EXPLORING THE RELATIONSHIP BETWEEN BUSINESS CYCLES AND CARTELS

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ABSTRACT

The goal of this paper is to understand the relationship between cartel formation and the business cycle, looking to predict the profitability of collusion with respect to changes in macroeconomic activity and demand factors. After an overview of the principles of cartel behavior and a review of previous research and historical cases, I begin with an observational analysis of European Commission cartel decisions from 1984-2008. I map the start dates to macroeconomic data, but the evidence does not substantiate any one predicted pattern or provide a causal explanation.

I then move into a theoretical analysis, developing models to determine the profit stream from colluding versus choosing to deviate with respect to a dynamic level of demand. The model predicts that firms gain the most profit by deviating at the beginning of an economic expansion. By assuming that deviation decisions inversely mirror collusion decisions, the model implies an increased expectation for firms to decide to collude at the onset of a contraction.

The final section is a practical analysis of US Steel, a firm currently under investigation for alleged collusive behavior. A margin analysis of the firm’s financials supports and estimates the magnitude of the increased profits from participation in a cartel. Two regression models test the correlation between profit streams and overall Gross Domestic Product and product-specific demand. The results imply a positive relationship, corroborating the game-theoretical analysis. Taken as a whole, the three analyses suggest that an understanding of the business cycle and the current state of the economy can be used to relieve some of the uncertainty regarding cartel behavior, especially for prosecutors during cartel investigations.
INTRODUCTION

From 1990 to 2009, the European Commission has decided 82 cases regarding cartel operations in restraint of trade (European Commission 2009, 9). These cases are brought forth as violations of Article 81 (previously Article 85) of the EC Treaty, which prohibits “all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the common market” (European Commission 1992). In the United States, cartel cases are brought under Section 2 of the Sherman Antitrust Act, which serves the same purpose as the EC Article. Few in number, these formal cases are the tip of an iceberg of collusive behavior; the estimated annual probability of the European Commission detecting a cartel is roughly 13% (Combe et al. 2008). The OECD (2002) estimates that “on average, cartels produce overcharges amounting to 10% of the affected commerce and cause overall harm amounting to 20% of affected commerce,” leading to the troubling reality that consumers and other members of the industrial supply chains are impacted often without remedy (OECD 2002, 77). While a cursory understanding of microeconomic principles may suggest that investigating oligopolistic markets is the best way to find and prosecute cartels, such a market is neither a necessary nor sufficient condition for cartel formation or illegal activity. The tacit nature of most collusion makes investigations and prosecution complex and costly for federal courts, and cases are rarely discovered without an insider leak or a tip-off from a link in the supply chain. Courts and lawyers have tried to develop screening processes, but none have proved foolproof or accurate enough to apply universally.

A common thread in all of the studies of cartel behavior and collusive pricing is that certain market and economic conditions act as an incubator for cartel formation and collusion.
Undoubtedly, the level of growth in the economy has a profound effect on the decisions of firms to collude in the marketplace. I hypothesize that overall level of macroeconomic activity, GDP, and the specific product demand levels largely shape the decision to form and stay in a cartel by creating profit-based incentives for action. This paper will explore at how a firm’s profit varies in relation to these levels and how firms have behaved historically. I analyze the impact of the macroeconomy on a firm’s strategic decisions from a hypothetical lens and conduct a practical test of the hypothesis.

My analysis is structured as follows: I begin with a review of oligopoly theory and its relationship to cartel behavior. I then discuss the basics of collusion, explaining how cartels are formed, maintained, and what factors increase their profitability and success. After exploring the connection between these factors and the macroeconomy, I take a brief look at contemporary work on the subject in order to see if any common findings emerge. I then conduct a survey of the EC cartel decisions from 1984-2008, cataloguing the industry and start dates. By mapping these findings to macroeconomic data from Western Europe and the European Union (after its creation), I plan to trace patterns in cartel start dates with respect to levels of economic activity.

As this observational evidence does not provide any causal explanation, I further my argument with a game-theoretical model to determine at which point during the business cycle is collusion most profitable. The model represents the returns (payoffs, profits) received by the acting firm based on his decision to collude or deviate from cooperation at different levels of economic activity. The business cycle will consist of four periods, two with equal, high demand followed by two with equal, lower demand. The payoffs are compared by summing each of the individual action profits at each point of the cycle. Through these calculations, I determine at which point in the cycle it is most profitable for a firm to deviate from a collusive agreement and
when deviation is most expensive. Assuming that decisions to enter a cartel are the inverse of deviation decisions, these results imply an increased likelihood of cartel formation at certain points in history.

I close out my study with by testing my hypothesis using financial performance data from a company involved in a cartel. I use a margin-based analysis to estimate the profit in the absence of collusion (the “but for” margin), which confirms that profits were artificially inflated above normal levels during the cartel period. I then conduct a regression analysis using GDP and product-specific demand to examine the degree of correlation between profit and the business cycle. The ultimate goal of this paper is to suggest that an understanding of the business cycle and the current state of the economy can be used as a tool for prosecutors to allocate resources efficiently when investigating anticompetitive behavior and determining punishment.

I. COMPETITION UNDER OLIGOPOLY STRUCTURE

An analysis of cartel behavior inevitably involves the concepts of oligopolies. An oligopoly, loosely defined, is a market with relatively few firms that experience less competition than that of perfect competitors, but does not operate as a fully non-competitive monopoly. Understanding the fundamental characteristics, motivations, and impact on price and output behind the oligopoly structure is complicated but highly relevant to understanding cartels. Not unlike perfect competition, oligopoly firms face some constraints on price and output through interaction with each other, but the unique nature of the market and the strong barriers to entry allows for some realization of economic profits from a relative dominance of the market. The firms’ behaviors can be thought of as a collective monopoly; as a whole, they are able to produce below the competitive output level and charge a higher price than in perfect competition. Their
concentration and domination of market power allows them to realize an economic profit and can prevent each other and other potential entrants from diluting their status through retaliation.

The theoretical experiment in this paper uses a Cournot Duopoly game to model a non-cooperative, oligopolistic strategy. In a Cournot Duopoly, two firms producing homogenous products set production quantities simultaneously and independently. These quantities are decided by determining what action would maximize the firm’s payoff given the other firm’s action. These quantities are known in game theory as “best response” functions, and calculations of such are included later in the paper. Both firms produce the quantity that satisfies this condition, resulting in Nash Equilibrium. This equilibrium guarantees that neither firm could be made better off by a different choice. Thus, the outcome will be static and lasting as long as the parameters remain unchanged. The total quantity produced is greater than the total quantity of a monopolist. This quantity is inefficient in the eyes of the firms, because the quantity they produce is greater than what would maximize their joint profit (Watson 2008). This concept will be explained in the following section on cartel formation.

II. PRINCIPLES OF CARTEL BEHAVIOR

Most cartels form out of oligopolistic markets, the nature of which nearly forces participants to behave cooperatively and anticipate each other’s actions. The extent of that cooperation is what draws the line of legality. Cooperation to limit output and raise profits “is generally done by means of price fixing, allocation of production quotas or sharing of geographic markets or product markets […] collusion does not need to take the form of a full blown cartel. Less elaborate structures such as information exchanges can also lead to significantly higher prices” (Monti 2000, 3). Forming conjectures, plans that consider the expected reactions of competitors, is legal and often an optimal strategy given the conditions of the market (Connor
2001). Simply acting upon such conjectures without formally discussing or arranging strategies with rivals is considered *tacit collusion*, which is also not illegal. A typical example is when a firm follows suit and changes prices after an announcement by another firm in the market (Connor 2001). However, if the firms consciously enter into an agreement to fix prices or restrain trade in any other form, this *overt collusion* is punishable by law. According to Article 81, the EC considers the following practices taken by firms to restrict competition:

(a) directly or indirectly fix purchase or selling prices or any other trading conditions;
(b) limit or control production, markets, technical development, or investment;
(c) share markets or sources of supply;
(d) apply dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage;
(e) make the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts (European Commission 1992).

The U.S. Department of Justice adopts similar guidelines. The subsequent analysis focuses on overt collusion rather than tacit and considers the above practices in the real-world context.

**A. FORMATION**

Firms use a number of practices to carry out market cooperation by fixing prices, dividing market shares, and setting production quotas. Once firms act on the specified collusive parameters, the cartel is in action. The model introduced later in this paper concerns the decision to create a cartel, and the observational analysis matches cartel start dates to the status of the macroeconomy. But the concept of formation and creation dates is a complex and convoluted web of speculation, decisions, and actions without a clear definition. Defining the collusive parameters to establish the cartel is not cut and dry. The difference between the legal definition of a start date and the actual actions and practices of the firms is important, and I will attempt to outline and clarify this distinction.
When prosecuting cartels, the courts review hard facts to determine a start date for the purpose of assessing damages and issuing fines and punishments. Because a court ruling can be based only on indisputable or reasonably undoubted evidence, most start dates are related to initial meetings, document exchanges, or signed formal agreements. The durations later catalogued in the observational analysis section of this thesis are taken directly from official proceeding documents and reflect this legal definition; most were determined by the courts based on the signing date of an official agreement, price list, or secret meeting at which coordination plans were implemented. It is plausible to suggest that these meetings and agreements did not occur spontaneously without careful consideration, deliberation, research, and planning by the participants. More often than not, the organizational and planning stages of the cartel take place months or even years before the official, legal “start date.” To add more doubt to the accuracy of the legally-defined duration, the courts and firms often negotiate the start date as part of the plea. The dates specified in many cases are a rough estimate at best, and offer only marginal insight into the actual operations of the cartel.

In order to get a deeper perspective on cartel behavior, a thorough understanding of their formation beyond the arbitrary legal definition is necessary. Researching historical cartel cases reveals certain commonalities in the relationships among participants, the competitive and macroeconomic environments in which they operate, and the production and consumption characteristics of industries that are often cartelized. In *Cartels In Action*, George Stocking and Myron Watkins (1991) investigate the conditions leading up to a number of notable historical cartels. The similarities in the considerations mentioned above provide interesting insight into what could be a better definition of “start-up” for a cartel.
Stocking and Watkins (1991) detail the actions of international industrial cartels during the early 20th century, including WWI and up to the beginning of WWII: nitrogen, steel, aluminum, magnesium, incandescent electric lamps, the chemical industries, and alkalies and explosives. In each of these cases, the production characteristics and the global nature of the markets had a large impact on the motivations and structure of the cartel organization. Compared to the more recent cases used in the observational analysis section below, the historical cartels operated in a much more transparent fashion, often originally allowed, and sometimes created, by the government to protect or boost an infant or failing industry. For example, in the case of the nitrogen cartel, the Chilean government heavily regulated and protected the domestic market, allowing for complete control and stifling the competitive environment. In the steel cartel, the formal international accord specified that the cartel existed from September 30, 1926 to March 31, 1931; however, as a result of the WWI reparations settlement, Germany was not required to purchase French iron and steel duty-free, and a wave of international tariff barriers sprouted, serving to prohibit competition and return domestic control of markets (1991, 182). Often, tariffs, import and export quotas, and other legal, government-imposed trade restrictions helped facilitate the cartels and blurred the lines of official formation.

Intellectual property and licensing agreements are historical examples of conditions that served cartel interests before formal agreements were signed. In the case of the aluminum cartel, rapid scientific advances and technological innovations fueled the creation of an “independent business enterprise almost immediately” (1991, 220). Alcoa effectively controlled the entire domestic market as a legal monopoly due to its patent holdings. Competition and threats to its control came as new firms developed new processes and drove down the price. “To capitalize fully these monopolistic privileges they had first to settle conflicting patent claims,” and Alcoa
used litigation to get injunctions on other patents, blocking competition (1991, 221).

Internationally, Alcoa worked hard to monitor patent usage and acted quickly when it felt that new technologies were undercutting its patent monopoly. Though a formal bilateral agreement was signed in 1896 as a blatant antitrust violation, Alcoa granted one of the prevailing patents to a French company in order to threaten those competitors that were using other products in 1895. After legal action and other arrangements prohibited Alcoa’s direct involvement in the European and Canadian cartel, Alcoa still found ways to participate by owning a Canadian subsidiary and funding a new company that would be jointly owned by the European producers and the Canadian company. These investments and similar buy-outs of other, smaller companies gave Alcoa control without formal cartel participation (1991).

Furthermore, the magnesium cartel’s main participants, Dow, Alcoa, and American Magnesium Company (AMC, an Alcoa subsidiary), operated informally in much the same manner. Technology played an opposite role as it had for aluminum, though, as the high development costs of production insulated the industry from a high level of competition. Dow had a strong competitive advantage in production and offered to sell metal to AMC at a cost much lower than at what AMC could produce. Similar preferential treatment and patent cross-licensing agreements “had eliminated competition in magnesium production, greatly weakened it in the fabrication of magnesium alloys, and placed all potential competitors in either field at a sharp disadvantage without making irrevocable commitments” (1991, 284). In essence, the two companies were “living together” without a formal agreement (1991, 284). Later on, IG, a German company, sought to align itself with the United States’ producers by telling Alcoa and Dow that its production processes were more efficient and cooperation between the three would be mutually beneficial. IG conducted an investigation to see if its methods would be favorable to
the producers under American conditions. At the conclusion of the investigation but before
anything was decided, exchanges of letters revealed that managers at Dow had plans to initiate
“further conversations... looking to a community of interest” (1991, 285). The formal agreement
was not signed until 1931, which is the proposed cartel start date, if relying only on the hard
evidence for prosecution.

Perhaps the most notorious and referenced case dealing with patent pools and cross-
licensing agreements is that of the incandescent electric lamp industry, controlled by General
Electric in the United States. GE operated as a monopoly due to an exclusive patent of Thomas
Edison’s invention, and offered a cross-license with a competing patent to Westinghouse upon
expiration. In 1901, GE purchased 75% of the National Electric Lamp Company’s stock. The
NELC was comprised of companies that were all members of the Incandescent Lamp
Manufacturers, an association of six independent firms that fixed prices, divided markets, and
allocated customers (1991, 306). GE now essentially owned this operation, and the courts saw
this as an obvious antitrust violation. Legal action was taken to break up the anti-competitive
agreements. But GE found ways around resale barriers through wholesale and retail distributor
stipulations to affect competition in its favor all the same.

Beyond patent pools, cross-licenses, trade barriers, and preferential treatment, the
industrial environment and production parameters allowed for restriction of competition without
any agreement at all, presenting the obvious problem of determining an official start. Stocking
and Watkins (1991) note the conditions precluding agreements that served to cartelize the
industries without any formal arrangements: “Increases in the importance of fixed capital in the
production process, plant capacity in excess of normal requirements, and an inelastic demand all
made competition more hazardous and cartelization more attractive to the postwar incandescent
electric lamp industry” (1991, 325). As WWI brought down demand in most of the cartels mentioned, it also set the stage for postwar coordination. The idea of excess capacity and the elasticity of demand will be explored later, but it is important to note that they have a strong relationship to the skewing of an official start. As these cases show, cartel action often begins long before any legal agreements are signed or official meetings are held. Courts rely on documents of these meetings and conversations as evidence of cartel action; prosecution requires hard facts and indisputable proof, which ignores the prior events that often have the same or worse negative effects on competition. This will be an important consideration in the discussion of my observational analysis and theoretical model, but for now I will return to a more solid explanation of the conditions that the courts determine constitute a cartel formation.

**B. MAINTENANCE AND SUCCESS**

Overt collusion takes many forms, but the most common strategy is that of fixing prices above and output below the competitive level to secure higher profits. Each of the participants in the cartel operates at this arbitrary level and shares in the pool of higher profits. This type of overt collusion is called *joint-profit maximization* (Connor 2001). Raising prices unilaterally is considered tacit collusion and legal, but when conduct occurs bi- or multilaterally, it becomes a matter for antitrust analysis. The firms can alter the competitive environment through management of prices, market shares, and production, and by allocating customers. Some actions are transparent to prosecutors; if the firms print pricing lists or draft agreements to split customers, the courts have confirmation of cartelization to substantiate their legal action. As the historical overview shows, the firms seldom choose one strategy exclusively, using multiple avenues to curb competition in the market. Supply and demand laws dictate that increasing prices will automatically lower output and vice versa, but many cartels do both simultaneously to
mutually enforce the actions. Often, sales volume control is easier than price maintenance and a better indicator of cheating within the cartel (Connor 2001). Firms can easily restrict production volumes by forbidding plant expansions or investments. Producing below full capacity “insure[s] the cartel of long-term stability because capacity typically takes years to create and... discourages defection from the cartel” (Connor 2001, 25). Restricting production and sales to specific geographic regions to insulate and separate the domestic market from world competition is also highly common in international cartels. If these actions necessarily implied cartel behavior, the courts would have no problem with detection. But outside factors, such as a decrease in overall demand, can cause a firm to reduce capacity utilization. Increasing the efficiency of the supply chain often means creating relationships between suppliers and producers that could be called collusive, but in fact have more pro-competitive benefits that would outweigh any alleged cooperative harm. Courts often have to weigh the costs and benefits of actions in cartel litigation.

As is seen in practice from the evidence of the cartels discussed earlier, the success of the cartel depends on the continued cooperation of all participants and tight relationships between firms. The firms must share information on all aspects of production, including sales volumes, prices, and input costs. Certainty of the actions of rivals turns conjectures into cooperation, and each firm must monitor the relationship and actions of its competitors to ensure continued success. If any one firm were to cheat, the cartel profits would be undermined and the joint profit-maximization scheme would crumble. The cartel employs various monitoring and enforcement devices to maintain the system. It also must protect itself from detection by customers and the law, as paper trails from these monitoring, enforcement, and cover-up actions serve as prosecution fuel. One of the most commonly discussed tools of collusion enforcement is the Grim-Trigger punishment strategy. One firm deviating from cooperation is considered the
“trigger” that switches the game to noncooperative operation levels (Gibbons 1992). This noncooperative environment is “grim” in that it gives lower returns to the participants than if they had remained collusive. It works as follows: two colluding firms will operate at the joint profit-maximizing price and quantity until one firm deviates by increasing production to the most optimal level given the quantity produced by the other firm, known as the “best response.” Immediately, the non-deviating firm will punish the deviator by increasing production. It may seem intuitive that the punisher would increase production to take over the whole market, but doing so would drive his profit down to nothing, as he would produce until his marginal cost was equal to marginal revenue. A game-theory analysis reveals that increasing production to the quantities specified in the Cournot Duopoly model maximizes his profits. In every period following deviation, both firms will operate under the Cournot parameters, getting less profit than when they colluded. Enforcement must be severe enough to keep firms cooperating, but not so severe as to deter punishment. The Grim-Trigger strategy is used in the decision model introduced later. One can easily see the problem with blindly following this strategy; it is possible that outside conditions may make a firm appear to have deviated. Shifts in customers, decreasing regional or overall demand, and changes in costs from technology and other exogenous factors can all affect a firm’s operation.

C. MARKET CHARACTERISTICS

Characteristics of the market and the industry play an important role in cooperation success by reducing the impact of the exogenous factors identified above, such as lowered demand and economies of scale. Any change in operation increases suspicion and detection threats; frequent punishments and alterations to keep collusive agreements can be red flags to prosecutors. Because overt collusion is so strictly punishable under the Sherman Antitrust Act in
the United States and the EC Treaty in Europe, the potential gains from collusion must be much greater than the threat of getting caught to entice any firm to operate under a cartel. Many studies and investigations in both oligopoly and cartel theory suggest conditions that predispose an industry to cartel formation (Blair and Kaserman 1985; Dick 1996). These pre-conditions, many of which were discussed in the historical cases, support the formation of the cartel, bolster the ease of profitability, and limit the threat of detection. The characteristics are neither necessary nor sufficient to create a blanket rule for antitrust investigation, but they are a powerful tool in screening industries for collusive behavior. It would be relevant for courts to investigate the environments and actions, especially patent holdings, license agreements, and trade barriers, when determining whether or not a formal cartel exists.

Because the courts must prove that the actions of firms necessarily restrict trade and harm competition to condemn them under antitrust law, economic analysis of the markets and empirical tests provide the majority of the testimony in antitrust cases. Evidence of secret meetings, price lists, and the like can be a helpful confirmation for the DOJ, but the economic effects of these actions are what makes a case against the colluding firms. As shown above, firms use a wide variety of tools to circumvent the per se illegality of naked price fixing and coordinate their production to cartelize their markets. A court must show that these actions necessarily imply collusion to make a case against the cartel. Posner (2001) argues that this economic approach to cartel prosecution is more effective than the “traditional legal approach, which is based on proof of conspiracy” (Posner 2001, 69). He puts forth a two-step analysis, first identifying markets that are predisposed to collusive activity. This step is necessary to efficiently allocate the time, energy, and other resources involved in prosecution. Certain actions and decisions taken in a market lacking characteristics to facilitate collusion may produce no
evidence of cartel behavior; when paired with a concentrated seller market facing inelastic
demand, these actions almost indisputably imply collusion (Posner 2001). Based on the
assumption that cartels form only when the benefits outweigh the costs, these market and
industry conditions, which will be discussed in the subsequent section, are significant in two
ways: they increase the possibility and profitability of collusion and also lower the potential costs
and the risk of detection. These are not mutually exclusive or rival distinctions, and most of the
criteria support both the formation and the sustainability of the cartel. Brief considerations of
certain characteristics are necessary to understand their application and role in the screening
process.

The seller market in cartel cases is usually small and concentrated. Market concentration
is commonly determined by the “Herfindahl-Hirschman Index.” It is equal to the summation of
the square of each firm’s market share.¹ While some analysis uses a simple calculation of the
combined share of the top four or eight firms in an industry, the HHI accounts for the structure of
the market beyond the top-selling firms. Posner (2001) argues that the inclusion of the outside
firms is necessary for evaluating price conspiracies. An HHI close to 10,000 (in which one seller
holds 100 percent of the market) HHI implies a small number of firms. One caveat of this test,
however, is that a single number for the HHI does not yield any insight into changes in inter-firm
disparity or in the number of fringe sellers. The United States Department of Justice and the
Federal Trade Commission use this index to analyze the competitive effects of a merger, but it is
also applicable in the consideration of possible cartel behavior. The FTC divides the continuum
of indices into three regions: below 1000 is unconcentrated, between 1000 and 1800 is
moderately concentrated, and above 1800 is highly concentrated (US. Department of Justice and

¹A market where four firms hold ten, thirty, fifteen, and twenty percent market share respectively with twenty
percent held by outside competitors have an HHI of 1625.
the Federal Trade Commission 1997, 15). Economists search for the “magic number” of concentrated firms, but disagreements between researchers leave no firm conclusions (Connor 2001, 32). One study suggests that cartel formation is unlikely with a Herfindahl index of less than 2000. All can agree that the best number of firms to facilitate a cartel depends on the industry and the product in question.

Concentration is important for ease of cooperation, as the oligopoly model clearly asserts. Firms need to communicate to maintain prices and impose other restrictions; it is obvious that the tighter the circles of participation, the easier maintenance will be. Concentration also helps to mitigate cheating, which would undermine the cartel and possibly offer a red flag to investigations. According to Posner (2001), “the fewer the sellers in the colluding group, the easier it will be to tell whether a loss in sales is the result of price cutting by another member of the group” (2001, 68).

Continuing the analysis with oligopoly theory, it logically follows that entry into the market must also be slow or subject to high barriers to decrease the likelihood of new participants diluting the concentration. The barriers may come from high initial production costs or expensive technology, but the participants may also block entry through product standards or reducing prices so low that entry is unprofitable. Conversely, low concentration in the buyer market aids in price maintenance and the ability of firms to detect cheating of cartel participants. The difficulty in quantifying this concentration, however, contributes to the low amount of “empirical verification […] that low buyer concentration facilitates cartel behavior” (Connor 2001, 33). The firms are also likely to produce homogenous and standardized products, so that differentiation is not possible and pricing lists and standards are constructed easily. If the
products were too different or input costs too different, maintaining a price-fixing regime would be too costly and complicated for collusion to be profitable.

III. RELATIONSHIP BETWEEN COLLUSION AND THE BUSINESS CYCLE

There are a number of other characteristics based on oligopoly theory that hold weight in aiding cartel formation. Two are closely related and imply a tie to the business cycle hypothesis. Excess capacity in production and the level of market demand can both influence the feasibility and incentives for forming a cartel.

A. EXCESS CAPACITY

Excess capacity is linked to the business cycle by its connection to declining demand. Producing below capacity is not uncommon as a unilateral action in certain industries, but the sudden appearance of a group of firms all operating with excess capacity is a strong indicator of price-fixing schemes. The output level generally falls with cartel formation, and thus whatever the firms were producing at the competitive price becomes surplus. Strategic excess production capacity deters firms from entering the industry, keeping concentration among sellers high. As has already been discussed, blocking entry is paramount to cartel maintenance. Lieberman (1987) explores excess capacity as a deterrent, and finds a linkage in cases with high market concentration and low demand. Whether growth follows a predictable pattern or the market is subject to random and violent shocks, the ability to hold excess capacity decreases over time, undermining its utility as a barrier.

Excess capacity is not unique to cartels, however. Unilaterally, a firm may hold excess capacity to cope with cyclical demand. A good example would be a company that produces Christmas lights, which are only in high demand during the winter months. It follows that industries facing cyclical or seasonal demand are already predisposed to hold excess capacity.
Cartel formation in such industries by using this as an entry barrier faces less likelihood of detection. When demand declines overall, the same non-collusive, unilateral strategy becomes the default for all industries. In so far as gross domestic product represents demand to some extent, there should be a link between the business cycle and the formation of cartels.

B. LEVEL OF MARKET DEMAND

Characteristics of market demand are also important in determining the pricing behavior of cartels in operation, their profitability, and the sustainability of collusion. The elasticity of demand (its sensitivity to changes in price), affects the profits of the cartel participants. Inelastic demand at the competitive price is another factor that sustains collusive behavior. When demand is inelastic, the firms’ price increase of \( x \) percent causes a \( y \) percent decrease in output, with \( y < x \). This is consistent with oligopoly behavior; it allows the cartel to raise prices and restrict output. As they do so, the total revenue of the cartel increases, and thus increasing price is profitable up until the point where demand becomes elastic.

But more important than the elasticity is the level of demand in the market and the economy. The relationship between demand and collusion rests heavily on the principle that cartels are sustained through the threat of punishment. Deviation from the pricing scheme to reap greater short term profits must have severe enough consequences to deter its use. “Punishment is adequate when the net present value of the attempt to grab market share is a loss” (McAfee 2002, 120). In most cases, deviation causes a brutal price war among firms; when one lowers prices the rest immediately follow suit to undercut each other. Often, this price war is triggered by a pre-set value. If market demand declines enough to lower price to this value, policing becomes extremely difficult. The cartel is unsure if the price war was triggered by low demand overall or by a single firm’s action. This is one reason why collusion is difficult when demand is declining.
Even in the absence of an automatic Grim-Trigger strategy, declining demand changes the strategic decisions of cooperating firms by lowering the profits of their actions. The remainder of this paper will explore the relationship between the level of demand in the macroeconomy and the profitability of different cooperative and non-cooperative strategies. I will begin with a short review of the existing views in the literature, taking note of differing assumptions and the conclusions they present. I present an observational study of cartel behavior with respect to the business cycle taken from European Commission cases over the past two decades. I will then introduce the cycle payoff model and explain my findings. I conclude with potential implications for cartel investigations.

C. LITERATURE REVIEW

In a paper published in the March 2006 Journal of Economic Literature, Margaret Levenstein and Valerie Suslow investigate the sustainability of cartels with respect to different aspects of their operation. The authors discuss incentive structure, entry barriers, and concentration as possible determinants of cartel success, but their research is limited to epidemiological and observational studies, using outcomes from empirical work of other authors to test their claims. Their paper touches briefly on the relationship between demand and collusion, providing a short overview of other studies on the subject. The studies Levenstein and Suslow (2006) examine are contradictory. One finds that export industries support collusion, while another finds that collusion is more correlated with low sales growth (Levenstein and Suslow 2006, 65). Based on a number of these studies, they summarize their “non-findings” by showing that half of the cartels studied formed during downturns, and the industry cyclicality of those was mixed (2006, 68). My observational study presented later takes a different approach,
gathering information straight from the European Commission cases, not from previously
c Conducted empirical studies.

Other notable investigations on the subject yield similarly contradictory results. The 1984 study by Green and Porter predicts that unobserved negative demand shocks create price wars, while the 1984 Rotemberg-Saloner (RS) model that shows that price wars arise during economic booms (Levenstein and Suslow 2006). The RS study assumed no relationship between future and current demand, finding collusion more difficult when demand was high. This was supported by the intuition that gains from deviation would be high when demand was high because future expectations are irrelevant if demand shocks are observable (Rotemberg and Saloner 1984). A follow-up to the RS paper done by Haltiwanger and Harrington (HH) in 1991 changes this assumption and specifies that over time, market demand is cyclical, and the expectations of firms also change. The RS study presents a static view of the business cycle, which HH argues is unrealistic in its assumptions. The HH study defines a boom in the business cycle as any point when demand is increasing, not merely high, which they claim is “consistent with the standard (e.g. NBER reference cycle) chronology of booms and recessions” (Haltiwanger and Harrington 1991, 91).

In response to the discrepancy in findings based on assumptions, Rotemberg and Woodford’s 1991 “implicit collusion” model attempts to combine elements of the two studies. Though the model is applied in the context of pricing and markups, the intuition behind its development serves as the background for my theoretical work. Assuming that collusion is maintained through the threat of a price war if one firm reduces prices to reap short-term gains, “an increase in expected future profits thus reduces the incentive to deviate” because the firm could hold out until demand increases (1991, 70). Gallet and Schroeter (1995) tweak and test the
RW model against the United States’ rayon industry during the 1930s. Their study supports the “implicit collusion” intuition, finding that coordination degrees “fall when demand is high and when the expectation of future profits is lower” (1995, 193).

The previous research on the relationship between business cycles and collusion focuses heavily on pricing schemes to illustrate collusive behavior over the business cycle. These models are inadequate in answering the question my paper seeks to ask: how does the decision to collude, not the pricing strategies, change with respect to the status of the macroeconomy? The Gallet and Schroeter (1995) model is closer, quantifying the level of coordination among firms. They follow an econometrically-based approach “within the context of an optimization model” ultimately to test the RW predictions “through investigation of the relationship between conjectural variations and both current demand and future expected collusive profits” (Gallet and Schroeter 1995, 183). Other research relies on price-cost margins and other observable indices as the appropriate gauge of market power, which generally support the opposite idea that coordination is lower when demand is lower.

Because I believe in the intuition behind the RW and the GS models, my model will be based on the profit-maximizing decisions of firms with respect to the level of demand in the economy. I begin in a observational context, looking for a relationship between cartel formation and the business cycle. Determining whether or not any relationship exists in reality lays the foundation for determining causation. Though the observational study is seemingly inconclusive, I continue with the theoretical model and explain possible sources of error, concluding with applications of the findings.
IV. DATA ANALYSIS

A. OBSERVATIONAL ANALYSIS

I begin with a survey in which I catalogue key characteristics about European Commission cartel cases over the period from 1986-2008, summarized in Table 3. I used European data because of its availability and the detailed publications of the European Commission. I recorded only cases that charged the parties with infringement of Article 81 (previous 85) of the EC Treaty, which outlines the legal stipulations of interfirm conduct. I assign sectors based on my interpretation of the nature of the products. The number of participants denotes the number of participating, not necessarily charged, undertakings, not including subsidiaries and jointly-operated firms (those with notable differences are in parentheses). Duration is recorded as defined by the Commission ruling, though many noted a margin of error of a few years in the dating, as evidence is often hard to come by. Table 1 summarizes the findings, listed by start date.

The next step in the analysis maps the start dates against macroeconomic data. The aggregate GDP of Western Europe from 1986-2007 (most recent data available) revealed four major periods of economic downturn: 1980-1985 ($2,116,877 - $1,644,912); 1988-1989 ($3,099,438 – $3,093,507); 1992-1993 ($4,466,334 – $4,296,657); 1995-2000 ($5,375,250 – $4,312,394) (United Nations Statistics Division). These GDP values are measured in current $US. The UN Statistics Division converts the current prices in national currency using ”price-adjusted rates of exchange (PARE)” to eliminate “distorting effects of uneven price changes that are not well reflected in exchange rates and that yield unreasonable levels of GDP expressed in US Dollars” (United Nations Statistics Division). Figures 1 and 2 show the aggregate data of Western Europe in total and broken down by sector.
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<td>2005</td>
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Source: [http://ec.europa.eu/competition/cartels/cases/cases.html](http://ec.europa.eu/competition/cartels/cases/cases.html)
Figure 1: Western Europe GDP

Source: United Nations Statistics Division

Figure 2: GDP by expenditure (sector)

Source: United Nations Statistics Division
In mapping the findings from the case analysis to the economic data, I found similar results to the Levenstein and Suslow (2006) “non-findings.” I found that 53.93% of all cases began during the recessionary periods. In the two sectors with higher than ten total cases, chemicals and industrial supplies, the findings were mixed at 31.82% and 81.25%, respectively. The full results are summarized in Table 2 and Figure 3.

Table 2: Cartel start dates mapped to recession periods

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</table>

Source: http://ec.europa.eu/competition/cartels/cases/cases.html
Not only are these results unremarkable and inconclusive, they also do not make any statement regarding cause and effect. They are merely an epidemiological survey, which does not provide a convincing argument, but does open the door for further investigation. Thus, I will round out my paper with the explanation of my theoretical model, potential implications, and conclusions of my finding.

B. THEORETICAL MODEL

Given the relatively unconvincing evidence from the EC case survey, I sought to investigate the business cycle-strategy relationship on a practical level. The following model is designed to test at which point in the business cycle collusion would be most difficult by creating a numerical representation of the profit-maximization. The intuition is that firms will deviate from the collusive agreement when future profits are expected to drop, in order to reap the
highest possible current gains. The model thus calculates the acting firm’s payoff function at each stage of the business cycle dependent upon his decision to maintain the cartel or deviate.

The model follows a game-theoretic approach to determining the firm’s payoffs. The parameters of the game are as follows:

There are two firms, $i$ and $j$. The firms each face the same demand given as $P = (a_{t} - Q)$, such that $Q = q_i + q_j$, and demand varies over the course of the business cycle. The cycle is four periods that follow a pattern of expansions and contractions: two periods of high demand and two periods of low demand. An expansion sets $a_t = a_H$, and a contraction sets $a_t = a_L$, such that $a_L < a_H$. This gives the firm four decision points, one at the beginning and end of each expansion and contraction. Additionally, each firm faces constant and equal marginal cost of $c$.

The general form for the payoff to firm $i$, $\pi_i$, in one period is found by subtracting total cost from total revenue:

$$\pi_i = (a_{t} - Q)(q_i) - q_i c$$ where $Q = q_i + q_j$

When firms are operating as a cartel, they act as a single firm exercising monopoly power over the market. Each firm produces half of the monopoly quantity, hereafter referred to as the cooperative quantity $Q_C$, such that $q_i = q_j = \frac{Q_C}{2} = 2q_i$ and receives half of the monopoly profit. Thus, the payoff to firm $i$ is:

$$\pi_{iC} = (a_{t} - 2q_{iC})(q_{iC} - q_{iC} c)$$

$$= a_{t} q_{iC} - 2q_{iC}^2 - q_{iC} c$$

---

2 Values calculated under this condition are denoted by the subscript $C$. 
To maximize his payoff, firm $i$ will produce at the quantity where marginal revenue equals marginal cost. I solve for this quantity by taking the derivative with respect to $q_i$ of the payoff function and setting it equal to 0:

$$a_i - 4q_{iC} - c = 0$$
$$q_{iC} = \frac{a_i - c}{4}$$

The total market quantity is the sum of each firm’s production.

$$Q_C = q_{iC} + q_{iC} = \frac{(a_i - c)}{2}$$

From these values, firm $i$’s payoff,\(^3\) as a function of $a$ and $c$ is:

$$\pi_{ic} = (a_i - 2q_{iC})(q_{iC}) - q_{iC}c$$
$$= \frac{(a_i^2 - 2a_ic + c^2)}{8}$$

In each period after firm $i$ deviates,\(^4\) we assume a Grim-Trigger strategy in which there is no cooperation, and a total market quantity $Q_N$ is produced. The firms compete on the basis of quantity and behave as a Cournot Duopoly, where each firm chooses a $q_i$ or $q_j$ as a best response to his belief as to what the other firm will produce.

The general payoff function still holds, but $q_i$ and $q_j$ are no longer equal to one-half of the monopoly quantity, as competition reduces price and the quantity produced.

$$\pi_{ic} = (a_i - q_{iN} - q_{jN})(q_{iN}) - q_{iN}c$$
$$= a_iq_{iN} - q_{iN}^2 - q_{iN}q_{jN} - q_{iN}c$$

\(^3\) See Appendix I (1) for calculation.
\(^4\) Values calculated under this condition are denoted by the subscript N.
I find the firm $i$’s best response to firm $j$’s actions, the quantity that maximizes $i$’s payoff given $q_{iN}$, by setting the derivative of the payoff function with respect to $q_{iN}$ equal to 0 and solving for $q_{iN}$:

$$a_t - 2q_{iN} - q_{jN} - c = 0$$

$$q_{iN} = \frac{(a_t - q_{jN} - c)}{2}$$

Firm $j$’s best response to $q_{iN}$ is symmetric (calculation omitted):

$$q_{jN} = \frac{(a_t - q_{iN} - c)}{2}$$

I then find the quantity that satisfies the best response function for each firm:

$$q_{iN} = \frac{\left[a_t - \left(\frac{a_t - q_{jN} - c}{2}\right) - c\right]}{2}$$

$$q_{iN} = \frac{(a_t - c)}{2} - \frac{(a_t - q_{iN} - c)}{4}$$

$$q_{iN} = \frac{(a_t - c)}{3}$$

Inserting this value into firm $j$’s best response function yields a symmetrical outcome (calculation omitted):

$$q_{jN} = \frac{(a_t - c)}{3}$$

and a total market quantity of:

$$Q_N = q_{iN} + q_{jN} = \frac{2(a_t - c)}{3}$$

which notably exceeds $Q_C = q_{ic} + q_{jc} = \frac{(a_t - c)}{2}$
The payoff\(^5\) to firm \(i\) in this period is:

\[
\pi_{iN} = (a_i - q_{iN} - q_{jN})(q_{iN} - q_{iN}c)
\]

\[
= \frac{a_i^2 - 4a_ic + c^2}{9}
\]

In the period in which firm \(i\) deviates,\(^6\) he maximizes his payoff given that firm \(j\) is producing the cooperative quantity found previously, such that \(q_{iD} = q_{jC}^c\):

\[
\pi_{iD} = (a_i - Q_{iD})(q_{iD} - q_{iD}c)
\]

\[
= \left[\left(a_i - q_{iD} - \frac{(a_i - c)}{4}\right)q_{iD}\right] - q_{iD}c
\]

\[
= a_iq_{iD} - q_{iD}^2 - \frac{(a_i - c)}{4}q_{iD} - q_{iD}c
\]

The quantity that firm \(i\) chooses is:

\[
a_i - 2q_{iD} - \frac{(a_i - c)}{4} - c = 0
\]

\[
q_{iD} = \frac{a_i - (a_i - c)}{4} - c
\]

\[
q_{iD} = \frac{4a_i - 4c - a_i + c}{2}
\]

\[
q_{iD} = \frac{3(a_i - c)}{8}
\]

and the total market quantity is:

\[
Q_{iD} = q_{iD} + q_{jD} = \frac{3(a_i - c)}{8} + \frac{(a_i - c)}{4} = \frac{5(a_i - c)}{8}
\]

\(^5\) See Appendix I (2) for calculation.

\(^6\) Values calculated under this condition are denoted by the subscript \(D\).
Firm \( i \)'s payoff\(^7\) is:

\[
\pi_{id} = (a_i - q_{id} - q_{jD})(q_{id}) - q_{id}c
\]

\[
= \frac{9a_ic^2 - 18a_ic + 9c^2}{64}
\]

Given these quantities, determining the payoffs at each decision point is straightforward.

In the model, the firm makes its decision at one of the four key points in the business cycle: the first period of an expansion, the last period of the expansion, the first period of the contraction, or the last period of the contraction.\(^8\)

At \( t = H1 \), payoffs from each of the firm’s decisions, using the quantities calculated above, are as follows:

\((1a)\) No deviation in \( t=H1 \):

\[
\pi^{CH1} = \delta^0(\pi^{CH}) + \delta^1(\pi^{CH}) + \delta^2(\pi^{CL}) + \delta^3(\pi^{CL}) + \delta^4v^C
\]

\[
= (\delta^0 + \delta^1)\pi^{CH} + (\delta^2 + \delta^3)(\pi^{CL}) + \delta^4v^C
\]

\[
= (\delta^0 + \delta^1)\left(\frac{a_H^2 - 2a_Hc + c^2}{8}\right) + (\delta^2 + \delta^3)\left(\frac{a_L^2 - 2a_Lc + c^2}{8}\right) + \delta^4v^C
\]

\((1b)\) Deviation in \( t=H1 \):

\[
\pi^{DH1} = \delta^0(\pi^{DH}) + \delta^1(\pi^{NH}) + \delta^2(\pi^{NL}) + \delta^3(\pi^{NL}) + \delta^4v^N
\]

\[
= \delta^0\left(\frac{9a_Hc^2 - 18a_Hc + 9c^2}{64}\right) + \delta^1\left(\frac{a_H^2 - 4a_Hc + c^2}{9}\right) + (\delta^2 + \delta^3)\left(\frac{a_L^2 - 4a_Lc + c^2}{9}\right) + \delta^4v^N
\]

The values \( v^C \) and \( v^N \) are constants, representing the future value of the decision.

Assuming that the Grim-Trigger model holds until the firms stop producing, the payoff repeats infinitely following the second period of the contraction, when the next expansion begins. If the firm never deviates, this value, \( v^C \) is the summation of the discounted cartel payoff at \( t = H1 \),

---

\(^7\) See Appendix I (3) for calculation.

\(^8\) Denoted by the subscripts H1, H2, L1, and L2, respectively.
H2, L1, L2. If the Grim-Trigger strategy has been invoked, $\nu^N$ is the summation of the Cournot-Duopoly payoff with the same parameters. These values are added on to the end of each decision payoff in the first cycle based on the action taken and discounted for the appropriate period.

Payoffs at each of the remaining decision points are calculated in a similar fashion. As the firm moves from one period to the next to make its decision, the next cycle also moves up one period, and so the future payoff constants, $\nu^C$ and $\nu^N$, are discounted appropriately:

(2a) No Deviation in $t=H2$:

$$\pi^{CH2} = \delta^0(\pi^{CH}) + \delta^1(\pi^{CL}) + \delta^2(\pi^{CL}) + \delta^3\nu^C$$

$$= \delta^0\pi^{CH} + (\delta^1 + \delta^2)(\pi^{CL}) + \delta^3\nu^C$$

$$= \delta^0\left(\frac{a_H^2 - 2a_Hc + c^2}{8}\right) + (\delta^1 + \delta^2)\left(\frac{a_L^2 - 2a_Lc + c^2}{8}\right) + \delta^3\nu^C$$

(2b) Deviation in $t=H2$:

$$\pi^{DH2} = \delta^0(\pi^{DH}) + (\delta^1 + \delta^2)(\pi^{NL}) + \delta^3\nu^N$$

$$= \delta^0\left(\frac{9a_Hc^2 - 18a_Hc + 9c^2}{64}\right) + (\delta^1 + \delta^2)\left(\frac{a_L^2 - 4a_Lc + c^2}{9}\right) + \delta^3\nu^N$$

(3a) No Deviation in $t=L1$:

$$\pi^{CL1} = \delta^0(\pi^{CL}) + \delta^1(\pi^{CL}) + \delta^2\nu^C$$

$$= (\delta^0 + \delta^1)\left(\frac{a_L^2 - 2a_Lc + c^2}{8}\right) + \delta^2\nu^C$$

(3b) Deviation in $t=L1$:

$$\pi^{DL1} = \delta^0(\pi^{DL}) + \delta^1(\pi^{NL}) + \delta^2\nu^N$$

$$= \delta^0\left(\frac{9a_Lc^2 - 18a_Lc + 9c^2}{64}\right) + \delta^1\left(\frac{a_L^2 - 4a_Lc + c^2}{9}\right) + \delta^2\nu^N$$

---

Superscript T on $\pi$ denotes the total payoff.

32
(4a) No Deviation in $t=L2$:

$$\pi^{CL2} = \delta^0(\pi^{CL}) + \delta^1\nu^C$$

$$= \delta^0\left(\frac{a_{L}^2 - 2a_{L}c + c^2}{8}\right) + \delta^1\nu^C$$

(4b) Deviation in $t=L2$:

$$\pi^{DL2} = \delta^0(\pi^{DL}) + \delta^1\nu^N$$

$$= \delta^0\left(\frac{9a_{L}c^2 - 18a_{L}c + 9c^2}{64}\right) + \delta^1\nu^N$$

To determine whether or not a firm would choose to deviate in the given period, I calculate a value $\kappa^{Di} = \pi^{Di} - \pi^{Ci}$, which represents the additional payoff from deviating rather than staying in the cartel. The largest $\kappa^{Di}$ value suggests the best time during the cycle for the acting firm to deviate.\(^{10}\)

$$\kappa^{DH1} = \delta^0\left(\frac{a_{H}^2 - 2a_{H}c + c^2}{64}\right) + \delta^1\left(\frac{-a_{H}^2 + 2a_{H}c - c^2}{72}\right) + \delta^2\left(\frac{-a_{L}^2 + 2a_{L}c - c^2}{72}\right) + \delta^3(\nu^N - \nu^C)$$

$$\kappa^{DH2} = \delta^0\left(\frac{a_{H}^2 - 2a_{H}c + c^2}{64}\right) + (\delta^1 + \delta^2)\left(\frac{-a_{L}^2 + 2a_{L}c - c^2}{72}\right) + \delta^3(\nu^N - \nu^C)$$

$$\kappa^{DL1} = \delta^0\left(\frac{a_{L}^2 - 2a_{L}c + c^2}{64}\right) + \delta^1\left(\frac{-a_{L}^2 + 2a_{L}c - c^2}{72}\right) + \delta^2(\nu^N - \nu^C)$$

$$\kappa^{DL2} = \delta^0\left(\frac{a_{L}^2 - 2a_{L}c + c^2}{64}\right) + \delta^1(\nu^N - \nu^C)$$

\(^{10}\) See Appendix II for calculations.
To create a clearer picture of the firms’ decisions, I arbitrarily choose values for $a_H$, $c$, and $\delta$ and solve for $k^{Dt}$. I let $a_H = 4$, $a_L = 2$, $c = 1$. The results are as follows:\footnote{See Appendix III for calculations.}

\[
\begin{align*}
    k^{DH1} &= \left( \frac{9}{64} \right) - \left( \frac{\delta^1 + \delta^2 + \delta^3}{8} \right) \\
    k^{DH2} &= \left( \frac{9}{64} \right) - \left( \frac{\delta^1 + \delta^2}{8} \right) \\
    k^{DL1} &= \left( \frac{1}{64} \right) - \left( \frac{\delta^3}{8} \right) \\
    k^{DL2} &= \left( \frac{1}{64} \right)
\end{align*}
\]

From these calculations, it is evident that a firm benefits most from deviating in the end period of an expansion, but benefits least at the beginning of a recession. It follows that cartels should form at the onset of recessions and break down at the peak of economic growth.

The values of $k^{Dt}$ are functions of the discount factor, which has not been given much attention until now. The discount function measures the time value of money, adding into the equation the intuition that money today is worth more than and preferable to money in the future, due to the interest rate and other risk factors. In this model, the discount factor can be thought of in a different way. It can represent some value that makes the firm indifferent between staying in the cartel and choosing to deviate. There is some value of $\delta$ such that the payoff from deviation in any period, $\pi^{Dt}$, is equal to the payoff from sustaining the cartel, $\pi^{Ct}$. I solve for this “indifference condition,” $\delta^{Dt}_v$, by setting $k^{Dt} = 0$. Continuing to use the arbitrary values applied above for simplification and concreteness, the results are as follows:\footnote{See Appendix IV for calculations. For $t=L_2$, the discount factor is irrelevant.}
\begin{align*}
\delta_{DH1} &= .584 \\
\delta_{DH2} &= .673 \\
\delta_{DL1} &= .125 \\
\delta_{DL2} &= \emptyset
\end{align*}

1. CONSIDERATIONS

Though the calculations and results from the theoretical model are quite straightforward, the observational analysis shows that these predictions do not always hold perfectly true in reality. As with any model, the assumptions to determine specific parameters may help create a feasible model but prove to be unrealistic in practice. As the Haltiwanger and Harrington study also discussed, the firms’ knowledge and ability to predict future demand conditions is important in my model. I assume that firms are able to forecast with some certainty what levels of demand will be in the future and that the economy will follow a somewhat anticipated cycle of highs and lows. If at the end of the boom the firm does not know that the next period will bring much lower demand levels, its incentive to deviate is largely inhibited. For this reason, one could assume that firms might deviate at the beginning of a downturn after demand has fallen slightly, and similarly they may form cartels with some delay from the beginning of the recession.

My model also assumes a level of rationalizability in determining the appropriate quantity levels, which is fundamental to game theory but potentially nonexistent in reality. Rationalizability assumes that firms will only take actions that maximize their own payoffs, choosing to do whatever makes them better off given all available information. A traditional example of rationality not playing out realistically is the Ultimatum Game. In this scenario, one player has a sum of money and offers a percentage to the second player. The second player decides to accept or reject the offer. If he accepts, he gets that percentage, but if he rejects, both players get nothing. Solving the game mathematically reveals that player two should accept the
offer with 100% probability, since any percentage of the sum is greater than nothing, and both players are better off than if he rejects. However, real-life experiments have shown that players choose to accept with a probability much lower than 100%, showing that emotions and animosity often override rationality if money is the only thing that matters.

Another element to consider is the concept of capacity constraints. My model assumes that firms are able to produce any quantity without hesitation. This is sustained by the explanation that most cartels operate at below maximum capacity in order for the punishment threat to be credible because having excess capacity discourages potential new entrants. This ensures that the firm is able to produce the optimal quantity in the deviation period to yield a high enough return to cover the loss from the induced Cournot strategy after deviation. However, it is possible that firms are unable to produce this quantity, and deviation does not yield as high a payoff as predicted.

C. PRACTICAL ANALYSIS

To further explain the merits of looking at the business cycle to aid in cartel prosecution, I have conducted analysis on US Steel, which is currently under investigation by the U.S. Department of Justice for acts in violation of Section 2 of the Sherman Antitrust Act. To confirm my underlying assumption that a firm’s profit margins are higher during collusive periods than under competitive circumstances, I perform a simple margin-based “but-for” analysis. The outcome calculates the excess profits earned based on previous earnings. The “but-for” calculation estimates the margin in the absence of collusion based on a weighted average. To determine the role of GDP and industry-specific demand, I run a regression of financial performance on GDP and product-specific demand. I then use these models to predict the “but-
for” margins. I will begin with a background of the case, the company, and the industry, and then present the data analysis and conclusions.

1. COMPANY AND INDUSTRY BACKGROUND

Nine main firms dominate the United States domestic steel industry, the result of bankruptcy and consolidation. These firms are also the defendants in a complaint brought by Standard Iron Works on behalf of other steel consumers alleging anticompetitive behavior. The plaintiff firms all manufacture raw steel, which can be processed into any number of end uses by consumers. Across the market, each company uses one of two distinct processes for two separate types of steel output: flat products and long products. Case background reveals that “with respect to these “flat” and “long” product groups, the market for domestic production is similarly concentrated” (Standard Iron Works 2009, 5). Likewise, the production processes are distinct but similar enough to mitigate production differentiation and make competition on price the only advantage. The facts surrounding this alleged cartel make it a relevant case with respect to the parameters in my model and hypothesis. The judge of the complaint affirms the merits of the actions of the individual firms as being in line with the characteristics of a typical cartel:

[H]igh concentration on the supply side (80-85% controlled by Defendants) and diffusion on the demand side, high barriers to entry (huge costs to build [production facilities], high transportation costs, and tariffs on imports), a commodity good, high fixed costs, and a natural capacity shortage in the domestic market that made a supply cartel particularly likely to succeed in inflating price (Standard Iron Works 2009, 8).

While all of the companies combined control between 80 and 85% of the total market for product Y, “no single U.S. producer has the power to control supply and price unilaterally,” implying that a relationship between the companies is necessary for market manipulation (Standard Iron Works 2009, 9). Aside from the slight differences in manufacturing and output
end use, steel is virtually homogenous across the eight competitors. The standard input factors and the fact that the market is confined to U.S. production and sales uphold the assumption that firms face similar and relatively stable manufacturing costs. For my analysis, I chose U.S. Steel because it operates solely in the U.S., and thus the financial data would not be affected by international operations.

2. MARGIN-BASED “BUT-FOR” ANALYSIS

In order to test the hypothesis that profits would be higher during periods of collusion than during periods of competition, I begin with a margin analysis of U.S. Steel before, during, and after the alleged cartel period. The plaintiffs and the court define the cartel period as January 1, 2005 to “the present” Standard Iron Works 2009, 5). (Though the complaint was filed in July, 2009, I end the cartel period with the quarter ending December 31, 2008 for simplicity. The margins are calculated by subtracting the cost of sales from the sales revenue at the end each quarter from January 1, 2000 through September 30, 2009. I calculate a “but-for margin” by taking the simple average of the calculated margin for the periods preceding the first quarter of 2005. I exclude the first three quarters of 2009 because residual effects of cartels can linger and skew margins even after the official collusion has ended. In this case, the actual end date of the cartel is unknown, further justifying the exclusion of the 2009 data. I also exclude the third quarter margin in 2004. The high 2004 margins are likely a result of the industry consolidation, probably motivated by low returns and sliding performance, and not due to normal market conditions. The excess margin is the difference between the actual margin during the cartel period and the “but-for” calculated value. The average “but-for” margin was $2,692,154,000 and the average excess, excluding the quarter when the actual margin was less than the “but-for,”
was $394,888,000. This is consistent with the theoretical finding that collusion raises profits above the competitive level.

**Figure 4: But-for margin analysis**

![Excess Margin and Margin graph]

3. **REGRESSION MODEL**

a. **DATA**

The margin-based but-for analysis is an interesting but crude exploration of the profit stream. Increased profits may simply be a factor of market conditions, such as increasing demand or an improvement in the business cycle. To determine what role these conditions play in the profit realization of the firm, I conduct a regression analysis of the profit margin on various demand factors to determine if a correlation exists to support my theoretical model. To adhere to the cost assumption, I base the margin on an average cost across all periods. I include the cartel period in the calculation because I assume that cost is independent of collusion. The dependent
variable, denoted ChMarginAvg, is the quarterly change in revenue (sales) less the average cost of sales across all quarters, measured in thousands of U.S. dollars. Using a robust Ordinary Least Squares (OLS) linear regression model to correct for possible heteroskedasticity, I regress the ChMarginAvg on two independent variables\(^{13}\). The first independent variable in Model I is the quarterly change in U.S. Gross Domestic Product (GDP) measured in thousands of U.S. dollars. The second independent variable in Model I is the quarterly change in Gross Domestic Product of U.S. Motor Vehicle Output (MVO) measured in thousands of U.S. dollars. As motor vehicles are one of the largest end uses of steel, MVO serves as a good proxy for product demand. The data was collected from the Bureau of Economic Analysis’ National Income and Product Account Tables. I include only data from before and after the cartel period, from January 1, 2000 to the quarter ending December 31, 2004. I conclude by predicting the “but-for” margin during the cartel period, January 1, 2005 to December 31, 2008, against the actual cartel data using both models.

**b. MODEL RESULTS**

**Table 3: Regression analysis results**

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<th>X variable</th>
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<td>GDP</td>
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<td>MVO</td>
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*significant at the .01 level

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<td>( R^2 )</td>
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<td>Durbin-Watson</td>
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</table>

The GDP coefficient is significant at the .01 level, but the MVO coefficient is not statistically significant. However, the coefficients on GDP and MVO imply a positive

\(^{13}\) For data collection, see Appendix IV.
relationship between overall demand and product demand with the profit stream, which was expected. I use the models to predict the “but-for” profit stream during the cartel period by fitting the actual change in GDP and MVO through the cartel period to the model. I add the predicted change the actual margin, as shown in Table 4. The predicted “but-for” margin is less than the actual margin by an average of $57,269,000, indicating that US Steel earned less during the alleged cartel period than it would have if the model were a true predictor of market conditions. While this is in opposition to the result expected given the theoretical and margin-based analyses, the findings do not nullify the allegations of cartel behavior. The regression above weighs in favor of the defendant, but no plaintiff would present such a simplistic model in a federal court. The model brought before the court would employ a complex and detailed regression analysis including tens of factors, proxies, and demand determinants.

Though the initial regression produced a negative result, the factors may still be useful in determining if the profit during the cartel period was reasonable. As seen above, the relationship between product-specific demand and profit should be positive in the absence of collusion. I perform a second regression of ChMarginAvg on the MVO and GDP during the cartel period (Model II). The GDP and MVO coefficients are not statistically significant, but the MVO coefficient is negative (see Table 5 for results). This result suggests that profits during the alleged cartel were potentially arbitrary and did not align with ordinary market conditions. When taken with the results of the previous set of models, the output reflects the idea that changes in GDP and product demand effect profit, and when macroeconomic growth stagnates, collusion is an option to maintain profitability.

The simplicity of the model, while easy to understand and appropriate in this context, leads to certain statistical problems. The models exhibit a possible source of omitted variable
bias, as only two independent variables are tested in each variation. There are many other factors affecting profit stream aside from demand, but my goal was not to uncover all of the characteristics of profit. The simple OLS models are appropriate and sufficient to accept or reject the observed relationship.

Table 4: Prediction results

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<tr>
<th>Quarter Ending</th>
<th>Actual ChMarginAvg</th>
<th>But-for Change</th>
<th>But-for Margin</th>
<th>Excess Margin</th>
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<td>-392,512</td>
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<td>948,348</td>
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<td>960,748</td>
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<td>1,039,823</td>
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<tr>
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<tr>
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Average Margin: -57,269

Table 5: Second regression analysis results

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<td>GDP</td>
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<tr>
<td>MVO</td>
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<tr>
<td></td>
<td>(.0149)</td>
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<tr>
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</table>
CONCLUSION AND EXTENSIONS

As the above analyses suggest, a firm looking to maximize profits would choose to enter into a cartel at the beginning of a recessionary period. Doing so any earlier, the firm would forgo profits from the higher demand, and waiting would decrease profits, assuming that demand is declining or constant. Though the predictive ability of the observational, theoretical, and practical analyses have a few notable shortcomings, the evidence does suggest a positive relationship between the business cycle and firms’ strategic decisions. This relationship could be a valuable tool for prosecutors looking to investigate cartel behavior. Because cartels operate so discreetly, detection by enforcement agencies is low, as is evidenced by the small number of cases heard and the time lapse between the actual cartel action and the prosecution. In 2006, the EC revised its fine calculation methods, and the details of its leniency programs and settlement options, trying to increase the incentive for firms to admit to collusion and help combat the damaging problem in the market. A firm that blows the whistle on its own actions receives much lower fines and sometimes is completely relieved of fines and prosecution, which undoubtedly has increased the number of cases heard and helped fight anticompetitive behavior. Relying on this mechanism is good practice for enforcement agencies, but many resources are wasted on investigations and monitoring conditions. With the knowledge of times when collusion is more likely, enforcers could better allocate their resources to monitoring prices and other signals of collusive behavior when the macroeconomic market predicts an increased likelihood of action. While this would not be a foolproof method, it would reduce wasted resources and help focus the energy where it is more likely to yield positive results.

Further work on the subject could adapt the model to include more than two firms, product substitutability, and differing costs in the determination of payoffs. As it stands, the
model is only applicable to a narrow subset of, and relaxing these parameters will open the model to a greater range of industries to run a test of the model in practice.
Appendix I: Payoff Calculations

(1) \( \pi_{ic} = (a_i - Q_i) (q_{ic} - q_{ic} c) \)

\[
= \left[ a_i - \left( \frac{a_i - c}{2} \right) \right] \left( \frac{a_i - c}{4} \right) - c \left( \frac{a_i - c}{4} \right) \\
= \left( \frac{a_i^2 - a_i c}{4} \right) - \left( \frac{a_i^2 - 2a_i c + c^2}{8} \right) - \left( \frac{a_i c - c^2}{4} \right) \\
= \frac{a_i^2 - 2a_i c + c^2}{8}
\]

(2) \( \pi_{in} = (a_i - Q_i) (q_{in} - q_{in} c) \)

\[
= \left[ a_i - 2 \left( \frac{a_i - c}{3} \right) \right] \left( \frac{a_i - c}{3} \right) - c \left( \frac{a_i - c}{3} \right) \\
= \left( \frac{a_i^2 - a_i c}{3} \right) - 2 \left( \frac{a_i^2 - 2a_i c + c^2}{9} \right) - \left( \frac{a_i c - c^2}{3} \right) \\
= \frac{a_i^2 - 4a_i c + c^2}{9}
\]

(3) \( \pi_{id} = (a_i - Q_i) (q_{id} - q_{id} c) \)

\[
= \left[ a_i - 5 \left( \frac{a_i - c}{8} \right) \right] \left( \frac{3(a_i - c)}{8} \right) - c \left( \frac{a_i - c}{3} \right) \\
= 3 \left( \frac{a_i^2 - a_i c}{8} \right) - \left( \frac{15a_i^2 - 30a_i c + 15c^2}{64} \right) - 3 \left( \frac{a_i c - c^2}{8} \right) \\
= \frac{9a_i^2 - 18a_i c + 9c^2}{64}
\]
Appendix II: k Calculations

(1) $\kappa^{DH1} = \pi^{DH1} - \pi^{CH1}$

$$= \left[ \delta^0(\pi^{DH1}) + \delta^1(\pi^{NH}) + \delta^2(\pi^{NL}) + \delta^3(\pi^{NL}) + \delta^4(\pi^{N}) \right] - \left[ \delta^0(\pi^{CH1}) + \delta^1(\pi^{CH}) + \delta^2(\pi^{CL}) + \delta^3(\pi^{CL}) + \delta^4(\pi^{C}) \right]$$

$$= \delta^0\left(\frac{9a_{H}c^2 - 18a_{H}c + 9c^2}{64}\right) + \delta^1\left(\frac{a_{H}^2 - 4a_{H}c + c^2}{9}\right) + \delta^2\left(\frac{a_{L}^2 - 4a_{L}c + c^2}{9}\right) + \delta^3(\pi^{N} - \pi^{C})$$

(2) $\kappa^{DH2} = \pi^{DH2} - \pi^{CH2}$

$$= \left[ \delta^0(\pi^{DH2}) + \delta^1(\pi^{NH}) + \delta^2(\pi^{NL}) + \delta^3(\pi^{NL}) \right] - \left[ \delta^0(\pi^{CH2}) + \delta^1(\pi^{CH}) + \delta^2(\pi^{CL}) + \delta^3(\pi^{CL}) \right]$$

$$= \delta^0\left(\frac{9a_{H}^2 - 18a_{H}c + 9c^2}{64}\right) + \delta^1\left(\frac{a_{H}^2 - 4a_{H}c + c^2}{9}\right) + \delta^2\left(\frac{a_{L}^2 - 4a_{L}c + c^2}{9}\right) + \delta^3(\pi^{N} - \pi^{C})$$

$$= \delta^0\left(\frac{a_{H}^2 - 2a_{H}c + c^2}{8}\right) + \delta^2\left(\frac{a_{L}^2 - 2a_{L}c + c^2}{8}\right) + \delta^3(\pi^{N} - \pi^{C})$$

(3) $\kappa^{DL1} = \pi^{DL1} - \pi^{CL1}$

$$= \left[ \delta^0(\pi^{DL1}) + \delta^1(\pi^{NL}) + \delta^2(\pi^{N}) \right] - \left[ \delta^0(\pi^{CL1}) + \delta^1(\pi^{CL}) + \delta^2(\pi^{C}) \right]$$

$$= \delta^0\left(\frac{9a_{L}^2 - 18a_{L}c + 9c^2}{64}\right) + \delta^1\left(\frac{a_{L}^2 - 4a_{L}c + c^2}{9}\right) + \delta^2(\pi^{N})$$

$$= \delta^0\left(\frac{a_{L}^2 - 2a_{L}c + c^2}{8}\right) + \delta^2(\pi^{N} - \pi^{C})$$
\( \kappa_{\text{DL}^2} = \pi_{\text{DL}^2} - \pi_{\text{CL}^2} \)

\[
= \left[ \delta^0(\pi_{\text{DL}}^0 + \delta^0\nu^N) \right] - \left[ \delta^0(\pi_{\text{CL}}^0 + \delta^0\nu^C) \right] \\
= \left[ \delta^0\left( \frac{9a_{L}c^2 - 18a_{L}c + 9c^2}{64} \right) + \delta^0\nu^N \right] - \left[ \delta^0\left( -a_{L}^2 - 2a_{L}c + c^2 \right) \right] + \delta^0\nu^C \\
= \delta^0\left( \frac{a_{L}^2 - 2a_{L}c + c^2}{64} \right) + \delta^0(\nu^N - \nu^C)
\]
Appendix III: Arbitrary Value $k^{Dt}$ Calculations:

Let $a_H = 4; a_L = 2; c = 1$

1. $k^{DH1} = \pi^{DH1} - \pi^{CH1}$

$$= \frac{4^2 - 2(4)(1) + 1^2}{64} - \delta^1 \left( \frac{4^2 - 2(4)(1) + 1^2}{72} \right) - \left( \delta^2 + \delta^3 \right) \left( \frac{2^2 - 2(2)(1) + 1^2}{72} \right)$$

$$= \frac{9}{64} - \left( \frac{\delta^1 + \delta^2 + \delta^3}{8} \right)$$

2. $k^{DH2} = \pi^{DH2} - \pi^{CH2}$

$$= \frac{4^2 - 2(4)(1) + 1^2}{64} - \left( \delta^1 + \delta^2 \right) \left( \frac{2^2 - 2(2)(1) + 1^2}{72} \right)$$

$$= \frac{9}{64} - \left( \frac{\delta^1 + \delta^2}{8} \right)$$

3. $k^{DL1} = \pi^{DL1} - \pi^{CL1}$

$$= \frac{2^2 - 2(2)(1) + 1^2}{64} - \delta^1 \left( \frac{2^2 - 2(2)(1) + 1^2}{72} \right)$$

$$= \frac{1}{64} - \frac{\delta^1}{8}$$

4. $k^{DL2} = \pi^{DL2} - \pi^{CL2}$

$$= \frac{2^2 - 2(2)(1) + 1^2}{64}$$

$$= \frac{1}{64}$$
Appendix IV: Indifference Condition Discount Factor Calculations

(1) \( \kappa^{DH_1} = \pi^{DH_1} - \pi^{CH_1} = 0 \)

\[
\frac{9}{64} \left( \frac{\delta^1 + \delta^2 + \delta^3}{8} \right) = 0
\]

\( \delta_y^{DH_1} = .584 \)

(2) \( \kappa^{DH_2} = \pi^{DH_2} - \pi^{CH_2} = 0 \)

\[
\frac{9}{64} \left( \frac{\delta^1 + \delta^2}{8} \right) = 0
\]

\( \delta_y^{DH_2} = .673 \)

(3) \( \kappa^{DL_1} = \pi^{DL_1} - \pi^{CL_1} = 0 \)

\[
\frac{1}{64} - \frac{\delta^1}{8} = 0
\]

\( \delta_y^{DL_1} = .125 \)

(3) \( \kappa^{DL_2} = \pi^{DL_2} - \pi^{CL_2} = 0 \)

\[
\frac{1}{64} = 0
\]

\( \delta_y^{DL_2} = \emptyset \)
Appendix V: But-For calculation data

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<tr>
<th>Quarter Ending</th>
<th>Net sales</th>
<th>Cost of sales</th>
<th>Margin</th>
<th>Margin with Ch. avgCOS Avg COS</th>
<th>margin</th>
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Average COS: 2,692,154

(1) Values for quarters ending in December are calculated by subtracting the sum of the first three quarters from the year-end value.
(2) Italicized values have been excluded from “but-for” calculation.
Works Cited


--. Methodology for Data Estimation.  


EDUCATION

THE SCHREYER HONORS COLLEGE, THE PENNSYLVANIA STATE UNIVERSITY  May 2010
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Minors: Business Law, Political Science
GPA: 3.98/4.00

WORK EXPERIENCE

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TRANSATLANTIC BUSINESS DIALOGUE  Jun 2008 – Aug 2008
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INSTITUTE ON COMPARATIVE POLITICAL AND ECONOMIC SYSTEMS  Jun 2007 – Aug 2007
Participant

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Public Relations Chair

SCHREYER HONORS COLLEGE  Aug 2007 – Aug 2009
Orientation Mentor

SCHREYER HONORS COLLEGE STUDENT COUNCIL  Sep 2006 – May 2009
Homecoming Overall & Member
NORTH HALLS ASSOCIATION OF STUDENTS  
Administrative VP, Pennsylvania State University  
Apr 2007 – Apr 2008

PENN STATE DANCE MARATHON (THON)  
Rules and Regulations/Hospitality Committee Member  
Sep 2006 – Feb 2008

HONORS & AWARDS

- Monroe Newman Award (Economics Department)  
  May 2009
- The Evan Pugh Scholar Award  
  Mar 2009
- Beta Gamma Sigma Honors Business Fraternity  
  Sep 2008
- Golden Key International Honor Society  
  Sep 2008
- National Residence Hall Honorary  
  Dec 2007
- National Society of Collegiate Scholars  
  Sep 2007
- Smeal Academic Achievement Award  
  Sep 2006
- Schreyer Honors College Summer Internship Grant  
  May 2007
- The President’s Freshman Award  
  Dec 2006