar estimate of 112 international cartels in existence in 1912; Rahl (1981) cites studies of cartel activity around the start of World War II reporting a total of 179 international cartels, with U.S. firms participating in 109 of these arrangements.

deterministic to allow us ever to make such a statement. Many economists have noted this indeterminacy. Sutton, for example, remarks that "Case studies of cartels show that different cartels do indeed behave in quite different ways" (Sutton 1995, p. 68). Spar presents a detailed analysis of four industries with extensive international cartel activity and concludes: "[T]here seem to be no specific features of the market that predetermine the extent or form of cooperation." (Spar 1994, p. 218) Pindyck (1979) comments that "[e]valuating the prospects for successful cartelization in the future will have to be done on a market-by-market basis…" (p. 155) Slade also finds it unreasonable to expect one model to fit all cartel behavior: "Institutional detail such as observability of choice variables, product characteristics, the number and size distribution of participants, and their method of communicating have been found to be important determinants of the likelihood of cartel formation...These same features are expected to affect the dynamics of punishment phases and breakdowns." (Slade, 1990b, p. 534)[27]

Sutton (1995) suggests a solution to this indeterminacy by proposing a "bounds" approach which presupposes that there are certain *necessary but not sufficient* conditions for cartel success. If this approach is correct, we should be able to determine where a cartel *cannot* succeed, because the underlying demand and cost fundamentals do not allow it. That is, the goal of cartel research should not be to extract precise predictions to support a unique equilibrium or market outcome, but rather to locate a range of observable conditions which generate a distinct set of market outcomes. For example, if the cost to new entrants of overcoming barriers to entry into an industry are low, then a cartel cannot survive in that industry. Measures of the extent of barriers to entry, or even better the costs of overcoming those barriers, can thus be used to bound where collusion is feasible and infeasible.

Within the bounds where cartels *could* succeed – that is, in the range where the necessary cost and demand conditions are satisfied – whether or not collusion is attempted *and sustained* depends on a host of other less tangible factors such as managerial strategy, the history of the industry, or dominance of one firm in holding the cartel together. Managers facing the same economic fundamentals but operating under different

[27] Although we focus on empirical indeterminacy here, there is a theoretical literature that addresses this issue as well. For example, Ross (1992) shows that, contrary to standard thinking on cartel facilitating mechanisms, product differentiation can actually enhance cartel stability, assuming that finding an agreement is feasible. More recently Kreps (1999) has made a similar argument, showing that cartel stability may be path dependent.

institutional dynamics, can lead their companies along starkly different paths of competition or collusion.

In this part of the paper we first ask, what can the existing cross-sectional literature tell us about these necessary demand and cost conditions? The empirical literature on international cartels, taking a deterministic approach, has focused on a wide range of variables that are intended to relate industry fundamentals to cartel existence, success, and stability. These include (but are not limited to) concentration variables, cost variables, demand variables, and government policy variables. Second, we ask which variables influence cartel success in industries that lie within the bounds in which success is possible.

We begin by giving an overview of the theories of cartel behavior in Section II. Section III discusses some of the stylized facts on cartel stability from the cross-section literature on international cartel activity. Section IV investigates selected case studies and discusses their contribution to systematizing or synthesizing our knowledge of cartel behavior. Section V presents some preliminary data on recent international price-fixing conspiracies uncovered by the Antitrust Division of the U.S. Department of Justice and the European Commission. Section VI brings the analysis together and summarizes what we can learn from these studies about the location of the bounds of feasible collusion. Concluding remarks are given in Section VII.

II. Theories of Cartel Behavior[28]

Note to the reader: those readers familiar with basic theories of cooperative oligopoly can skip to subsection C.

Oligopoly is generally characterized by a "fewness" of firms and "mutual interdependence." That is, firms are aware that in their industry the choices made by any firm affect at least one other firm's profits (and possibly every other firm's profits). This mutual interdependence implies that oligopolistic firms must consider rivals' short term and long term reactions to any (significant) change in strategy. Therefore, oligopoly behavior is complex and

[28] This section borrows heavily from Scherer and Ross (1990), Carlton and Perloff (1994), Tirole (1988), and Schmalensee, R. and Willig, R., eds., *Handbook of Industrial Organization* (1989), Vol. 1, Chapters 6 and 7.

strategic in character, and unsurprisingly there are many theories of how firms in oligopolistic industries interact.

Oligopoly theory can be divided into noncooperative and cooperative theories. In a cooperative oligopoly, a small number of firms coordinate their actions to maximize joint profits. In models of noncooperative oligopoly, a small number of firms act independently (as rivals) although they are aware of one another's existence. In this review, we focus on cooperative theories of oligopoly behavior, including both tacit collusion and formal cartels.

A. Static Oligopoly Games

The goal of a cartel is to increase profits above the competitive profit level. To achieve this goal, output must be restricted below the competitive level. Figure 1 uses basic microeconomic theory to illustrate why cartels form.

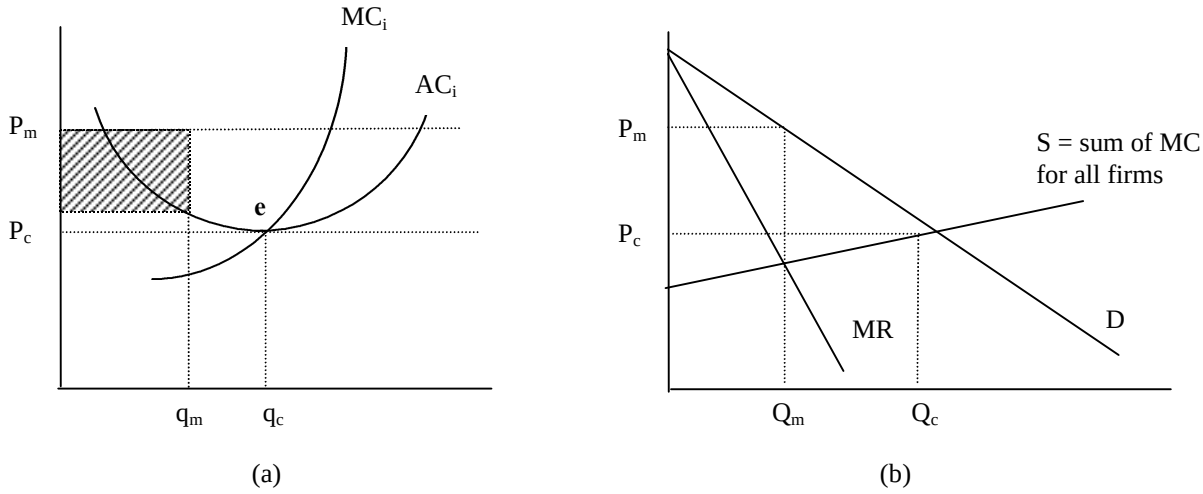


Figure 1

Panel (a) of Figure 1 shows a typical firm's marginal cost (the additional cost associated with producing one more unit) and average cost curve. Panel (b) shows the industry supply curve, which is the sum of the n firm's individual marginal cost curves if the industry is perfectly competitive. The competitive output, Q_c, is determined by the intersection of this supply curve and the industry demand curve. The market price is P_c and each firm chooses to produce q_c. Long-run economic profits under perfect competition are driven down to zero by free entry and exit. The long-run equilibrium is point e in Figure 1(a).

Acting collectively, the firms in this industry can increase total profits. Whereas the marginal revenue (the additional revenue earned by selling one more unit) for an individual

competitive firm is equal to the market price, the marginal revenue for a cartel (by acting as a monopolist) lies below the demand curve and is given by MR in panel (b). A cartel can increase industry profit by lowering industry output. Profits will be maximized when output is set at Q_m, where marginal revenue equals marginal cost. When output is restricted, price rises to P_m.[29] The cartel's output target must be divided into individual quotas or production targets for each firm. If the cartel is made up of n identical firms which reduce output equally, each firm must reduce its output to $q_m = Q_m/n$. As a consequence, each firm receives a total economic profit equal to the shaded area in Figure 1(a). Setting a price target without restricting production levels (either by setting quotas, assigning customers, assigning territories, etc.) guarantees failure.

An individual cartel member always has an incentive to cheat on a cartel agreement that does not punish defectors. Although the cartel as a whole is producing at the profit maximizing point, each individual cartel member sees a profit opportunity from producing in excess of their quota. Different firms will have a greater or lesser incentive to cheat depending on a number of factors, including,

a. The higher the elasticity of an individual firm's demand curve, the greater any price cut will increase sales. Each firm's own demand elasticity is affected both by the industry-wide elasticity and by the number and size distribution of firms in that industry.
b. If marginal costs rise steeply (in the neighborhood of the cartel output), cutting price and increasing sales is less profitable.
c. The higher fixed costs are as a fraction of total costs, the greater the temptation to cut price and increase market share in order to decrease excess capacity.
d. If sales are large and infrequent (often called "lumpy" sales) the incentive to cut price is higher since it can result in a substantial increase in sales.

Game theory can also be used to illustrate the incentive to cheat and highlight a different set of problems facing members of a cartel. The basic elements of the game are the players, strategies, and the payoffs associated with each permutation of those players' strategies. In a

[29] This is assuming no price discrimination across market segments.

one-period game where players make their moves simultaneously, the individually optimal strategy is to "cheat" on the cartel agreement by lowering price and raising quantity. All firms will come to the same conclusion, focusing only on their own self-interest. This famous game is known as the *Prisoners Dilemma*. Each firm, trying to maximizing its own profits, will produce a "high output level," but both firms would be better off if they both produced a low level of output. In the cartel setting, producing "high" means producing more than your output quota. The problem is one of commitment, or loosely speaking "trust". Both players would be better off it they could commit themselves to producing low levels of output, but without such a commitment each has an incentive to cheat.

The Prisoners' Dilemma game is used to illustrate the problems of tacit collusion (trying to reach the cartel point without communicating). However, it can also be used as a starting point to discuss the problems of formal cartels. Even with a written cartel contract, firms still face the same basic incentive problem. In a static setting, there is nothing to deter a firm from cheating. If the game is going to be played just one time, the strategy of cheating is the inevitable choice.

Osborne (1976) neatly summarizes the main issues:

> A cartel faces one external and four internal problems. The external problem...is to predict (and if possible, discourage) production by nonmembers. The internal problems are, first, to locate the contract surface[30]; second, to choose a point on that surface (the sharing problem); third, to detect, and fourth, to deter cheating. (p. 835)

We explain each of these "cartel problems" in turn, looking at the first two in a static setting and the last two in the next section, where dynamic considerations are introduced.

External Problem: Substitution and Entry: A cartel will not be successful if the firms within the cartel do not have sufficient market power to control the price. This will be the case if

a. the cartel has a small market share, or

[30] The contract surface is the collection of points that maximize joint profits for the firms in the cartel. There are many points on a contract surface due to the fact that there are many ways to divide the joint profit maximizing output among the cartel members.

b. there are many close substitutes for the cartel's product, or

c. the cost of entry by non-members firms is low or zero.

The market share requirement is obvious. However, the cartel membership need not encompass the entire industry. If a few large firms make most of the sales in an industry, and if they can coordinate their activities, they may be able to raise price without involving the smaller firms in the industry. By being outside the cartel, the fringe firms can "free ride" by selling as much as they want at the high cartel price, since they are not subject to output quotas. However, if enough firms free ride, the market price will be depressed to the competitive level unless the cartel members are willing to continually reduce their output to accommodate those outside the cartel. The paper by d'Aspremont, Jacquemin, Jaskold-Gasbzewicz and Weymark (1983) presents an analysis of this problem of stability in cartel membership.[31]

But even if the cartel has a large market share and raises the price in the short run, the increase in profits will only be temporary if consumers can easily switch to cheaper substitutes or if other firms, attracted by the profit opportunities, can easily enter the market. The speed with which non-cartel members can undermine the efforts of the cartel depends on the elasticity of supply of non-members.[32] If non-member supply is very elastic, entry into the cartelized market or into the production of close substitutes will be easy and the cartel will find it difficult to maintain its high price. In other words, if the long-run elasticity of demand or supply facing the cartel is high, the cartel's ability to earn high profits will be short-lived.

Pindyck (1979) illustrates the importance of the non-member elasticity of supply as a determinant of cartel success in his article examining the copper market. He finds that the International Council of Copper Exporting Countries (CIPEC) was unable to significantly raise prices due to the fact that CIPEC faced a very elastic fringe supply coming from secondary (recycled scrap) copper producers. John Underwood (1977) uses a similar approach and estimates a model of the tea market and copper market in order to calculate the expected gain from cartel formation. As with Pindyck, he finds that the expected gain

[31] Also see Schmitt and Weder (1998) for a model of cartel formation. In their model, Schmitt and Weder show that cartels are more likely to form during economic downturns and in industries with significant sunk costs.

[32] Elasticity of supply is the percentage change in supply due to a given percentage change in price. If the response in supply, in percentage terms, is greater than the percentage change in price we say that supply is elastic. If supply responds little to changes in price, then supply is inelastic.

was much higher for the tea cartel than for the copper cartel. Two reasons underlie these findings: (1) the demand curve facing the copper cartel is more elastic at current prices, and (2) estimated long-run primary supply elasticity of copper is quite high in the United States and Canada, the two primary producer countries not in the cartel.[33] Knowledge of the supply (and demand) elasticities is, therefore, critical for predicting whether a cartel will have a chance at success.

Internal Problem #1: Organizing and Sharing Production

Even if the potential for long-run profits is high, a cartel may be too costly to organize. Transactions costs of negotiating, monitoring and policing the agreement may be prohibitive. These problems are compounded where the desire to avoid prosecution by the antitrust authorities encourages firms to be secretive about their actions. On the other hand, these problems can be ameliorated by a history of successful collusion that creates expectations of future cooperative behavior or well-defined focal behavior that has been adhered to in the past.

When firms are identical, reaching an agreement is relatively easy. The more asymmetries that exist, the more complex the negotiations, the greater the cost of creating the cartel. The following factors create asymmetries between firms:

a. a large numbers of firms are involved or large number of decision-makers,
b. the firms produce differentiated products,
c. the firms have different costs of production,
d. the firms differ in the degree to which they are capacity constrained,
e. the firms have differing time preferences.

We are all familiar with the intuitive argument that the larger the number of firms trying to come to an agreement, the harder it must be. There are some who argue that the number of *decision-makers* is more important than the number of firms in predicting cartel success (Cyert, *et al*, 1995). Decentralized pricing authority can lead to less price discipline, making it more likely that price wars will break out. Sonnenfeld and Lawrence find that this was true in the cartonboard industry, where there was a

[33] Underwood (1977), pp. 241-242.

decentralized price-setting mechanism: "The prices for folding boxes…are heavily influenced by very junior managers and salespeople.…Thus people can get involved in pricing issues for status reasons alone…It is also clear that the more decentralized pricing decision become, the more difficult it will be for top managers to control collusion." (1978, pp. 150-151)

Points (b) – (e) are relevant for both the formation of the cartel and the decision of how to allocate the cartel output among members. Asymmetries across firms in the cartel will affect each firm's view of the optimal price and quota assignments. Thus, agreeing on output and price levels will be harder if firms produce differentiated products (differentiated according to quality, location, distribution channels, etc.) and have different costs of production. If products are differentiated, the coordination problem becomes multi-dimensional, involving both the price level and the amount of the differential appropriate for each grade or variety of the product. Thus, it becomes necessary to agree on an entire schedule of prices or outputs. This in turn multiplies the possible points of disagreement. (It does not mean that creating such a cartel is impossible. When each firm produces a range of products, negotiations can be simplified by tying all product prices to the price of a pre-specified product.)

With cost heterogeneity, difficulties with the division of profits arise. If firms are not equally efficient in production, they will disagree on the appropriate profit maximizing output level. When firms have different marginal cost curves, joint-profit maximization requires that firms produce unequal output, earn unequal profit, and may even require that some firms close down altogether. The outcome is difficult to predict, for it will depend on the relative bargaining strengths of the firms within the cartel. A common compromise solution is to divide the market by customer or geographic region. Although this will often not maximize joint profits, it can lead to a stable agreement which will at least result in profits higher than they would be under competition.

Finally, if firms have different rates of time preference (discount rates), they will disagree about the weights to be given to current and future profits. One firm may prefer setting a high price today (or having a tighter restriction on production) even though that price will encourage entry tomorrow. Another firm may take a longer run view, giving additional weight to future profits, and prefer to keep the current price at more moderate levels. This is

a dynamic strategic issue, but it is worthwhile mentioning in the context of organizational costs. We will return to this issue section C below.

B. Dynamic Oligopoly Games

Durable investments, technological expertise, and barriers to entry tend to promote long-run interactions among a relatively stable set of firms. If firms compete repeatedly over time, they can adjust their beliefs about rivals' behavior over time and possibly use more complex strategies than in single-period models. "Bad" behavior in one period can be "punished" in a later period. In a repeated game (played a fixed number of times), each player also has the opportunity to establish a reputation for cooperation, and thereby encourage the other player to do the same.

Repeated interaction (over time or across markets) can, by providing the incentive of future collusive profits, deter firms from cheating in the present and allow them to escape the Prisoners' Dilemma.[34] This tradeoff facing each cartel member at each point in time can be expressed very generally: does the (discounted) expected stream of profits from future collusion exceed the expected profits earned by cheating today (which equals the sum of the profits from cheating today until that cheating is detected and the stream of profits that occurs after detection and possible punishment by other cartel members). Put in algebriac terms does

$$E[\Pi_{\text{cheating today}}] + E\ [\Sigma\ (\Pi_{\text{following detection of cheating}})] < E\ [\Sigma\ (\Pi_{\text{colluding forever}})]?$$

In order for this inequality to hold--so that collusion is self-enforcing by the conspiring firms--it will be necessary for cartel members to detect and deter cheating. In addition, the rate at which firms discount future profits is critical: the more important are short-run profits, the higher the weight given to "profits today" and the less weight given to "profits tomorrow." Thus, when firms discount the future heavily (i.e., take a short-run view) it is difficult to enforce this inequality and maintain a successful cartel.

[34] Most of the theoretical and empirical literature focuses on repeated interaction over time. Benoit and Krishna (1993) provides the theoretical basis for the argument that repeated interaction across space or markets may also support collusion. Discussion of the empirical literature on multi-market contact is found below.

In sum, maintaining the cartel price and output level depends on several factors, such as the speed with which competitors learn of a rival's price cut, the probability that any defection from the cartel agreement is detected, and the extent of retaliation by the loyal cartel members. Any practice, which enhances the prospect that cheating will be swiftly detected and severely punished, will undermine the incentive for cartel members to cheat in the first place.

Internal Problem #2: Detecting Cheating: Stronger, swifter, or more certain punishments allow the firms to support a more collusive outcome. The following factors will tend to make detection of price cuts easier and collusion more successful:

a. Few sellers: If prices are not observable, firms may have to infer whether others are cheating by observing their own sales. If there are relatively few firms in the market it may be possible to detect a secret price cut by one firm because it causes rival firms' sales to fall significantly.[35]

b. Many buyers: Suppose each firm has a certain distribution of expected sales. If a firm's actual sales fall significantly below their expected level, that firm will suspect price-cutting. If a particular rival's sales rise at the same time, it will be identified as the probable cheater. The larger the number of transactions, or buyers, the less the loss in sales revenue required to trigger a presumption of cheating. As the probability of detection increases, the incentives to cheat will fall. See Stigler (1964) for a theoretical model of this point.

c. Increased information: Detection will be easier if firms have better information about rival behavior. For example, information can be increased by individual firms getting together to pool sales information. Trade associations, for example, have been involved in a substantial number of U.S. price-fixing cases, see Posner (1970), Hay and Kelley (1974) and Greer (1977). Firms therefore often find it useful to invest in information collection in order to support a collusive equilibrium.[36]

[35] Models of tacit coordination in a dynamic setting (to be discussed later in this section) have stressed the role played by unanticipated demand fluctuations in determining the longevity of cooperative behavior. The classic paper is Stigler's (1964). For more recent work, see e.g., Green and Porter (1984); Rotemberg and Saloner (1986); Abreu, Pearce, and Stacchetti (1985); Haltiwanger and Harrington (1991).

[36] Genesove and Mullin (1999) and Levenstein (1996) examine the information collection procedures of two cartels in the sugar and bromine industries, respectively. Industry associations often engage in the collection and dissemination of information, which may facilitate collusion. The government may

d. Price Visibility: Detection of secret price-cutting is enhanced by the visibility of prices offered to prospective customers. If price bids are secret, a firm can hide the fact that it is bidding less (cheating). When price bids are open, such as in open outcry auctions or securities exchanges, detection of cheating is easier.

Internal Problem #3: Deterring Cheating: Detection without punishment is not sufficient to deter cheating. There are many complex punishment strategies discussed in the literature. Some of the most general and well-known strategies are listed below. The key to developing punishment strategies that will make a cooperative agreement self-enforcing is that the announced punishments must be *credible.* An empty threat will be ignored by rivals. One way to make threats credible is to pre-commit to the threatened action. If a firm has no choice but to carry through with its threatened action, the threat will be believable.

Common forms of credible punishment strategies discussed in the literature are:

1. Contractual Clauses: One frequently used provision is the "most favored customer" or "most favored nation" clause, which assures buyer A that if the seller ever gives a lower price to another buyer he will (retroactively) give the same discount to A. The seller thus ties his own hands and provides itself with a strong disincentive to cut price. (Salop 1986) Somewhat similar, the "meet or release" clause assures a buyer that if a rival seller offers a lower price, the seller with the contract will either match the price or release the buyer from the contract. The buyer is thus given an incentive to reveal lower offers. If a contract does not include the release part of the clause, the seller has, in effect, committed himself to punishing his rivals by matching their price cuts.

2. Fixed Market Shares: As a cheating firm lowers its price, its market share will increase. Remaining cartel members will retaliate by increasing their production to regain their agreed-upon market shares. Since this will depress the price even further, the potential defector should anticipate the retaliation and decide that cheating will not be profitable. (See Orr and MacAvoy 1965, Osborne 1976, Spence 1978a and 1978b).[37]

3. Trigger Prices: Suppose that firms cannot observe their rivals' prices perfectly, but rather must infer them from their own sales. If a firm's sales drop significantly it must decide

---

encourage this information dissemination, as did the federal government during the open price policies under the NRA (Alexander 1994) or as state governments did even more directly in the salt industry (Levenstein 1995).

whether the low demand reflects a general downturn in the industry or is due to a rival's lower price. In this case of stochastic demand and asymmetries of information, all cartel members could agree that if the market price drops below a certain level (called the trigger price), each firm will expand output to the pre-cartel level.[38] Thus, a firm contemplating cheating will be dissuaded because the short-run gains will be more than outweighed by the punishment.

4. Multi-market Contact: The number of times and places when cheating can be punished also increases with the extent of interaction, increasing the likelihood that collusion will succeed, see Benoit and Krishna (1993) and Bernheim and Whinston (1990). In other words, the classic oligopoly feature of mutual interdependence is extended across markets. In turn, this opens up new opportunities for strategic behavior. This theory is alternately called the theory of "multi-market contact," "linked oligopoly," or "mutual forbearance."

   Gelfand and Spiller (1987) highlight two ways in which multi-market contact can increase the severity of punishment and thus decrease the possibility of cheating:

   1. Retaliation involving simultaneous attacks across multiple markets can be more severe; and

   2. Although the cheating may occur in a relatively unimportant market, the punishment can be inflicted in a market where the cheating firm's potential losses are large.

   In other words, firms competing in multiple markets have an additional tool available for punishing defectors from the cartel and thus multi-market contact can facilitate collusive outcomes. If all firms expect retaliation to occur in multiple markets, then the overall level of market competition may fall. The theory, however, is not unambiguous. Multi-market contact may also hinder coordination because informational and monitoring requirements for maintaining collusive arrangements become increasingly complex. We will return to the empirical evidence on multi-market contact in our discussion of case studies in Section IV.

---

[37] A problem with Osborne's theory is that retaliation is assumed to be instantaneous. Orr and MacAvoy discuss the effect of detection lags on credible punishment strategies.

[38] For an early treatment of this problem see Friedman (1971). This literature was then renewed and further developed in a classic article by Green and Porter (1984).

C. Recent Game Theory Contributions: Understanding Cartel Stability and Price Wars

Slade (1990a) classifies the theoretical work on price wars into three categories: (1) monitoring models, such as Green-Porter (1984), where uncertainty is key; (2) learning or asymmetric information models, which involve permanent structural shifts, causing firms to select a new optimal price, which can trigger a price war (see Slade (1989) and Slade (1990b)); and (3) cyclical models, where, unlike Green-Porter, all variables are observable.

The monitoring models are rooted in Stigler's (Stigler) article, which argues that the primary challenge to cartel success is the possibility that the incumbent firms will cheat on an implicit or explicit agreement. In particular, Stigler's analysis focuses on price movements and statistical inference techniques for detecting cheaters. In Green and Porter's (1984) extension of Stigler's model, price wars occur because of unobservable shocks to demand. If the demand shock is large enough, it will trigger a price war (firms will make the probabilistic assumption that there is chiseling). Their theory predicts a cycle of collusive behavior and price wars.[39]

The classic article in the "cyclical model" category is Rotemberg and Saloner (1986). The extent of collusion (or the success at raising price over marginal cost) will depend on the cartel's ability to promise a future stream of cartel profits. It is the existence of this future stream of profits that deters cheating in the present. Fluctuations in demand, changes in technology and input costs, and the development of new differentiated products can all change a firm's long term payoff for cooperating with a cartel. These shocks, even when completely observable, can destabilize a cartel and at a minimum require that cartels members renegotiate both its pricing strategy and the division of profits among the firms in the industry. In other words, in the Rotemberg and Saloner model the punishment phase is never triggered, instead the optimal cartel price changes with the business cycle. In this case, a cartel must have a very sophisticated mechanism for renegotiating and then implementing changing price and output agreements if it is to

[39] There have been many extensions of the Green-Porter model. For example, Abreu, Pearce and Stacchetti (1986) extend the model by expanding the set of possible trigger strategies to allow firms to choose the optimal trigger strategy that maximizes expected profits.

survive fluctuations in demand. This becomes all the more problematic if such renegotiation and implementation must be done in secret because of anti-trust concerns.

In sum, the heart of the problem facing an oligopolist is uncertainty about rivals' actions and reactions and the resulting stream of expected profits over time. In theory, the collusive outcome is only one of many potential market outcomes, whether the former prevails depends upon the industry's structural conditions, the nature of the cartel agreement, and most importantly, the information available to each cartel member. Game theory models point out the factors that tend to facilitate collusion, such as careful monitoring of rival actions, or the ability to change prices or production levels quickly in response to other firms' actions. How important these factors are in real markets is the subject of empirical tests.

III. Evidence From Cross-Section Studies

In this section we first survey descriptive statistics on the mean and variance of cartel length across several cross-section studies. Every data set gathered includes short-lived and long-lived cartels. It is therefore not surprising that there is considerable disagreement among economists and policymakers about how stable cartels are and how successful they are at increasing profits. This lead us to examine the determinants of cartel longevity. Third, we look at profitability results, meager though they are. Finally, we compare the primary causes of cartel breakdowns or renegotiations across samples.

For the purposes of this study, we focus on studies of international cartels (that is, cartels with members from more than one country). We ignore a valuable branch of the literature which examines the characteristics of firms prosecuted for price-fixing by the Antitrust Division of the Department of Justice. This literature began with Richard Posner's (1970) pathbreaking study, and continued with Hay and Kelley (1974), Asch and Seneca (1975), and Fraas and Greer (1977).

The advantage that these U.S. studies have is that the cases (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. The disadvantage of working with these data is sample selection bias. Almost all cartel data sets (whether cross-section or single industry, domestic or international) are plagued with measurement

error, unobservable variables, and sample bias. But the U.S. price-fixing samples face a particular bias. As Posner notes, we cannot be sure whether these are samples of firms that are collusion-prone or prosecution-prone.[40] Asch and Seneca (1975), 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, or whether these were particularly unsuccessful price-fixing conspiracies – and therefore all the more obvious to antitrust authorities. We will discuss the Asch and Seneca paper later, as it relates to the bounds approach.

Although these broad U.S. cross-section studies highlight interesting characteristics of price-fixing cases, the likely bias in the data spurred later researchers to study legal cartels outside of the United States. International cartels have historically been treated as legal, but most require self-enforcement. Although cartel members can communicate, seek information and enforce penalties in an overt manner, they cannot rely on a third party to enforce the agreement.

The studies we review here are Great Britain Board of Trade (1944), Eckbo (1976), Griffin (1989), Suslow (1991), Marquez (1994), and Dick (1996). The first five papers look at samples of international cartel activity primarily before World War II, although Griffin and Marquez included some cartel activity through the early 1980s. Andrew Dick's data set is comprised of Webb-Pomerene export cartels over the period 1918-65. The data sets are described in Appendix A.

The stylized facts that we draw from these studies are:

- As market share and concentration increase, cartel duration increases.
- Faster demand growth is associated with shorter cartels, as are business cycle downturns.

It is perhaps surprising that there is no common or reliable result that relates cartel stability to the number of firms. We can get a better understanding of why when we look at the variance in cartel duration within each sample.

[40] 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 overrepresented 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)

A. Cartel Duration

1. Are Cartels Short- or Long-Lived?

Before examining the determinants of duration, let us look at the stylized facts regarding duration. Table 1 shows that the average sample duration of international cartels lies between 3.7 years and 7.3 years.[41, 42] Economists differ in how to interpret such descriptive statistics. Marquez, for example, whose sample generates on average cartel duration of 7.3 years, concludes that this and other empirical literature show that cartels are typically short-lived. But Marquez also notes that the variance in life expectancy is high (Marquez 1994, p. 331). The high variance in cartel longevity appears clearly in Table 1, ranging from approximately 6 to 62 years. The shortest cartel in Eckbo's "Sample 2", for example, survived less than a year and the longest, the magnesium cartel, lasted 18 years.[43] In Griffin's sample, it is interesting to note that the minimum cartel life is one year, and the maximum is 29 years, *both in the same market* – wheat.

Table 1 also reveals that while roughly half of the cartels lasted on average less than five years, a significant fraction (between 12% and 37%) lasted more than ten years. (Examples of lengthy cartels were the match and titanium cartels, which apparently lasted for 24 and 23 years respectively.) It is difficult, then, to put cartel longevity into a particular pigeon hole. The variance in longevity seems the more robust result. Some cartels can barely get off the ground, while others last for decades.

2. Do Cartels Have One or Many Episodes ?

The British Government study attempted to cover all private international industrial price-fixing agreements to which British firms were members. The authors assembled a sample of cartel activity across 125 products. Their analysis shows that cartel members often reached a new agreement after a short interval of competition and that these firms

[41] Regrettably, the Great Britain Board of Trade study listed in Appendix A and referred to later in this paper presents a great deal of interesting information, but not in a way that is quantifiable. We are told only that the term of the typical cartel agreement varies considerably from cartel to cartel; averaging 3-5 years. (Great Britain Board of Trade 1944, p. XIII)

[42] 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 are used to calculate average duration or just those that ended for reasons other than WWII.

[43] In "Sample 1" Eckbo is able to measure seventeen dimensions of cartel and market characteristics. For "Sample 2" Eckbo has information on only five dimensions. 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 high variance of 22.4 years in Eckbo's Sample 2.

seemed to expect that a new agreement would be reached. Eckbo comes to a similar conclusion: "… in industries whose structure is favorable for collusive arrangements successful cartels tend to come back." (p. 44)

This observation raises the question of whether cartel breakdowns should be labeled as cartel failures or simply a pause in the effectiveness of the agreement. Is it part of the equilibrium dynamic of cartel operations in a changing market to have "renegotiations" or is it a "failure" when then cartel ends temporarily? Put another way, are price wars part of an equilibrium reversion to competitive pricing in order to enforce a long-term agreement, or an indication that the agreement has failed?

Case studies have revealed that not all price wars can be interpreted as punishment of cartel members. Conflict over the terms of the agreement, termed "bargaining price wars" by Levenstein (1996) in her examination of the bromine cartel, are distinct from those that form the "punishment phase" in Green-Porter. Gupta (1997) also finds evidence of bargaining price wars for the tea industry cartels in 1931 and 1932.

In contrast, in cross-section studies there are many ambiguities in empirically measuring the duration of price wars and, therefore, the duration of cartel episodes.[44] Despite the difficulties, most studies of international cartels have tried to label distinct cartel episodes. The data, such as they are, demonstrate a pattern of behavior in which participants repeatedly turn to cartels to increase profits.[45] These cartels typically last 2-5 years, break down, and are often re-created after some period of time. For example:

Industry	Length of Cartel Episodes (with first and last start dates indicated)					
Aluminum	5^{1901}	2	2	3	4	5^{1931}
Copper	2^{1888}	4	4	6	4	19^{1968}
Steel	4^{1926}	0.5	0.17	6^{1933}		
Sulfur	3^{1907}	10	5	11^{1947}		
Tin	2^{1929}	3	2^{1935}			

[44] Posner also cautions the reader in interpreting the duration statistics from U.S. price-fixing cases: "It is rarely clear from the Bluebook summaries whether a conspiracy alleged to have begun many years previously in fact continued throughout the period or was intermittent, or how much of the sales of the product in question were actually subject to the price-fixing agreement." (p. 399)

[45] 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)

The beginning dates of the first and last cartel episodes are shown in superscript. Some cartels re-formed several times within a very short span of years, while others went off and on over fifty years or more. For example, of the 45 industries investigated by Suslow, 31 appear to have a single cartel period. Cartels in the remaining 14 industries have a total of 40 distinct episodes. For these 14 industries with recurring cartels, the average amount of time between the successive cartel contracts is roughly 2 years (with a standard error of 2 years). Also, the median duration of successive (non-censored) cartels episodes grew from roughly two years to close to five years in length.[46]

In another class of industries, participants repeatedly turn to cartels to try to increase profits, but apparently have little success, even in the short run. For example:

Industry	Length of Cartel Episodes (years)
Coffee	1^{1957} 1 3^{1959}
Sugar	0^{1864} 10 0 0 0 0 0^{1958}

The numerous sugar cartels were less than one year in duration, except for one ten-year spell. Why do they keep trying? If Green and Porter are right then (at least some of) these breakdowns are evidence of equilibrium price wars and the cartel should be characterized as a single cartel of long duration. Slade phrases the puzzle as follows: "Can we really say that firms cheat, given that cheating is part of an equilibrium strategy? Perhaps it would be better to say that, to the outside world, firms appear to cheat." (Slade 1990b, p. 538) [47] On the other hand, if Stigler is right and these are cartels have failed, then each observation is an individual cartel.[48]

[46] This pattern of recurrence does not appear in Dick's (1996) study of Webb-Pomerene cartels. These export cartels apparently did not normally reorganize after dissolving: only in 16 of the 93 industries did firms repeatedly try to organize a cartel agreement. In addition, Webb-Pomerene cartels did not tend to grow more stable with experience or age, unlike those cartels studied by Suslow (1991) or Marquez (1994). Dick suggests that both of these differences reflect the frequency of government intervention in international cartels or anticipated future government assistance.

[47] Slade is also puzzled by the apparent length of some price wars (lasting more than a year). She states that "very long wars are at variance with the predictions of all of the theoretical models" and goes on to propose that protracted price wars "wars may be evidence of true breakdown of cooperation rather than merely punishment phases of an equilibrium repeated-game strategy." (Slade 1990b, p. 536)

[48] It is also possible that there is an "empty core," i.e., an unstable competitive equilibrium gives firms an incentive to form coalitions, but these coalitions are also unstable. This could lead to a disequilibrium phenomenon of cycling in and out of collusion. For an example of this pattern of behavior see studies of the sugar industry, e.g., Alfred Eichner, *The Emergence of Oligopoly: Sugar Refining as a Case Study*, Johns Hopkins Press (1969), and Genesove and Mullin (1998); For a discussion of empty core models,

Bresnahan expresses this theme concisely: "a core implication of modern theories of cartels, as well as an ancient empirical assertion about them, is that their conduct is not constant over time" (Bresnahan 1989, p. 1041). The empirical literature has yet to come to terms with this fundamental issue.

3. What Determines Cartel Duration?

Cartel duration is clearly not well understood. Table 2 summarizes the empirical cross-section work on international cartel duration. A "Pos" indication in the table means that the variable listed is positively associated with cartel survival or duration. In Suslow's study, for example, an increase in the number of countries involved in a cartel results in a decrease in cartel duration ("Neg"), although the relationship is not statistically significant. Cartel market share, on the other hand, is positively related to duration in all three studies shows in Table 2. Marquez, for example, finds that increased cartel concentration or increased market share significantly raises cartel life expectancy.

Suslow's results show that having relatively few products covered by the agreement has a positive effect on duration. Variables measuring the existence of penalties and patent agreements are also positively related to the probability of cartel survival. Provisions for penalties were used *in addition* to methods for limiting production. Penalties appear to be used most often by those cartels with more participants (more countries) and those contracts covering a broad assortment of products. 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 tends to last.[49]

The underlying assumption in Marquez (1994) is that "[f]aster growth means more uncertain growth and this uncertainty lowers the expected (maximum-punishment) cost of abandoning the (tacit) collusion relative to the case of a fixed demand" (p. 332). While the theoretical model is based solely on demand growth and market share, Marquez adds other variables to the estimating equation: whether the product is renewable or non-renewable (for example, sugar or coffee versus copper or magnesium), whether the cartel began before 1945, the number of previous cartel episodes, and

---

how they compare to cartel models, and empirical tests, see Telser (1985), Sjostrom (1989), and Pirrong (1992).

[49] 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

whether the cartel ended in 1939. Theory is used to structure the econometric model relating cartel stability and external market factors, but internal factors are included on an ad hoc basis. Marquez does not attempt to measure cartel organizational characteristics.

Is demand uncertainty an important determinant of cartel success? Suslow (1991) finds that demand uncertainty undermined collusion in the 1920-39 period. She also finds that demand uncertainty variables explained *more* of the variation in the probability of cartel failure than variables associated with coordination issues (i.e. those that described the organizational characteristics of the cartel). Marquez also finds that faster demand growth lowers cartel durability (although the effect is not significant).[50] This is consistent with the idea that a smaller number of firms and more stable conditions simplifies the process of negotiating and implementing a cartel agreement.

The consistency of these kinds of results across a variety of studies highlights that these managerial costs do undermine cartel stability, at least in environments with significant anti-trust enforcement. Therefore, markets with highly volatile demand tend to be outside the bounds of feasible collusion.

Dick constructs a survival model to estimate the conditional probability of cartel failure. Some of these export cartels were organized for price-fixing, while others were purely cost sharing. He finds that Webb-Pomerene cartels selling to relatively larger buyers tended to dissolve sooner (Dick 1996, p. 261). This conforms to Stigler's prediction. He also tests for the effects of demand stability. He finds that "[c]onsistent with Stigler's prediction, cartels that operated in noisier environments tended to dissolve sooner." (p. 266) (This is shown by the "Neg" indication in Table 2 under demand instability.) Although Dick's measure of uncertainty differs from Suslow's, the spirit of the result is the same, namely uncertainty in the economic environment increases cartel instability. The data reveal that Webb-Pomerene cartels were more likely to collapse during downturns in their export market. (Dick 1996, p. 271) Dick also finds that cartels were less stable during anticipated downturns, but that their stability was unrelated to unanticipated business cycle timing.

[50] It is conceivable that growth in demand could make it easier to collude by increasing the value of markets tomorrow relative to markets today, in a sense making firms more patient than they would otherwise be. But most of the empirical results seem to find that demand growth is negatively associated with cartel stability, suggesting that any increased "patience" is outweighed by the increased coordination costs.

The anecdotal evidence presented in the British Government study shows that the extent to which quotas were adhered to and penalties are enforced are important factors determining cartel stability. The authors are unable to estimate the degree of importance because of the secrecy with which cartels operate. (Great Britain Board of Trade 1944, p. XXXI) They also note that instability is not a characteristic shared by all of the cartels in which British firms participated. Instability is claimed to be a feature mainly in those industries susceptible to violent changes in economic conditions. More stable industries – such as matches, electric lamps, and quinine – have seen stable cartels over long periods, e.g., matches, electric lamps, quinine (British Government 1944, p. XXXII). This finding is consistent with the econometric results described above.

4. Reasons for Cartel Failure or Renegotiation

Up to this point we have covered both stylized facts about duration mean and variance and surveyed those variables that can be linked econometrically to cartel stability. Another way of learning about cartel stability is to probe written documents for the reasons for cartel failure. Eckbo, for example, categorizes cartel failures as 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 3. The main reason for cartel dissolution, 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.

Griffin also looks into the reasons for cartel "disintegration." He finds that for his sample of 54 cartels, 27 died for primarily political reasons. Substitution responses rank second, with a count of 18. What Griffin calls "behavioral" reasons caused another 14 to fail. WWII ended another 12. Finally, technological change was decisive in ending 4 cartels (rubber, zinc, sulphur, and nitrate).

The primary reasons for cartel breakdowns in Suslow's sample of international cartels are internal conflict or cheating (roughly 24% as shown in Table 3), antitrust indictment of a

U.S. firm in the cartel (18%), growth of substitutes from outside the cartel (16%), and, due to the sample period chosen for these studies, World War II (39%).

The British Government study gives several examples (see p. XXX) but no categorization of the entire sample. For instance, the sheet glass cartel was suspended in 1937 due to the depreciation of the Belgian currency. Entry is another cause often cited: the appearance of cheap Russian matches in European markets temporarily caused the international match cartel to lose control of the market. In the potash market, a new source of supply temporarily destabilized the potash cartel.

Thus, the primary conflicts that arise (other than political ones) are due to entry (from substitutes already in existence or from technological change) and cheating. If the cartel can solve these two problems, it has a chance at success. Whether cartels have in fact been successful is the topic of the next section.

B. Cartel Performance

1. Do Cartels Raise Prices? Are Cartels Profitable?

Due to the difficulty in measuring profits, most cartel scholars who work with cross-section data use duration as a proxy for cartel success. Of course, cartels can survive as de facto organizations without having much effect on price.[51] Still, some scholars have managed to obtain enough data to investigate the true success of firms' attempts to coordinate actions to increase price. [52, 53]

Only two of the cross-section studies surveyed here, Eckbo (1976) and Griffin (1989), attempt to measure profits. Eckbo studies both the characteristics and the performance of

[51] "There is indeed, sufficient evidence to show that in some industries the agreements were not carried out or were carried out only in part." (British Government 1944, pp. XLI-XLII)

[52] The price-cost margin literature is quite sophisticated in its attempts to tie margins to industry and firm characteristics. (See, for example, Domowitz, et al (1986).) It is an interesting literature, but hard to connect to cartel performance because we do not know whether there was a formal cartel in the industries that are revealed to have high price-cost margins.

[53] Another important body of work analyzes 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. Froeb (1993) criticizes the literature, pointing out that most studies ignore cost differences and other factors that may affect prices. He proposes an alternative method for "backcasting" what prices would have been without the conspiracy and comparing them to actual prices. For a bid-rigging case in frozen seafood between 1981-89 he uses this methodology to show that there was a significant increase in prices during the conspiracy (30% in one period and 23% in a second period). (Froeb, pp. 421-22)

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,” which he defines as able to “raise price 200% above the unit cost of production and distribution.” (Eckbo 1976, p. 26).

All who cite Eckbo's work note that his categorization of cartel characteristics was very subjective (Eckbo himself encourages the reader to adopt a "critical attitude"), but give him credit for being one of the first to attempt a systematic study. For example, Table 4 shows that “efficient” cartels tended to operate in more concentrated industries (the sample mean for Eckbo’s binary concentration variable is 0.9 for efficient cartels versus 0.36 for inefficient cartels). Eckbo also finds that firms in efficient cartels tend to have similar costs (a mean of 0.9 versus 0.58 for inefficient cartels in Sample 1).

The intuitive prediction that the higher the elasticity of a firm’s demand curve, the greater the temptation to cheat is borne out. Eckbo finds that cartels are able to raise price substantially only if demand is sufficiently inelastic and there are few short-term substitutes (p. 42). Eckbo also directly examines the issue of entry by analyzing the effect of both long-term substitutes and cost advantages on the ability of a the cartels to consistently raise price substantially above marginal cost. He finds that, without a cost advantage creating a barrier to entry, it was “impossible for most cartel organizations to last for more than a few months” (p. 42).

Griffin’s (1989) study covers 54 legal international cartels (both legal pre-WWII cartels and more recent legal cartels up through 1984). In his model cartel performance depends on the elasticity of demand facing the cartel, which in turn depends on the market demand elasticity and the elasticity of fringe supply, weighted by the cartel’s market share. Griffin also proposes that the relative size of cartel members and the form of cartel organization are the two most important internal factors determining the success of collusive behavior. Thus he includes in his regression the Herfindahl index of cartel concentration and a subjective index on cartel organization.[54]

Table 4 shows that increases in the Herfindahl and cartel market share increase the Lerner index (price-cost margin), as does an increase in cartel organizational effectiveness.

Griffin summarizes his analysis as follows: "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). This theme echoes throughout the empirical literature.

Although Griffin and Eckbo's work are the only extensive cross-section studies of international cartel profitability, others provide scattered evidence. Asch and Seneca (1975) sample 51 firms indicted for price-fixing in the U.S. and compare their characteristics to 50 randomly selected non-colluders from a list of Fortune 500 companies. Overall, they find that poor profit performance is associated with collusion, although they are not sure why.[55] They then associate this low-profit characteristic with other measurable characteristics. For example, they find that large, low-profit firms are associated with collusive behavior to a much greater degree than small, high-profit firms.

Suslow (1991) gathers price data for 34 of the 71 cartel episodes in her sample. For twenty of these cartel episodes there is an increased real average price over the cartel contract period versus the pre-cartel period. Forty percent of these twenty cartels also experienced a decrease in price dispersion over the cartel period. Of the fourteen cartel episodes with *lower* average prices during the cartel period, roughly seventy-five percent also show a decline in price dispersion.

The British Government study also presents some anecdotal information on price (see p. XLIX): steel prices were "certainly raised" during the post-depression cartel period, but it is difficult to separate the effect of the cartel from the effects of the general recovery; mercury prices were "far higher" in cartelized markets; and, prices for dyestuffs were "100 to 200 percent" higher in 1936 (four years into the cartel period) than in 1913.

Finally, there is anecdotal evidence of price increases from the recent international price-fixing conspiracies uncovered by the Department of Justice. For example, the U.S. price

---

[54] 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)

[55] We do not know, for example, whether the 50 randomly selected "non-colluding" firms were in fact not colluding. We only know that they were not prosecuted for price fixing. We also don't know enough about the sample of the 50 prosecuted firms: Were they long-lived or short cartels? At what point were the profits measured (beginning, middle, or end of the cartel)?

for lysine apparently doubled in the first three months of the conspiracy. According to Mr. Gary Spratling, Deputy Assistant Attorney General, one recent cartel (still under investigation at the time of the interview) raised prices by 60 percent throughout the length of the conspiracy and another was able to impose annual price increases of approximately 26 percent. A Sentencing Commission report estimated that profits rise on average by ten percent of the selling price as a result of price-fixing behavior.[56]

Thus, we are left with a long list of questions: How profitable are long-enduring cartels? Enduring but unstable cartels? Or, reversing the question…how enduring are profitable cartels? Although no exact answers emerge from the existing empirical work, the studies reviewed here concur on a few general points:

- Concentration appears to increase both duration and success.
- Organization and the history of the cartel are clearly important, but difficult to measure.
- Cartels tend to reappear in some industries, and cartel duration may increase as an industry becomes more experience with collusion.
- Instability in the economic environment destabilizes cartels (in particular, unanticipated economic downturns can cause either failure of the agreement or a temporary price war)
- Cheating and entry are the most common cause of (non-war related) breakdowns

To summarize, why is it difficult to generalize about cartel behavior? It is not just a matter of many of the key variables being either unobservable or hard to measure. Nor is it just a question of simultaneous determination of many endogenous variables. It is the indeterminacy of the many theories of cartels which frustrates straightforward characterizations of cartel behavior[57]. Therefore, it is wrong to think about cartel behavior as a deterministic relationship. We need an approach that recognizes this theoretical indeterminacy, and locates those sets of industry, firm, and national characteristics which

[56] For the lysine case, see Garland and Thornton (1998). Mr. Gary Spratling's comment can be found in Adler (1998). The Sentencing Commission estimate is reported in Cohen and Scheffman (1989, pp. 342-43). Cohen and Scheffman raise strong doubts, however, as to whether the empirical literature supports this claim.

[57] In addition theoretical studies of cartels have yet to examine the some of the rich organizational structures that case studies of cartels have uncovered.

support a wide range of collusive outcomes and those sets of characteristics which do not. The final section proposes a bounds approach as a step forward. But before that we briefly review the contributions of selected case studies and then comment on the recent international price-fixing cases.

IV. Case Studies

Case studies provide us with a rich information set about a particular industry and its experience with cartel agreements. The equilibrium outcome in game theoretic models of collusive behavior turns on small differences in the information available to each player and the conjectures each player makes about 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 beliefs about how they will react in response to changes in strategy. By studying the interaction of one set of firms in depth, we can learn more about how expectations of future cooperation are affected by past management strategies. A case study might do a much better job of identifying these critical subtleties than the typical cross-section study.

1. Duration

Table 5 attempts to bring together some basic descriptive characteristics about those cartels that have been the subject of case analysis, i.e., number of firms, beginning and ending date or dates (if multiple episodes), cause of failure, and any information on profits or price-cost margins. Comparing Table 1 and Table 5, we find that cartel longevity for this set of twenty-two case studies selected is longer than the average for the cross-section studies discussed above. The average duration is 12.9 years (assuming these cartels ran from the first of the beginning year to the end of the final year, which will tend to slightly overstate the length for certain cartels that began or ended mid-year) rather than the roughly 4 to 8 year average found in cross-sections. However, the variance in cartel longevity for the cases reported in Table 5 far exceeds that for the cartels studied in cross-sections. The range of cartel duration is between 2 and 63 years with a variance of 213. It is hard to know whether this variance reflects a more accurate measure of the true variation in cartel longevity or whether scholars naturally 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 either case, the lesson learned once again is that cartels cannot be categorized as "short" or "long" – they are both.[58]

The most common cause of breakdown was substitution or entry, accounting for 10 of the cartel episodes listed or 48%.[59] That is far larger than the figures given in Table 3 for cross-section studies, although it is in the same neighborhood as Griffin's 33% figure. Tied for second and third are breakdowns due to WWI or WWII (4 of the cartel episodes or 19%) and Department of Justice action (also 19%). Trailing far behind are 2 cartel episodes, or 10% of the sample, that ended due to cheating. Only one cartel is recorded as ending due to coordination problems. The difference in the evidence presented in Tables 3 and 5 most likely reflects the economist's determination of what constitutes the end of a cartel. In industries where cartels recur, problems of cheating and coordination are often classified as a "pause" in cooperation, not its cessation.

2. Price Wars

There are only a few industries for which we currently have sufficient data to analyze price war patterns (see, for example, Porter (1983), Berry and Briggs (1988), Ellison (1994), Levenstein (1995, 1997), Gallet (1997), and Slade (1992)). The Joint Economic Committee data, studied by Porter (1983) and others, shows fairly conclusively that switches in conduct occurred in the late nineteenth century railroad industry.[60] Many studies find 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).

Characteristics of price wars other than their timing over the business cycle have been analyzed as well. For example, Fiona Scott-Morton (1997) studies cartel agreements in merchant shipping lines at the turn of the century. Her sample contains observations on 47 incidents where an entrant attempted to join a cartel in a particular shipping line. Scott-Morton finds that weaker entrants (less financial strength, smaller, less experience) encounter price wars. She reports that a "typical price war might last three months and feature a price drop of 50% to the ports the entrant has chosen to serve. Price decreases

[58] It also reinforces the point made above that there are inherent sample selection problems in cartel studies.
[59] Note that Sulfur #2 and the Uranium cartels list multiple reasons for breakdown.
[60] See Slade (1990a, pp. 531-32) for a complete discussion. Slade also points out that although empirical evidence on the JEC cartel demonstrates that booms in demand did not trigger price wars, we cannot conclude that unexpected downturns were the cause of price wars.

greater than 50% are also observed, as well as wars that lasted as little as two days or as long as one year." (p. 697)

3. Rate of Time Preference

There are numerous theoretical predictions regarding the importance and effect of time preference on the sustainability of collusion. Case studies have proven a much better ground for testing these predictions than the cross-sectional literature. For example, firms with a high debt-equity ratio are more likely to cheat on collusive agreements than those that do not face the impending threat of bankruptcy (Lamoreaux 1985). The age profile of a firm's investors can make a difference in its attitude toward collusion, as the future may matter more to younger investors than to older ones (Levenstein 1996, 1998)[61].

Spar (1994) emphasizes that it is the *personal* time horizons of managers that matters, and that their time preferences may be independent of market structure or other economic phenomenon (p. 27). Sonnenfeld and Lawrence (1978) present fascinating evidence on this issue, based on extensive interviews with executives and employees in the cartonboard industry (the subject of a broad investigation into price-fixing activities). They report a number of interesting results, for example: [62]

- "Our interviews clearly reveal that not all the factors contributing to price fixing come from the industry, economic, and technical factors we have considered. Some come directly from the companies themselves and the subculture of the industry; some are build into personnel pricing, sales, and legal staff practices."
- In a number of companies convicted, management almost exclusively appraised individual performance on the basis of profits and volume….[M]any of the lower officials see only strong pressures and inducements to 'get the numbers no matter what.'
- Concern over job security affected the incentive to engage in price fixing.

Inclusion of the interest rate in cross-sectional studies as well as case studies could enable us to establish maximum interest rates above which collusion is virtually impossible to sustain. A similar bound for debt service ratios would also, in principle, be possible to establish. However, the importance of idiosyncratic preferences of managers and owners

[61] While interest rates have not been included in most cross sectional studies of collusion, Marquez does find that higher interest rates are associated with shorter-lived cartels. Similarly, Barsky and Killian (1999) argues that OPEC's fluctuating success may be explained in part by changes in interest rates.

suggests the difficulty in measuring overall firm impatience. We will never be able to say that any particular industry will collude as the result of a fall in the interest rate, even though more industries will fall within the bounds of feasible collusion when the interest rate falls. Whether or not they enter into collusive agreements will depend on the other determinants of successful collusion.

4. Joint Sales Agencies and Product Differentiation

Joint sales agencies provide a mechanism by which cartels can increase observability. There is a long history of attention to joint sales agency in the anti-trust literature, see for example Levenstein (1995 and 1993) on joint sales agencies in bromine and salt. In the only treatment of the issue in the cross-sectional literature, Dick (1996) finds that the use of a single sales agent is associated with a decreased likelihood that a cartel will fail.

Because differentiated products have less elastic demand, collusion may be more successful in such markets. But there is a cost to product differentiation, as differentiation increases coordination problems. The empirical results suggest that the benefits from less elastic demand are outweighed by the coordination costs. For example, Asch and Seneca (1976) find that firms in homogenous markets were more likely to be convicted of illegal collusion. Griffin (1989) finds a negative relationship between product differentiation and the Lerner Index (a measure of a firm's ability to raise prices above marginal costs.) In industries where coordination costs are not too high, we may actually see cartels engage in strategic product differentiation. For example, in 1908 the Dow Chemical Company and the German Bromkonvention agreed to create different purity standards for pharmaceutical bromine products in the U.S. and Europe. By making it more difficult to substitute European and American bromine, it made demand less elastic in each region and increased the cartel's ability to raise price.[63]

5. Multi-market Contact

[62] See Sonnenfeld and Lawrence (1978), pp. 146-150.

[63] There is a significant literature on strategic product differentiation (e.g. in cereals) that illustrates that strategic differentiation can allow firms to charge higher markups, even in the absence of explicit collusion. Here we restrict our discussion to the impact of differentiation (strategic and not) on the stability and success of explicit cartels.

Another important area that case studies have contributed to immensely concerns the importance of multi-market contacts and the extent of repeated interactions. There is a small amount of evidence on the effect of repeated interactions across time. Williamson (1985) notes this phenomenon in his analysis of the railroad cartels of the late 1800's: "The early railroads evolved a series of progressively more elaborate interfirm structures in an effort to curb competitive pricing" (p.277). For Suslow's sample, the evidence appears to show that cartels experiment with different methods of organization as the cartel matures, e.g., they begin with productions quotas and move to export quotas.

Although industry cross-section research in this area is rare (Dick (1996) finds that cross-market linkages significantly decrease the probability of cartel failure), there are numerous case studies of the effect of repeated interaction across markets. Much of the work focuses on the airline and banking industries. For example, Pilloff (1999) reports that studies on nonbanking industries generally support the concept of "linked oligopoly," particularly for concentrated industries. [64] In the airline industry, the evidence suggests that airlines use their presence in a rival's hub to reduce the competitive intensity of that rival in the airline's own hub. (Gimeno 1999) Evans and Kessides (1994), who also study the U.S. airline industry, find that fares are higher in city-pair markets served by carriers with extensive interroute contacts.

Jans and Rosenbaum (1996) study 25 regional cement markets in the U.S. over the period 1974-89. They find that multi-market contact influences pricing in the industry, but the exact effect depends on whether the concentration of sales non-home markets is taken into account. The more concentrated are firms' sales in markets other than their home market, the further price diverges from marginal cost in the home market.

This review has highlighted how empirical studies have struggled to operationalize a body of theory. One problem is that beliefs and expectations cannot be empirically observed. The other is that measuring "contact" is not straightforward. Some studies simply use the number of contacts, others weight the "contact" variable by sales, while still others try to determine the number of contacts that are not purely random. The final measurement problem has to do with the outcome – whether the market more or less

[64] For studies of the banking industry see Rhoades and Heggestad (1985), who report mixed findings, and Gelfand and Spiller (1987) and Martinez (1990), who find support for multi-market theory. Mester (1987) finds that in the savings and loan industry *more* competitive behavior emerges between dominant firms with multi-market contact in highly concentrated markets.

competitive due to the increasing number of contacts. Proxies used most often are price-cost margins or stability of market shares.

V. Anecdotal Evidence From Recent International Price-Fixing Cases

A sample of recent international price fixing cases and the length of each conspiracy are given in Table 6. The data come from public sources: the press releases of the United States Department of Justice (DOJ) and European Commission (EC), newspapers and periodicals.[65] This is not a complete list of recent international price-fixing cases, but it encompasses most of the larger (and more newsworthy) markets where price fixing has been uncovered.

1. Duration

It is interesting that the average lifespan for this cross-section of "recent" cartels is on par with the "historical" cartels. The mean length reported in cross-sections of primarily pre-WWII international cartels was roughly 4 to 8 years, compared to an average of about 7.5 years for the cartels listed in Table 6. Once again the evidence shows that some conspiracies last only a year or two (aluminum phosphide, plastic dinnerware, stainless steel), while other conspiracies last nine, ten or even eighteen years, (with an allegedly forty-six year cartel in the soda ash market). Still, the variance in duration for recent cartels is similar to that found by Eckbo and Suslow if the soda ash cartel is excluded.[66]

None of the sources consulted thus far discuss any breaks in the conspiracy period. Instead, a continuous set of years, e.g., 1991-1995 or 1973-1981, is listed. It would be surprising if upon further research it turns out that none of these cartels experienced "pauses" or temporary breakdowns of the agreement. If that is true – if few or none of the cartels had bargaining price wars or punishment price wars – then something fundamental has changed about how cartels in the 1980s and 1990s operate. According to the Antitrust Division, at least some of these recent cartels had ups and downs in their

[65] Different sources sometimes give conflicting dates for each firm's participation in a given price-fixing conspiracy. It is not clear whether these conflicting dates are accurate, i.e., whether an individual firm joined the conspiracy in progress, or whether one of the sources is incorrect.

[66] The soda ash cartel was comprised of the two biggest players in the market, Imperial Chemicals Industries in the United Kingdom and Solvay of Belgium. ICI was involved in numerous successful cartels before World War II. These two firms apparently divided the market so that they were not in competition

prices during the cartel period. However, these pauses or breaks in the agreement were not serious enough or long enough for the Department of Justice to identify distinct conspiracies. Thus, all of the recent conspiracies appear publicly to be continuous.[67]

2. Cartel Activity Over the Century

Table 7 takes the list of recent antitrust indictments by the DOJ and the EC presented in Table 6 and adds to it the list of "historical" international cartels from the cross-section studies discussed earlier. The letters next to each product market (a, b, c, d) indicate whether the cartel episode studied was before WWI, between WWI-WWII, between WWII-1970, or after 1970, respectively. The year 1970 was chosen arbitrarily as the dividing line between past and present.

There are numerous products listed in Table 7 with both an "a" and "b" entry. That is, many industries engaged in cartel activity from the early 1900s through at least WWII. A handful of products show an even stronger pattern of recurring cartel activity over the years – as far back as pre-WWII and recently as the 1990s. Citric acid, coffee, copper, mercury, various steel products, sugar, and wood pulp all fall into this category. (Note that this count *underestimates* the true recurrence of cartels in certain commodities because it records only recent government cases. It does not include recent or recurrent legal activity in commodity cartels, such as tin or cocoa.) Therefore, either there are structural market conditions that are particularly conducive to cartel organization and/or experience with cartel activity and a history of cartel activity promotes further attempts at cartel pricing.

3. A Resurgence of International Cartels?

Does the evidence on international cartels in the 1990s suggest that there has been a resurgence of cartels or does the evidence point to greater antitrust enforcement efforts? If it is the former, do we have any evidence that the bounds of collusion have changed? Although we cannot know for sure, we can certainly say that part of the explanation is increased enforcement. The vast majority of the DOJ cases listed in Table 6 have been

---

with each other and had an agreement to keep out of each other's region. It was one of the longest standing cartels in Europe.

[67] Phone conversation with Mr. Scott Hammond, Senior Counsel to Deputy Assistant Attorney General Spratling, September 3, 1999.

filed since 1997, going undetected throughout the bulk of their price-fixing years (for example, food additives and sorbates conspiracies).

Motta and Polo (1999) argue in their recent paper that "if the Antitrust authority has limited resources, and is therefore unable to prevent collusion ex-ante, the use of Leniency Programs can improve the effectiveness of the policy, by sharply increasing the probability of interrupting collusive practices. Hence, in a second best perspective, fine reductions may be desirable because they allow to better implement ex-post desistence from collusion." (p. 3)[68] In fact, the Corporate Amnesty Program, revised in 1993, has been the major factor in unveiling price-fixing conspiracies. Mr. Gary Spratling, Deputy Assistant Attorney General, recently said that the Antitrust Division "has strived to make the Corporate Amnesty Program as attractive as possible to induce companies to self-report antitrust offenses. As a result of these efforts, the Amnesty Program is the Division's most effective generator of large cases, and it is the Department's most successful leniency program."[69]

The Corporate Amnesty program has been so successful that the Antitrust Division has expanded this program recently to a new "Amnesty Plus" program, which encourages firms who are targets of investigations in one market to bring evidence forward about a conspiracy in another market where they compete. By doing so, they can be given amnesty in the second market investigation, while also being given a discount in the fine associated with anticompetitive conduct in the first investigation. [70]

Clearly increased enforcement is part of the answer, but it is also possible that the number of cartels has increased. Although the truth is fundamentally unknowable, due to the clandestine nature of cartels, it may be possible in future research to assemble various pieces of the puzzle. One clue, for example, might be found by looking at recent patterns in cartel activity in countries where collusion is legal. One could also look at trends in customer complaints regarding cartel activity. (Complaints from customers about rising or fixed prices is an important source of information for antitrust authorities.) Finally, one could look at evidence on the increasing number of multinational enterprises and/or

[68] Motta and Polo (1999), p.3.
[69] Spratling (1999).
[70] Conversation with Scott Hammond, Antitrust Division, Department of Justice (1999).

increasing research and development alliances and joint ventures.[71] Although such trends do not directly imply an increase in cartel activity, they are one indicator of closer legal relations between large firms that may in turn make pricing coordination both tempting and easier to coordinate.

One can also speculate regarding the forces making cooperation easier or harder in today's global market. For example, alliances between competitors may make communication easier, which in turn tends to support more collusive market outcomes. However, the increasing ease and speed of communication can also help buyers gain information on pricing from a variety of competitors, which tends to undermine pricing discipline and collusion. The same type of opposing forces are at work in the increased globalization of many product markets: some markets have become vastly more competitive, disrupting oligopoly pricing, while others have gradually become more concentrated through a decade or two of merger activity. (Note that increased concentration through mergers does not necessarily imply that these industries will become less competitive, but it does reduce the number of players needed for a cartel, which in turn increases the ease of coordination.)

One interesting area for future study is the incidence of price wars in recent cartels. We mentioned earlier that recent cartels appear to have avoided deep price wars. Is it that companies have gotten better at colluding? Price wars are an extremely expensive method of punishment. It is possible that the recent cartels have found better ways to discipline would-be defectors. Or, it is possible that increased multimarket contact between firms implies that the collusive outcome is easier to support and therefore there are fewer price wars.

If we are to look for a trend in international cartel activity due to increasing global concentration, expanding multinational companies, or changes in technology that enhance communication and information sharing, we would need to trace back trends that began decades ago. Opinion on the question is divided. Some think that price-fixing attempts never declined after WWII, but instead went underground. (Mirow and Maurer 1982, pp. 8-9) Others argue that effective international collusion has undoubtedly declined since World War II. Caves (1996) notes that examples of international cartels

[71] See, for example, Cantwell and Barrera (1995). Cantwell and Barrera comment that technology-based international alliances between firms "mark the reappearance of an old phenomenon, and one that was well established in the interwar period." (p. 75). See also Freeman and Hagedoon (1994).

"still turn up" but that there is no comparison to the extent of such activity before World War II. He cites several reasons for the decline in international cooperation among multinational enterprises:

> "During 1945-55 many U.S. MNEs were successfully prosecuted under the antitrust laws for their earlier collusive behavior…After World War II many countries passed antitrust laws, and if these varied in toughness and degree of enforcement, they were still tougher than nothing at all. Partly in response to antitrust prosecutions, partly seizing the opportunity opened by the wartime destruction of their European competitors, U.S. MNEs shifted from cooperative behavior to aggressive behavior during 1955-65 and rapidly expanded the number of standardized product lines (i.e., not intensive in R&D) that they produced in Europe. With the successful recovery of Europe and Japan, far more 'significant' companies (actual and potential MNEs) came to operate worldwide in most industries than before World War II, and seller concentration measured at the *world* level probably declined in many of the more concentrated industries…Finally, the mix of important industries has shifted from those producing homogeneous primary materials (wherein the gap between collusive and rivalrous profits is apt to be large) toward those producing differentiated or heterogeneous goods (in which the differentiation supplies natural insulation to the individual seller while complicating the maintenance of collusion)." (Caves 1996, pp. 92-93)

The World Trade Organization (1997) notes that government authorities are taking an increasing interest in cartels and restrictive business practices, and cites four main factors for this renewed interest:

> "One is the perception that as governmental barriers are peeled back through successive rounds of trade negotiations, trade restrictions and distortions resulting from enterprise practices may be becoming relatively more important than before. Associated with this is the increasing integration of the world economy, spurred not only by trade liberalization but also by the vast expansion of foreign direct investment (FDI). Thus, anti-competitive enterprise practices have increasingly a transborder dimension…A further influence has been the growth of international

> rules…that protect the interests of foreign companies operating within a country's territory…Lastly, an important development has been the growing convergence of views…that competition law is often the appropriate legal means for addressing anti-competitive enterprise practices, even if convergence on specific details still has a considerable way to go." (WTO 1997 pp. 32-33)

What are the welfare implications of our answer to this question? If cartels are more prevalent, this might be a concern for policymakers. Many countries have recently made declarations denouncing "hard core" cartels. However, the second explanation (cartels are not more prevalent but they are only now being caught due to increased enforcement) is not as benign from a welfare perspective, especially as antitrust investigators have more and more success with plea bargains, fines, and jail terms and thus further increase their energies in this area. If surveillance by the government increases in the future (so that Antitrust Division staff devote increasing resources not only to aggressively prosecuting anticompetitive conduct that comes their way, but also actively watch over pricing in various industries), then firms will take measures to reduce the probability of a suit being brought against them. Firms who wish to avoid being investigated may well distort their investment and pricing decisions. In other words, aggressive enforcement and high fines can create inefficiencies.[72]

To conclude, we cannot know for sure if international cartels are becoming more prevalent. And since cartels are associated with a range of possible market outcomes, including occasional bouts of competitive pricing, using any one or indeed a restrictive subset of market outcomes to detect cartels is likely to be misleading for two reasons. First, some international cartels may go undetected. And secondly, some firms that are not engaged in an international cartel may nevertheless fall under suspicion. Instead, as was argued earlier, we need an approach which recognizes that many different circumstances can generate international cartels, and perhaps more important, to locate those observable circumstances where welfare-reducing international cartels cannot be

[72] As Cohen and Scheffman (1989) discuss (pp. 352-55), there are potentially significant costs to over-deterrence.

sustained. The latter could be used to filter allegations about international cartels, and we now turn to a discussion of the components of such a filter.

VI. Using A Bounds Approach to Filter Allegations about International Cartels

As is clear from the above discussion, neither existing theory not existing empirical work provide a straightforward rule of thumb for detecting cartels. One cannot simply look at the number of firms or market shares and determine whether collusion is taking place.

But all is not lost. The bounds approach, outlined by Sutton (1995), recognizes that often we cannot identify a unique equilibrium outcome for cartels or collusive arrangements between firms. We should instead look for a set of outcomes that could be potential equilibria and a set of outcomes that can be ruled out as possible equilibria. As Sutton puts it

> "Many quite different cartel models are available. Case studies of cartels show that different cartels do indeed behave in quite different ways. But even if we narrow the domain to a specific cartel over a specific period, we still fall short of any precision of predictions." (Sutton 1995 p. 68)

The point of the bounds approach is to find that set of market structures where (in our case) an international cartel cannot exist or is not welfare-reducing. For example, once the elasticity of demand grows exceeds a certain critical level (implying dozens of substitutes for the cartel's product) the welfare costs of any cartel must be minimal. Or, we could ask, is the market in question characterized by numerous circumstances which make cheating easy or detection and punishment difficult?

There are three advantages of the bounds approach. First, it is based on a wide range of theoretical models on cartels and empirical studies of cartels. Secondly, the required data are publicly available. Thirdly, the approach can be applied to a specific market across countries and across time. However, the bounds approach is not a substitute for a full investigation – it is just a filter. To the extent that the filter works it can save scarce enforcement resources.

Table 8 categorizes the myriad of factors that determine cartel activity, stability, and success. Next to each variable we list a possible empirical counterpart and a sample of the theoretical and empirical papers which discuss the variable's role. The table attempts to cover all those factors discussed in the previous section. However, in the discussion in this section, we focus on the most important factors such are barriers to entry (which captures both substitution by consumers and entry by firms), time horizon, extent of repeated interaction, volatility of demand, number of players (included and excluded), and the ability to punish defectors.

We would like to stress that if one is applying the bounds approach over time in a given industry, then the variables suggested in Table 8 will give some indication if the conditions for successful collusion are becoming stronger or weaker. If they are becoming weaker, then there is less likelihood of a cartel existing in the first place, or if a cartel does exist then there is a greater likelihood that the cartel will collapse or that the damage done by the cartel is smaller. In this case, the bounds approach can help antitrust officials determine what they should look for and where they should devote their scarce investigative and legal resources.

A. Barriers to Entry

Barriers to entry are a critical determinant of sustained price-fixing conspiracies. When firms do manage to coordinate their conduct on incentive-compatible collusive strategies, they create an incentive for outsiders to enter the industry. Coping with and preventing entry can undermine the best-laid collusive plans. In some industries it may be that firms resist the temptation to collude because they know that it would only lead to entry (which might, given any cost of exit, make the incumbent firms worse off). Barriers to entry are, therefore, crucial to long term cartel success. Contestability of markets, on the other hand, should undermine any fantasies of successful collusion.

Simply put, an increase in price will attract entry which will in turn undermine the cartel. Only if there are significant barriers to entry can a cartel raise price in the short-run without guaranteeing its own demise in the long run. (Of course, how short the “short

run" is compared to the "long run" depends on industry specific factors, such as technology.)

Barriers to entry are an industry specific factor. The questions to ask are: Can specific barriers to entry be identified? Have they changed over time? If there are no significant barriers to entry, or if barriers have fallen over time then it calls into question whether a cartel can exist and/or be sustainable.

Table 8 lists various (rough) empirical measures of barriers to entry. Note that barriers to entry exist not only in production but in distribution as well. If there is specialized information in distribution then entry may take longer. If there is a joint (or central) sales agency, then distribution may also be more difficult or more expensive for an entrant. If firms are vertically integrated into distribution, this may also deter entry. Finally, patents are one of the strongest ways to deter entry.

B. Time Horizon

Perhaps the single most robust result of the repeated game literature on collusion is that as players become more impatient (perhaps due to higher interest rates), collusion is harder to sustain. How cartel members value the future is vital in determining whether they will find it optimal to maintain the cartel price and forgo higher short-run profits (and lower profits in the long run when the cartel fails).

The rate of time preference is firm-specific, but is likely to be affected by national economic factors. The market interest rate can be observed and used as a proxy for the impatience of cartel participants. In addition to differences in the level of interest rates across nations, one can also question whether interest rates differ in their volatility across the countries where a possible cartel might have members. If so, cartel activity will be harder to coordinate. Finally, one can look at changes in the interest rate over time and ask whether that is likely to affect the sustainability of collusion.

The theoretical and empirical work discussed above also points to the importance of personal rates of time preference. In firms where ownership is divorced from control,

managers must have a clear incentive for their firms to join the cartel. If it is possible to observe the compensation packages of key managers, then this may shed light on their personal time horizons and their incentives to sign their firms up to a cartel. For example, if a firm moves towards a compensation schedule where managerial income depends increasingly on the stockmarket value of the firm (which is set in forward-looking equity markets) then this is conducive to collusion. More importantly, if managerial compensation scheme emphasizes short-run performance, or the compensation scheme weakens the link (or has no link) between pay and performance, then this would reduce the likelihood of successful cartelization. Differences in managerial compensation packages across countries and over time introduce further asymmetries that make coordination more difficult, with some managers having no clear incentive to join the cartel.

C. Extent of Repeated Interaction

Do firms compete or interact in multiple markets? Are these markets concentrated? Is there an increase over time in the number of multi-market contacts between firms? As firms' expectations of the number of repeated interactions they are likely to have with their competitors increase, so do the possible benefits of collusion. Since the number of times and places when cheating can be punished also increases with the extent of interaction, a price-fixing agreement among firms that meet each other in multiple markets can be more stable.

One critical point to mention is that in order for collusion to be supported by multi-market contact, firms must have strong barriers to entry in every market, which can be expensive to maintain. Therefore, barriers to entry and multi-market contact must be measured together.

Table 8 lists a few of the simpler measures of multi-market contact used in the literature. It is important to note that applying the bounds approach to multi-market contact is a bit different. Just because firms interact in only one market does not mean collusion is unsustainable. It could mean quite the opposite. As mentioned above, the theory is not unambiguous. Multi-market contact may also hinder coordination because informational

and monitoring requirements for maintaining collusive arrangements in any one market can increase substantially.

D. Volatility of Demand

Cyclical variance in demand, even when expected and observed, will change the relative benefits of colluding and cheating. At a minimum, demand fluctuations create coordination and complexity problems, as the optimal price changes whenever demand shifts. As the cross-section literature has found, economic instability is destabilizing for cartels. Also, demand growth can be destabilizing: at sufficiently high levels of demand, the incentive to cheat will be too high for firms to ignore.

Volatility of demand can be measured across time, across industries that the firms operate in, and across international markets. The correlation of movements in demand across each of these dimensions will matter.

E. Number of Players (Included and Excluded)

There is no clear evidence from empirical studies on bounds for the number of firms in a cartel. Most, but not all, cartels involve 10 or fewer firms, but "number of firms" rarely is significant in regressions with profits or duration as the dependent variable. However, concentration has been shown to be consistently and positively related to collusive success. It is possible that concentration reflects barriers to entry. But to the extent that concentration exhibits its own, independent effect on collusive success (as opposed to simply positively correlating with success and stability), it is probably because it is easier to design an agreement with fewer participants.[73]

[73] 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.

This concept of "fewness" occurs in Table 8 under both "Structure of Cartel's Market" and "Cartel/Firm Decision Structure." As discussed above, it may be that the number of decision-makers in a cartel is more important than the number of firms forming the cartel. The relevant questions are: How many firms form the cartel? Are cartel sales a major portion of world sales (there must be a lower bound to the cartel's market share)? Is there a dominant firm outside the cartel (this raises the supply elasticity of the "fringe" and make a successful cartel highly unlikely)? Has there been a major shift in the organization of the firm (or firms) that would lead to decentralized decision-making and an increased likelihood of price wars?

F. Ability to Punish

A post-World War II study by the British government (Great Britain Board of Trade, 1944) finds that most cartels go through periods of competition, suggesting that price wars are a common form of punishment.[74] These are perhaps the simplest, though certainly not the least costly, punishment strategy to implement. There is very little consensus in the literature about whether to treat these price wars as evidence of the difficulty in sustaining collusion or as evidence of the punishments that cartels have available to facilitate their own success. Antitrust enforcement can make it difficult for a cartel to punish its members, as such punishment would make the existence more obvious to the antitrust enforcement authorities.

Spar (1994) argues that since cartel maintenance requires continuous bargaining and is "best managed by those producers who are able to keep the circle of negotiators small, the rules flexible, and the power to retaliate as strong as possible" (p. 219). These issues reflect both the importance of being able to design effective punishments and being able to design a collusive mechanism that is flexible without incurring high coordination and transactions costs.

[74] Price wars are the only punishment considered in much of the theoretical literature, including Green and Porter (1984) and Abreu, Pearce, and Stacchetti (1986), Briggs (1996) and Lanning (1987). Case studies indicate that firms have been more creative in the design of punishments, as price wars are very expensive, and hurt non-cheaters as well as cheaters. Thus many cartels use an elaborate system of fines to avoid costly price war punishments.

Although we most often think only of tradable goods, there is a strong possibility that some of these internationally traded products have a service (unobserved post-sale) component. The stronger this component is, the greater the ease of cheating, and the lower the ability of rival firms to detect and punish. Service goods not only add another aspect of product differentiation to the mix, but an unobserved component as well.

VII. Concluding Remarks

What determines cartel success? Structure, such as demand, technology and cost parameters. Organizational factors, such as the power structure or voting structure within the cartel, the sophistication of any mechanism for detecting and deterring cheating. Exogenous factors, such as government regulations and anti-trust enforcement. And finally, idiosyncratic and history dependent determinants, such as how fast the organization learns about cartel design, start-up costs, reputation of cartel members. Economists have amassed a great deal of evidence on when cartels break down. We still have a lot to learn about why.

The "bounds" approach can be used to add skepticism regarding whether a cartel is feasible. For example, if a cartel is suspected in the chalk industry and an investigation reveals there is a chalk producer which is excluded from the cartel and whose market share is growing over time, then there should be a real presumption against the cartel being successful. However, if an allegation is not "filtered out" then a full investigation might follow.

Few economists have systematically looked at differences in industries with and without cartels. The one exception is Asch and Seneca (1975), who find some systematic differences between collusive and non-collusive industries. This is a major weakness in the literature. When cartels do exist we can turn to the literature to see if they share characteristics with cartels that have been weak or failed. We cannot yet systematically look at whether they share characteristics with industries that have been proven to have no history of collusion. Therefore, in its application to international cartels, the filter suggested by the "bounds" approach is necessarily be approximate. However, future research may well overcome this shortcoming.

References

Abreu, Dilip, David Pearce, and Ennio Stacchetti. "Optimal Cartel Equilibria With Imperfect Monitoring." Journal of Economic Theory 39 (1986): 251-69.

Adler, Howard Jr. "Interview with Gary Spratling: Dramatic Changes in Criminal Antitrust Enforcement." Business Crimes Bulletin 5, 5 (June 1998): 1-5.

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

American Bar Association, International Trade and Antitrust Task Force. Private Anticompetitve Practices and Market Access Barriers 1999, Draft Report.

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

Bagwell, Kyle. "Optimal export policy for a new-product monopoly." American Economic Review 81 (1991): 1156-1189.

Ballande, L. Essai d'étude monographique et statistique sur les ententes économiques intern." 1936. Paris: Librarie Technique et Économique.

Benoit, Jean-Pierre, and Vijay Krishna. "Renegotiation in Finitely Repeated Games." Econometrica 61, 2 (1993): 303-23.

Bernheim, Douglas, and Michael Whinston. "Multimarket Contact and Collusive Behavior." The Rand Journal of Economics 21, 1 (1990): 1-26.

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

Bresnahan, Timothy F. "Empirical Studies of Industries With Market Power." In Handbook of Industrial Organization Richard Schmalensee and Robert D. Willig, eds. Vol. 2. 1989. New York: Elsevier Science. 1012-57.

Bresnahan, Timothy F., and Peter C. Reiss. "Entry and Competition in Concentrated Markets." Journal of Political Economy 99,5 (1991): 977-1009.

Bosch, Jean-Claude, and E. Woodrow Eckard, Jr. "The Profitability of Price Fixing: Evidence from Stock Market Reaction to Federal Indictments." Review of Economics and Statistics 73.2 (May 1991): 309-317.

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

Cantwell, John, and Pilar Barrera. “Intercompany Agreements for Technological Development: Lessons from International Cartels.” *International Studies of Management and Organization*, Vol. 25, Nos. 1-2 (1995): 75-95.

Carlton, Dennis, and Jeffrey Perloff. Modern Industrial Organization. 1994. New York: HarperCollins College Publishers.

Caves, Richard. Multinational Enterprise and Economic Analysis. 1996. Cambridge: Cambridge University Press, Second edition.

Coalition for Open Trade. "Addressing Private Restraints of Trade: Industries and Governments Search for Answers Regarding Trade and Competition Policy." 1997. Washington DC.

Cohen, Mark A., and David T. Scheffman. "The Antitrust Sentencing Guideline - Is the Punishment Worth the Costs?" American Criminal Law Review 27 (1989): 331-366.

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

D'aspremont, Claude et-al. "On the stability of collusive price leadership." Canadian Journal of Economics 16, 1 (February 1983): 17-25.

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

Dick, Andrew R. "Identifying Contracts, Combinations, and Conspiracies in Restraint of Trade.” Managerial and Decision Economics 17, 2 (1996b): 203-16.

Djankov, Simeon D., Simon J. Evenett and Bernard Y. Yeung, "Decomposing the Growth of OECD Trade During 1970-96," 1999. Mimeo.

Domowitz, I., G. Hubbard, and B. Peterson. "Business Cycles and the Relationship between Concentration and Price-cost Margins?" RAND Journal of Economics 17.1 (Spring 1986): 1-17.

Eastman Kodak Co. "Privatizing Protection: Japanese Market Barriers in Consumer Photographic Film and Consumer Photographic Paper." Memorandum in Support of a Petition Filed Pursuant to Section 301 of the Trade Act of 1974, as amended. 1995.

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

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

Evans, W., and I. Kessides. “Living by the “Golden Rule”: Multi-market Contact in the U.S. Airline Industry.” Quarterly Journal of Economics 109, 2 (1994): 341-66.

Feenstra, Robert C. "Integration of Trade and Disintegration of Production in the Global Economy." Journal of Economic Perspectives 12, 3 (1998): 31-50.

Feinberg, Robert. "Mutual Forbearance as an Extension of Oligopoly Theory." Journal of Economics and Business 36, 2 (1984): 243-49.

Fraas, A., and D. Greer. "Market Structure and Price Collusion: An Empirical Analysis." Journal of Industrial Economics 26, 1 (1977): 21-44.

Freeman, Chris, and John Hagedoon. "Catching Up or Falling Behind: Patterns in International Interfirm Technology Partnering." *World Development*. Vol. 22, No. 5, (1994): 771-780.

Friedman, James. "A Noncooperative Equilibrium for Supergames," Review of Economic Studies, 28 (1971): 1-12.

Froub, Koyak, and Werden. "What is the effect of bid-rigging on prices?" Economic Letters 42, 4 (1993): 419-423.

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

Garland, Susan B., and Emily Thornton. "Justice's Cartel Crackdown." Business Week (July 27, 1998): 50.

Gelfand, Matthew D., and Pablo Spiller. "Entry Barriers and Multiproduct Oligopolies: Do They Forebear or Spoil?" International Journal of Industrial Organization 5 (1987): 101-113.

Genesove, David, and Wally Mullin. "The Sugar Industry Learns to Organize Information Exchange." In Learning by Doing in Firms, Markets, and Countries. Naomi Lamoreaux, Daniel Raff, and Peter Temin, editors. Chicago: University of Chicago Press, 1999.

Gimeno, Javier. "Reciprocal Threats In Multimarket Rivalry: Staking Out 'Spheres of Influence' In the U.S. Airline Industry." Strategic Management Journal 20 (1999): 101-128.

Graham, Edward M. Global Corporations and National Governments. 1996. Washington D.C.: Institute for International Economics.

Graham, Edward M., and Robert Z. Lawrence. "Measuring the International Contestability of Markets." Journal of World Trade 30, 5 (1996): 5-20.

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

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

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

Grindley, Peter, David J. Salant, and Leonard Waverman. "Standards WARS: The Use of Standard Setting as a Means of Facilitating Cartels. Third Generation Wireless Telecommunications Standard Setting." 1999. Mimeo. Law and Economic Consulting Group Ltd.

Guerrin, Maurice, and Georgios Kyriazis. "Cartels: Proof and Procedural Issues." Fordham International Law Journal 16 (1993): 266-341

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

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

Hendricks, K., and R. Porter. "Collusion in Auctions." Annales d'Economie et Statistique 15-16 (1989): 217-30.

Hoekman, Bernard, and Michael Kostecki. *The Political Economy of the World Trading System.* 1995. New York: Oxford University Press.

Hummels, David. "Towards an Geography of Transport Costs." 1998a. Mimeo. University of Chicago Graduate School of Business.

Hummels, David. "Transportation Costs and The Growth of World Trade." 1998b. Mimeo. University of Chicago School of Business.

Hummels, David. Paper Presented at the National Bureau of Economic Research's Summer Workshop on International Trade, Boston MA. 1999. [INCOMPLETE REFERENCE.]

Jacquemin, Alexis, and Margaret Slade. "Cartels, Collusion, and Horizontal Merger." In Handbook of Industrial Organization. Richard Schmalensee and Robert Willig, eds. Vol. I. Amsterdam: Elsevier Science Publishers, 1989. Chapter 7, pp. 416-73.

Jans, Ivette, and David I. Rosenbaum. "Multimarket Contact and Pricing: Evidence from the U.S. Cement Industry." International Journal of Industrial Organization 15 (1996): 391-412.

Krepps, Matthew B. "Facilitating Practices and the Path-Dependence of Collusion." International Journal of Industrial Organization 17.6 (1999): 887-901.

Krugman, Paul R. "Growing World Trade: Causes and Consequences." Brookings Papers on Economic Activity 1995, 1: 327-362.

Lall, Sanjaya. "Exports of Manufactures by Developing Countries: Emerging Patterns of Trade and Location." Oxford Review of Economic Policy 1998, 14: 54-73.

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

Lanning, Steven G. "Costs of Maintaining a Cartel." The Journal of Industrial Economics 36, 2 (1987): 157-74.

Lawrence, Robert Z. "Imports in Japan: Closed Markets or Minds?" Brookings Papers on Economic Activity 2 (1987): 517-554.

Lawrence, Robert Z. "Efficient or Exclusionist? The Import Behavior of Japanese Corporate Groups." Brookings Papers on Economic Activity 1 (1991): 311-330.

Lawrence, Robert Z. "Japan's Different Trade Regime: An Analysis with Particular Reference to *Keiretsu*." Journal of Economic Perspectives 7,3 (1993): 3-19.

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

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

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

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

Litvak, Isaiah, and Christopher Maule. "Cartel Strategies In The International Aluminum Industry." Antitrust Bulletin 2, 3 (1975): 641-663.

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

Martinez, John E. "The Linked Oligopoly Concept: Recent Evidence from Banking." Journal of Economic Issues 24, 2 (1990): 589-594.

Mirow, Kurt, and Harry Maurer. Webs of Power: International Cartels and the World Economy. 1982. Boston: Houghton Mifflin Company.

Morton, Fiona Scott. "Entry and Predation: British Shipping Cartels, 1879-1929." Journal of Economics and Management Strategy 6, 4 (Winter 1997): 679-724.

Motto, Massimo, and Michele Polo. “Leniency Programs and Cartel Prosecution.” 1999. IGIER Working Paper, No. 150. p. 3.

Neven, Damien, Penelope Papandropolous, and Paul Seabright. Trawling for Minnows: European Competition Policy and Agreements Between Firms 1998. London, United Kingdom: Center for Economic Policy Research

Notz, William N. "Representative International Cartels, Combines and Trusts" U.S. Department of Commerce. Bureau of Foreign and Domestic Commerce. Trade Promotion Series No. 81. 1929. Washington D.C.: G.P.O.

Nussbaum, Helga. "International Cartels and Multinational Enterprises." In Multinational Enterprises in Historical Perspective. Editors Alice Teichova, Maurice Levy-Leboyer, and Helga Nussbaum. 1986. New York: Cambridge 131-45.

OECD. *Open Markets Matter*, 1998. Paris.

Orr, D., and P. MacAvoy. "Strategies to Promote Cartel Stability", Economica, 32 (1965): 186-197.

Osborne, D.K. "Cartel Problems." American Economic Review 66, (December 1976): 835-844.

Parker, Phillip M., and Lars-Hendrik Röller. "Collusive conduct in duopolies: multimarket contact and cross-ownership in the mobile telephone industry." RAND Journal of Economics 28, 2 (Summer 1997): 304-322.

Pilloff, Steven J. "Multimarket Contact in Banking." Review of Industrial Organization 14 (1999): 163-182.

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

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

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

Porter, M.E., 1981, "Strategic Interaction: Some lessons from industry histories for theory and antitrust policy." In S. Salop, ed., Strategy, Predation and Antitrust Analysis. Washington D.C.: Federal Trade Commission. 449-506.

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

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

Rahl, James. "International Cartels." Competition in International Business. 1991. New York: Columbia University Press. 240-276.

Redding, Stephen J. "The Dynamics of International Specialization." 1999. Mimeo. Department of Economics, London School of Economics.

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

Ross, Thomas W. "Cartel Stability and Product Differentiation." International Journal of Industrial Organization 10 (1992): 1-13.

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

Salop, S. "Practices that (Credibly) Facilitate Oligopoly Coordination." In Joseph Stiglitz and G. Frank Mathewson, Eds., New Developments in the Analysis of Market Structure. 1986. Cambridge, MA: The MIT Press. Ch. 9, 265-290.

Saxonhouse, Gary R. "Differentiated Products, Economies of Scale and Access to the Japanese Market." In Robert C. Feenstra, ed., Trade Policies for International Competitiveness. 1989. Chicago: University of Chicago for the National Bureau of Economic Research.

Scherer, F.M. and Ross, David. Industrial Market Structure and Economic Performance. 1990. Boston: Houghton Mifflin Company.

Schmalensee, Richard and Willig, Robert (eds.) Handbook of Industrial Organization. 1989. New York: Elsevier Science Publishers BV.

Schmitt, Nicolas and Weder, Rolf. "Sunk costs and cartel formation: Theory and application to the dyestuff industry." Journal of Economic Behavior and Organization 36 (1998): 197-220.

Shin, Hyun Ja. "Possible Instances of Predatory Pricing in Recent U.S. Antidumping Cases." Brookings Trade Policy Forum 1 (1998): 81-97.

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

Slade, Margaret. " Price Wars in Price-Setting Supergames." Economica, 56 (1989): 295-310.

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

Slade, Margaret. "Cheating on Collusive Agreements." International Journal of Industrial Organization, 8 (4), (December 1990b): 519-533.

Slade, Margaret. "Vancouver Gasoline Price Wars: An Empirical Exercise in Uncovering Supergame Strategies." Review of Economic Studies, 59 (2), (1992): 257-76.

Sonnenfeld, Jeffrey, and Paul R. Lawrence. "Why Do Companies Succumb to Price Fixing?" Harvard Business Review 56 (1978): 145-157.

Spar, Debora L. "Of Cooperation, Competition, and Cartels." In The Cooperative Edge: The Internal Politics of International Cartels. Debora L. Spar (ed.). 1994. Ithaca: Cornell University Press. 1-36.

Spence, Michael. "Tacit Coordination and Imperfect Information", Canadian Journal of Economics. 11, (1978a): 409-505.

Spence, Michael. "Efficient Collusion and Reaction Functions", Canadian Journal of Economics. 11, (1978b): 527-533.

Spratling, Gary. "International Cartel Prosecutions: Antitrust Division Policies Relating to Plea Agreements In International Cases." March 1999: 1-35.

Sproul, Michael F. "Antitrust and Prices." Journal of Political Economy 101, 4 (1993): 741-753.

Stigler, George. "A Theory of Oligopoly." Journal of Political Economy 72 (1964): 44-

61.

Suslow, Valerie Y. "Cartel Contract Duration: Empirical Evidence From International Cartels." 1991. Mimeo. University of Michigan Business School.

Sutton, John. "Game-Theoretic Models of Market Structure." In Proceedings of the World Congress of the Econometric Society. David Kreps and Wallis (eds). 1995. Chapter 4.

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

Telser, Lester G. "Cooperation, Competition, and Efficiency." Journal of Law and Economics 28 (1985): 271-95.

Tirole, Jean. The Theory of Industrial Organization. 1988. Cambridge: The MIT Press.

Underwood, John. "Optimal Rules For Cartel Managers With Empirical Applications To The Copper And Tea Markets." Annals of Economic and Social Measurement (6-2-77): 231-243.

Vernon, Raymond. In the Hurricane's Eye: The Troubled Prospects of Multinational Enterprises. 1998. Cambridge, MA.: Harvard University Press.

Viscusi, W. Kip, John M. Vernon, and Joseph E. Harrington. Economics of Regulation and Antitrust Second Edition 1995. Cambridge MA: Massachusetts Institute of Technology Press.

Weinstein, David and Yishah Yafeh. "Japan's Corporate Groups: Collusive or Competitive? An Empirical Investigation of *Keiretsu* Behavior." 1992. Mimeo. Harvard University.

Whitman, Marina V.N. [INCOMPLETE REFERENCE].

Williamson, Oliver E. "A Dynamic Theory of Interfirm Behavior." Quarterly Journal of Economics 79 (1965): 580-607.

Williamson, Oliver E. The Economic Institutions of Capitalism. 1985. New York: Macmillan.

Wolff, Alan Wm., Thomas R. Howell, and John R. Magnus. "Trade and Competition Policy: A Suggested U.S. Strategy." November 4, 1998. Dewey Ballantine LLP.

Wolff, Alan Wm. "Unanswered Questions: The Place of Trade and Competition Policy In the "Seattle" Round." Paper delivered to an OECD conference on Trade and Competition Policy, June 30 1999. Paris.

World Bank. *The World Development Report 1999/2000, Entering the 21st Century: The Changing Development Landscape*. 1999. (Washington, D.C.: Oxford University Press.)**TABLE 1**

CARTEL LONGEVITY

(average cartel lifespan measured in years)

	Eckbo – Sample 1#[a]	Eckbo – Sample 2#[a]	Griffin/ Marquez[b]	Suslow	Dick
Average Duration	3.8[c]	4.6[c]	7.3	3.7[e]	5.3[f]
Variance of Duration	5.8	22.4	40	9.2	62
Duration Range	1 –18	0 – 18[d]	1 – 29	1 – 13	1 - 37
% 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 subsamples, 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 variances reported in the two papers are therefore extremely similar, but not identical.

[c] Average duration for "efficient" Sample 1 cartels (those able to raise price at least 200% above unit costs) 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 variance of 38 years. The mean duration of the 28 uncensored cartel episodes is 3.7 years with a variance of 9.2 years.

[f] 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 2

DETERMINANTS OF DURATION

(* = statistically significant)

Author	Dick	Marquez	Suslow
Number of Observations	93 industries 111 episodes	22 industries 52 episodes	45 industries 71 episodes
Dependent Variable[a]	Conditional probability of continued survival	Duration	Conditional probability of continued survival
Independent Variable			
Number of Firms	Pos*		Neg (# countries)
Cartel Concentration		Pos*	
Cartel Market Share	Pos*	Pos*	Pos
Patent involved			Pos*
Government involved			Neg
Market allocations			Neg* if set production quotas. Other measures (exclusive territories, export quotas) were positive but insignificant.
Single sales agent	Pos		Neg
Penalties			Pos*
Buyer size	Neg*		
Demand Instability	Neg* Coefficient of variation in quarterly export prices.		
Rate of demand growth		Neg	Neg* 1 if country's production index was below trend 6 months before cartel breakdown
Business Cycle	Neg More likely to collapse during downturn		Neg* 1 if cartel ended during peak-to-trough period of business cycle
Anticipated Cycle	Neg*		

Author	Dick	Marquez	Suslow
Unanticipated Cycle	Insig		Neg* Variables measure standard deviation of positive and negative residuals from trend
Experience	Pos*		Pos
Age in single episode	Pos* Cartel in 10^{th} year had 38-48% higher probability of dissolving than cartel in 5^{th} year		
Cross-market linkages	Pos*		
Period of activity before WWII		Neg* Average 3 years shorter	
Ended in 1939		Neg	
Interest rate		Neg	

Notes:

[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 "Pos," directly indicating an increase in cartel duration.

TABLE 3

CAUSES OF CARTEL BREAKDOWN

Causes of Cartel Breakdown	Eckbo – Sample 1	Eckbo – Sample 2	Griffin[a]	Suslow
Internal Conflict (cheating)	43.5%	58.6%	25.9%	23.9%
External – nonmarket (e.g., political, WWII)	30.4%		50.0%	39.4%
Supply-side Substitution or Growth in Fringe	13.0%		33.3%	15.5%
Demand	8.7%			
External, nec	4.3%	41.4%		2.8%
Technological Change			7.4%	
Antitrust Indictment				18.3%
TOTAL # EPISODES	*23*	*29*	*54*	*71*

Notes:

[a] The percentages used in this table are based not on Griffin's Table 4, but on his text, which says that 27 of the 54 cartels ended due to WWII, 18 ended due to substitution responses, technological change was important for 4 cartels, and behavioral reasons were the primary factor in 14 of the 54 cases. There is clearly double counting by Griffin, since these numbers add up to 63, rather than 54. Griffin indicates that at times interpreted the literature as suggesting that "more than one cause is attributed to a cartel's disintegration." (p. 198)

TABLE 4

DETERMINANTS OF PERFORMANCE

(* = statistically significant)

	Eckbo – Sample 1	Eckbo – Sample 2	Griffin
Number of Observations	23	28	22 industries 54 episodes
Dependent Variable	Efficient/Inefficient 9 / 14	Efficient/Inefficient 10 / 18	Lerner Index Avg =0.31. Range=(-0.12, 0.80)
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 = (50%, 75%))	Pos*
Cartel Market Share	0.9 / 1.14 (2 > 75%, 1 if (50%, 75%))	2 / 1.2	Pos*
Demand Elasticity	0.22 / 0.06 (1 = elastic)		Pos
Social structure/ Organization			Pos* (index from 1-10)
Cost differences across members	0.9 / 0.58 (1 = high cost firm produces at cost no larger than 50% above low-cost firm)		
Government involved	0.12/ 0.58 (1 = yes)		
Short-term substitution	0.22 / 0.43 (1 = short-term substitutes)		
Long-term substitution	0.77/ 0.43 (1 = long-term substitutes)		

TABLE 5

SUMMARY OF SELECTED CARTEL CASE STUDIES

Author	Industry	Firms	Beg date	End date	Cause of Failure	Profit	Price-Cost Margin	Notes
Baker, J.	Steel	8 firms covered 75% of industry	1933	1939	WWII			NRA made cartel agreement legally enforceable (1933-35)
Baker, W.	Heavy electrical equipment	40	1950	1958	DOJ proceedings			Investigated in 1959, indictments in 1960
Feinberg	Aspirin	4	1983	1987	Imports			Monsanto and Dow Chemical account for most U.S. aspirin production. The case deals with how this "cartel" was affected by a surge of imports in the mid-1980s.
Gallet and Schroeter	Rayon	2 major producers	1932	1940				Ordered to end price fixing in 1937, but persisted
Genesove and Mullin	Sugar #1	18	1887	1889	Entry		Prices rose 16% immediately after formation of ASRC	Cartel bought out new competitor after long price war; now control 95%
	Sugar #2	19	1892	1898	Entry			Market share declined slowly until two big competitors entered, triggering a long price war (1898-1900)
	Sugar #3	21 (never explicitly stated)	1900	1910	Antitrust action (never went to trial)			Cartel decided to voluntarily dissolve because of DOJ antitrust success against American Tobacco and Standard Oil
Grossman	Railroad express (parcel post)	5	1851	1913	Government creation of competing parcel post system			Controlled 80% of the market
Gupta	Tea #1	114	1929	1930	Coordination and bargaining problems (p. 161)			Output restriction voluntary before 1934, legislated after
	Tea #2		1933	1939	WWII		Prices rose 80% when output was restricted in 1933	

Author	Industry	Firms	Beg date	End date	Cause of Failure	Profit	Price-Cost Margin	Notes
Levenstein (1997)	Bromine	Around 5 major producers	1885	1914	WWI			
MacKie-Mason	Sulfur #1	US and Italy (Italy dominant)	1906	1916	Entry			
	Sulfur #2	US and Italy (US dominant)	1918	1956	Price war: Korean War shortages, new supplies in Canada and France			Webb-Pomerene; throughout this period, mines exhausted their deposits, and new firms entered
Porter; Briggs	JEC #1	3	1879	1881	Entry			
	JEC #2	4	1882	1884	Entry			
	JEC #3		1885	1886				
Teece, et al	Mercury #1	Spain and Italy	1928	1950	Price war caused by Italian firms cheating			Accounted for 80% of market in 1928
	Mercury #2		1954	1972	Entrants and new supplies			
	Uranium	France, Britain, Canada, Australia, South Africa	1972	1976	New supplies in Australia; threat of US gov't. action		Prices rose 700%	
	Diamonds		1934	present				

TABLE 6

RECENT U.S. DOJ AND EC ACTIONS

AGAINST INTERNATIONAL PRICE-FIXING CONSPIRACIES

Industry	Conspiracy Dates	Length (in years)
Aluminum Phosphide	1990	1
Bronze and Copper Flakes	1986-1988	3
Cartonboard	1986-1991	6
Citric Acid	1991-1995	5
Ferry Operators	1987-1994	8
Food Additives	1989-1995	7
Graphite Electrodes	1992-1997	6
Lysine	1992-1995	4
Marine Construction	1993-1997	5
Marine Transportation	1990-1995	6
Pigments	1984-1992	9
Plastic Dinnerware	1991-1992	2
Soda Ash	1945-1990	46
Sodium Gluconate	1993-1995	3
Sorbates	1979-1996	18
Stainless Steel	1994-1995	2
Steel Heating Pipes	1990-1994	5
Sugar	1986-1990	5
Tampico Fiber	1990-1995	6
Thermal Fax Paper	1991-1992	2
Uranium	1972-1975	4
Vitamins	1990-1999	10
Wood Pulp	1973-1981	9

23 cartels
Average length: 7.48 years (5.73 without soda ash cartel)
Variance: 83.44 (13.54 without soda ash cartel)

TABLE 7

PATTERNS IN CARTEL ACTIVITY ACROSS MARKETS AND OVER TIME

Key: a = cartel began pre-WWI (1914); b = cartel began 1915 - WWII (1939); c = cartel began 1940 - 1970; d = cartel began 1971 - 1999

	Historical Cross-Section Studies				Recent Cases	
Industry	**Eckbo**	**Griffin**	**British Govt.**	**Suslow**	**DOJ**	**EC**
acetic acid				b		
alkalis			a	b		
aluminum	a, b	a,b	a	b		
aluminum phosphide					d	
aniline dyes				b		
bauxite		d				
bromine					d*	d*
bronze and copper flakes					d	
calcium carbide				b		
cartonboard						d
cement						d
chemicals						d*
citric acid				b	d	
cocoa		d				
coal			a	b		
coke		b	a			
coffee		a,d				
commercial explosives			a	b		
copper (refined)	b,c	a,b,c	a	b	d	
cross-channel ferry operators						d
currency exchange fees						d
diamonds	b		a		d	
electric cables (high tension)			a	b		
explosives					d	
ferrosilicon				b		
graphite electrodes					d	
heavy electrical equipment				b		
hormones (synthetic)				b		
iodine	a					
incandescent electric lamps				b		
lead		b	a	b		
linen thread				b		
lysine					d	
magnesium (ingot and fabricated products)	b	b	a	b		
maltol (flavor enhancer)					d	
marine construction					d	
marine transportation					d	
maritime transport services						d
matches			a	b		

Key: a = cartel began pre-WWI (1914); b = cartel began 1915 - WWII (1939); c = cartel began 1940 - 1970; d = cartel began 1971 - 1999

	Historical Cross-Section Studies				Recent Cases	
Industry	**Eckbo**	**Griffin**	**British Govt.**	**Suslow**	**DOJ**	**EC**
mercury	b	b,c,d	a			
methionine (animal feed additive)					d	
military optical goods				b		
natural gas						d*
newsprint						d*
nitrogen		b	a	b		
nitrogen (synthetic)				b		
pharmaceuticals				b		
phosphate rock	b	b		b		
pigments					d	
plasterboard						d
plastic dinnerware					d	
plastics						d
plate glass			a	b		
platinum (and allied metals)		b		b		
polyethylene						d
polypropylene						d
potash (ore and related products)	b	b	a	b		
printing paper and stationary						d
PvC						d
quebracho extract	a,b		a	b		
rayon			a	b		
rubber (crude)	b	b		b		
rubber (sythetic)				b		
saccharine				b		
sawn softwood lumber				b		
sheet glass				b		
shipping (North Atlantic container traffic)						d
snap fasteners				b		
soda ash						d
sodium chlorate				b		
sodium erythorbate					d	
sodium gluconate					d	
sodium sulphate (crude)				b		
sorbates					d	
stainless steel						d
steel (crude and seminfinished)	b	b	a	b		
steel beams						d
steel pipe						d
steel tube						d
sugar (raw)	a,b,c	b,c,d		b		d
sulfur (crude)	b	a,b,c		b		

Key: a = cartel began pre-WWI (1914); b = cartel began 1915 - WWII (1939); c = cartel began 1940 - 1970; d = cartel began 1971 - 1999

	Historical Cross-Section Studies				Recent Cases	
Industry	**Eckbo**	**Griffin**	**British Govt.**	**Suslow**	**DOJ**	**EC**
tampico fiber					d	
tea	b	b,c		b		
thermal fax paper					d	
tin	b	b,c	a	b		
titanium products				b		
tubes (laminated)					d	
tungsten carbide (and related products)				b		
uranium		d				
vitamins					d	
wheat		b,c				
wood pulp (various types)				b		d
zinc (refined)		b	a	b		

Notes:
* currently under investigation

TABLE 8

DETERMINANTS OF CARTEL ACTIVITY

Variable	*Empirical Measure*	*Supporting Academic Work*[1]
ABILITY TO INCREASE PRICE		
Structure of Cartel's Market	• Number of firms as well as size distribution (is there one dominant firm that can provide discipline in the market?) • Cartel market share (sales as a percentage of world sales) • Industry concentration	• *Donsimoni (1986), Lanning (1987)* • Asch and Seneca (1975), Eckbo (1976), Fraas and Greer (1977), Bradburd and Over (1982), Scherer and Ross (1990), Suslow (1991), Alexander (1994), Marquez (1994), Rosenbaum and Mann (1994), Dick (1996b)
Cartel demand elasticity	• Number of substitutes (both current and potential if price were to rise)	• Eckbo (1976), Underwood (1977), Pindyck (1979)
Non-member supply elasticity	• Entry conditions, number of players in substitute goods markets • Ease with which production of substitutes could increase in response to higher cartel price • Number and identity of non-cartel members • Number of excluded firms from cartel • Size (market share) of excluded firms from cartel.	• *Donsimoni (1986)* • Underwood (1977), Pindyck (1979)

Variable	*Empirical Measure*	*Supporting Academic Work*[1]
Barriers to Entry	• Patterns in entry and exit over time • Capital costs • Minimum efficient scale as a percent of world output • Vertical integration into raw materials and/or distribution • Patents or patent agreements	• Dick (1996b), Grossman (1996), Morton (1997)
Number and identity of non-cartel members	• Number of excluded firms from cartel. • Size (market share) of excluded firms from cartel.	• *Donsimoni (1986)*
ABILITY TO ORGANIZE CARTEL		
Product heterogeneity	• Number of different products produced by firms. • Number of dimensions on which these products differ. • Producer (intermediate) good or consumer good	• *Ross (1992), Rothschild (1997)* • Hay and Kelley (1974), Asch and Seneca (1975), Griffin (1989)
Cost heterogeneity	• Differences in age of plants or technology • Differences in wages (e.g., union and non-union plants) • Differences in interest rates • Differences in grade or accessibility of raw materials	• *Rothschild (1999)* • Grossman (1996)
Capacity heterogeneity	• Differences in plant capacities and excess capacity	• *Rosenbaum (1989)*
Rate of time preference and time preference heterogeneity	• Market interest rate • Differences in interest rates across countries and/or over time • Managerial compensation scheme – does it emphasize short-run or long-run?	• *Harrington (1989), Stenbacka (1994), Verboven (1998)* • Lamoreaux (1985), Spar (1994), Levenstein (1996, 1998), Barsky and Killian (1999)
Government Assistance	• Government policies designed to aid or support cartel	• Baker (1989), Alexander (1994), McGahan (1995), Weinstein (1995), Hoffman (1995), Kreps (1997)

Variable	*Empirical Measure*	*Supporting Academic Work*[1]
Experience with collusion	• Prior known antitrust cases or cartel activity	• Suslow (1991), Dick (1996b), Spar (1994), Genesove and Mullin (1999)
INCENTIVE TO CHEAT		
Ratio of fixed costs to total costs	• Capital intensive technology	• Scherer and Ross (1990)
Cartel/Firm Decision Structure	• Company organization or major shift in organization • Degree of decentralized decision making	• *Cyert at al (1995)* • Sonnenfeld and Lawrence (1978), Gupta (1997)
Individual Firm Demand Elasticity	• Degree of product differentiation	•
Frequency of sales	• Commodity or custom-order products • Large, lumpy sales	• *Stigler (1964)*
ABILITY TO DETECT CHEATING		
Structure of Cartel's Market	• Number of sellers in the industry • Degree of product differentiation • Degree of vertical integration	
Structure of Buyer's Market	• Number of customers and their size. • Lumpy and infrequent orders	• *Stigler (1964)* • Hay and Kelley (1974), Dick (1996b), Levenstein (1999)

Variable	*Empirical Measure*	*Supporting Academic Work*[1]
Volatility of Demand	• Differences in business cycle across countries • Business cycle movements over time • Volatility in demand (especially unanticipated) • Growth in imports • Changes in tariffs • Degree of sunk costs (and effect of downturns)	• *Porter (1983), Rotemberg and Saloner (1986), Abreu et al (1986), Rothschild (1986, 1988), Slade (1990a, 1990b), Haltiwanger and Harrington (1991), Staiger and Wolak (1992), Damania (1994), Bagwell and Staiger (1997), Eswaran (1997),* • Lamoreaux (1985), Feinberg (1989), Hajivassilious (1989), Holcomb (1991), Suslow (1991), Marquez (1994), Ellison (1994), Rosenbaum and Manns (1994), Gallet and Schroeter (1995), Dick (1996b), Gallet (1997), Schmitt and Weder (1998)
Access to market information	• Trade association • Central sales agency/Joint distribution network • Homogeneous product (implies demand observability) • Secret discounts	• *Stigler (1964), Green and Porter (1984), Lanning (1987), Davis and Holt (1998)* • Suslow (1991), Levenstein (1995), Dick (1996), Grossman (1996)

ABILITY TO PUNISH CHEATING		
Speed of adjusting output or sales	• Type of product and type of manufacturing process	•
Non-price punishments, Capacity constraints, Contractual clauses	• Excess capacity • Meeting competition clauses or most-favored-nations clauses	• *Ayers (1987)* • Dick (1996b)
Multi-market Contact	• Number of markets in which firms overlap • Percentage of sales in overlapping markets and/or concentration in overlapping markets	• *Berhneim and Whinston (1990), Benoit and Krishna (1993), Spagnolo (forthcoming)* • Gelfand and Spiller (1987), Martinez (1990), Evans and Kessides (1994), McGahan (1995), Jans and Rosenbaum (1996), Caves (1996), Pilloff (1999), Gimeno (1999),

NOTES:

[1] Theoretical articles are italicized, empirical articles are shown in regular text; a few articles report the results of experimental research; PCM literature is not covered; some articles are cited that pertain only to U.S. cartels rather than international cartels. This is not meant to be a complete listing of the existing literature

Appendix

Description of Data Sets Used in Cross-section Cartel Studies

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

- Sample dates: 1958 – 1967 (p. 223)
- Number of observations: 101 large manufacturing corporations (p. 225)
- Scope: U.S. price-fixing cases(p. 225)
- Other
    - Sample consists of 51 firms found by the courts to have colluded and 50 randomly selected non-colluders
    - A firm is defined as a colluder if it was found guilty or entered a plea of nolo contendere in response to a Sherman Act conspiracy charge between 1958-1967.

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

- Sample dates: 1918-1965 (Dick doesn't state these years explicitly in this article, but he's using the same sample that he's used in other articles, and in those articles he gives these dates.)
- Number of observations: 111 (p.244)
- Scope: Webb-Pomerene export cartels
- Other: differentiates between "registered" and "active" W-P cartels (p. 246): a cartel is active if either
    - It operated a common sales agency to centralize order taking, billing, and shipping on behalf of members
    - The cartel set export price guidelines for the industry while leaving the logistics of shipping to member firms

Eckbo, Paul Leo. *The Future of World Oil*. Cambridge: Ballinger, 1976. (chapter 3)

- Sample dates: 1819 - 1964
- Number of observations: 51 cartels in 18 industries (p. 26)
- Scope: International cartels (p. 26)
- Other: Divided into two samples (p. 27)
    - Sample 1: 17 dimensions, 22 cartels (p. 31-32)
    - Sample 2: 5 dimensions, 29 cartels (p. 37)

Great Britain Board of Trade (1944), *Survey of International Cartels and Internal Cartels*, (2 vols., 1944 and 1946), London: Central Library, Department of Industry, 1976.

- Sample dates: World War I – World War II
- Number of observations: 125 primarily manufacturing products are surveyed.
- Other: Members of the British government gathered data on all private international industrial agreements to which British firms were parties before World War II.

Griffin, James M. "Previous Cartel Experience: Any Lessons for OPEC?" Chapter 7 in Klein, Lawrence R. and Marquez, Jaime (eds.) *Economics in Theory and Practice: An Eclectic Approach*. Dordrecht: Kluwer Academic Publishers, 1989.

- Sample dates: 1888 – 1984
- Number of observations: 54 different cartels, within 22 industries (p. 189-90)
- Scope: International cartels (p. 188)
- Other
    - includes renewable and nonrenewable resource cartels (p.188)

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

- Sample dates: 1888 – 1984
- Number of observations: 52 cartels (p.331)
    - Note that Marquez uses cartel sample and duration data from Griffin, but Griffin's sample has 54 cartels, not 52. Griffin (in Table 1 on pp. 189-90) includes "Copper V" and "Magnesium II". Marquez's Table 1 (p.335) does not have either of these cartels. Marquez does not say in the article why he dropped these two cartel episodes.
- Scope: International cartels (p.331)
- Other: Data on durability and market structure come from Griffin 1989 (p.333)

Suslow, Valerie Y. "*Cartel Contract Duration: Empirical Evidence from International Cartels,* mimeo, April 1991.

- Sample dates: 1920 – 1939
- Number of observations: 45 industries (p. 1)
- Scope: International cartels (p. 1)
- Other
    - International manufacturing and commodity cartels (p. 1)
    - European and U.S. cartel members (p. 3-4)
    - Explicit intergovernmental cartels and horizontal contracts with interlocking directorates excluded from sample (p. 4)