# Factors Influencing the Magnitude of Cartel Overcharges: An Empirical Analysis of Food-Industry Cartels

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## ABSTRACT

Using overcharge estimates for 395 cartel episodes from the 18th to the 21st century, we evaluate the impact of cartel characteristics on the size of overcharges imposed by cartels across several geographic regions and antitrust law regimes. The results of our study have important policy implications. We find that the average overcharge imposed by cartels in our sample is 19 percent with the median of 16 percent of the selling price. Food industry cartels achieve lower overcharges than domestic cartels. Longer cartel episodes generate higher levels of overcharges. Cartels that were found or pled guilty achieve approximately the same levels of overcharges as legal cartels. [JEL classifications: L1, L2, L4, L6]. © 2007 Wiley Periodicals, Inc.

## 1. INTRODUCTION

During recent decades antitrust authorities of many developed and developing countries started paying more attention to collusive behavior than ever before. There exist at least two explanations for this. First, many known cartels were considered to be legal in earlier times. In some cases governments were directly involved as participants in the cartels, as in the OPEC situation. In other cases different government policies encouraged cartel (quasicartel) formation, such as producers' associations and boards in agricultural sectors and export cartels. Second, there was little research available evaluating the effect of cartel activity on the market and consumer welfare. This was mostly because of the lack of data, as many cartels remained hidden from regulators.

Over time, more data became available from court records, uncovered cartels that had terminated earlier, and different public sources. Researchers in the rapidly developing

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area of industrial organization used available data and new econometric techniques to study cartel behavior and evaluate its impact on net social and consumer welfare. During the last decades this research made an important contribution to the literature on cartels and collusion.

Cartels can be found in any industry, and the food industry is no exception. The structure of some sectors of the food industry made possible existing cartels in different forms: legal and illegal, domestic and international, bid rigging and not bid rigging. For example, illegal bid-rigging cartels for milk have existed for several decades in different countries. International food and feed ingredient cartels are known for their global reach, which has imposed enormous damages on consumers all over the world. The conspirators were punished with considerable fines and treble damages by antitrust and court authorities in the United States, Canada, the European Union, and some other countries. As a part of the Webb-Pomerene agreement a group of food-industry cartels was allowed to collude legally as long as their collusion on the export markets did not affect the domestic, U.S. market.

During the last century the antitrust laws of many developed and developing countries have gone through remarkable changes that allow more effective detection and punishment of cartels. For example, the Federal Sentencing Guidelines (FSG) (2005) follow established U.S. antitrust law and consider the agreements intending to restrict output and/or raise prices to be illegal per se (paragraph 2R1.1). The FSG assume that the average gain from price fixing is equal to 10% of the selling price and establish a base fine equal to 20% of the volume of affected commerce in lieu of pecuniary loss. It is assumed that the actual losses imposed on consumers are higher that the actual gains generated by price fixers. For example, there are consumers who cannot afford to buy a product at higher prices. Similar laws in Canada and the European Union impose penalties comparable to the U.S. benchmark. Despite the progress made toward stricter antitrust law enforcement all over the world, cartels are common in many industries. It is considered that the expected gains from illegal collusive conduct outweigh expected losses, thus making collusion profitable. This highlights the need to change current antitrust laws and enforcement procedures in order to provide a deterrent effect. For example, the recently created U.S. Antitrust Modernization Commission aims to determine whether there is need to modernize U.S. antitrust law. Also, illegal cartels acting across different jurisdictions represent an important concern of antitrust authorities today, especially with respect to international trade within the WTO. Therefore, both domestic and international policy decisions may be influenced by empirical evidence of cartel behavior during the preceding decades and of the effectiveness of the antitrust law.

Many individual cases and several groups of cartels have been extensively studied in the theoretical and empirical literature. To the best of our knowledge there is no study that has analyzed the magnitude of overcharges for a relatively large group of cartels operating during a long period of time. In our opinion, this analysis would support the goals of the domestic and international antitrust and competition policies.

The objective of our study is to analyze a relatively large group of unrelated cartels that existed in different historical periods and operated on different geographic markets in order to evaluate the impact of organizational cartel characteristics and the market environment on the magnitude of overcharge. The characteristics we consider include international or domestic, legal or illegal, bid rigging or not, and whether cartels operate in the food industry or in other industries. Different geographic markets and different antitrust law regimes represent the market environment of cartel operation. Our study analyzes private cartels that would be subject to sanctions of antitrust law. The overcharge estimates

are taken from previously published sources such as monographs, chapters in edited books, working papers, and court decisions, and are summarized by Connor (2005).

Our article is organized as follows. Section 2 presents theoretical background relating to cartel theory. Section 3 outlines the methodology covering the empirical model and hypotheses tested. Section 4 presents the data-set description and is followed by a discussion of the estimation results in Section 5. Finally, the conclusion of the research is presented.

## 2. THEORETICAL BACKGROUND

Cartels, groups of independent companies binding themselves with an agreement on prices or quantities, are more likely to operate in heavily concentrated or oligopolistic markets. In most cases cartels are self-enforced agreements, and may be legal or illegal. Assuming that the behavior of the firms acting in oligopolistic markets is profit maximizing, they have an incentive to collude in order to increase their joint level of profit (Stigler, 1964). If their collusion is successful, the collusive firms may achieve a monopolistic level of profit if they manage to act as a multiplant monopolist. According to microeconomic theory, firms may achieve this goal by reducing output, which results in an increase in the market price. In practice, the firms may control output, prices, or both. In terms of implementation the easiest strategy to use is price control.

As it turns out not all cartels pursue joint profit maximization by the means of direct price increase as the main strategy. Another strategy is to reduce the variance of prices by homogenizing firms' business practices, as in the case of the Sugar Institute (Genesove & Mullin, 2001). A reduction in price variance could lead to an increase in the joint profits of colluding firms as well. Finally, colluding firms may implement a cost-efficiency strategy as in the case of some Webb-Pomerene export cartels (Dick, 1996).

As extensively discussed in the literature on collusion, the decision whether firms collude or not totally depends upon the expected increase in profit and the costs associated with enforcement of the collusive agreement. The cost of collusion often deals with the problem of information. It may make collusion impossible for many firms or make collusion more efficient in some environments than in others (Stigler, 1961, 1964). Also, the prisoner's dilemma of the pricing problem might prevent collusion (Asch & Seneca, 1976).

The success of collusion depends on at least three major factors. The first factor is the market environment the firms operate in, that is, market supply and demand conditions. The second factor is the legal environment of cartel operation. The presence or absence of antitrust regulation and the effectiveness of its enforcement in a country impact the decision to collude or not, and to what degree to increase the market price if firms decide to form a cartel. The third factor is internal enforcement discipline. Failure to enforce a collusive agreement effectively (i.e., quickly detect deviators, punish them, and prevent opportunistic behavior in the future) often leads to termination of the collusive agreement.

As pointed out earlier, collusive behavior is common in some food-industry markets. Different features of the market environment in some sectors of food industries create incentives to collude. High sunk cost serves as a barrier to entry and cost efficiencies drive collusive behavior in food and feed ingredients markets and in tobacco and soft drink industries. Further, bid rigging of transactions made possible conspiracies on the milk and frozen fish markets. Below we briefly discuss some of the conspiracies with different features that took place in food-industry–related markets.

The Sugar Institute did not fix prices or output directly. The members of this cartel organized their business operation in a way that allowed them to make price cutting as transparent as possible. They used weekly meetings to discuss every possible detail of the transactions that took place during the last week for which there was no previous agreement. It was realized that even though sugar was a homogeneous product, contract provisions such as credit terms, storage rates, and delivery time introduced heterogeneity in the transactions and created incentives to cheat (Genesove & Mullin, 2001).

Agricultural and food product cartels represented 30% of the total population of the Webb-Pomerene cartels. These were the American Association of Feed Exporters, the American Corn Products Export Association, the California Dried Fruit Export Association, the Flour Millers Export Association, the General Milk Company Inc., the Pacific Fresh Fruit Export Association, and the Vegetable Oil Export Company. They operated under the umbrella of the Webb-Pomerene Export Trade Act and were legal cartels with self-enforced discipline. They were allowed to pursue price-fixing strategies legally, but on the export markets only. If this collusion affected the domestic U.S. market it was considered illegal. Approximately 45% of these cartels identified themselves with the primary goal of a common price and/or market allocation. The rest of them followed a cost-efficiency strategy to exercise economies of scale. They usually achieved cost savings by cooperating in joint distribution, warehousing, and marketing services (Dick, 1996).

One U.S. firm (ADM) and three Swiss firms (Bayer AG, Hoffmann-La Roche AG, and Jungbunzlauer AG) pled guilty to fixing prices and output levels of citric acid, an important food ingredient, in the United States and European Union. This conspiracy lasted from the middle of 1991 to the end of 1995. The estimated range of the overcharge imposed by this global conspiracy on the U.S. market is between $116 million and $378 million and represents 14–21% of U.S., sales respectively (Connor, 1998; table IV).

Another widely known conspiracy is the global lysine conspiracy. This conspiracy involving ADM and two Japanese and Korean producers started at the beginning of the 1990s and ended sometime in the mid 1990s. The first civil treble-damages suit was settled in April 1996 for $45 million. ADM pled guilty to criminal price fixing in October 1996 and agreed to pay a $70 million fine. Given his own assumptions on the but-for price and the length of the conspiracy period, Connor (2001) estimated that the overcharge was $155–166 million, whereas the original defendant's estimate was $15 million.

A few of the known bid-rigging conspiracies involved food-industry products. Bid-rigging transactions are those organized through a sealed competitive bid process. In most of the known bid-rigging conspiracies a government agency is a party selling these bids. Starting from 1981 through 1989 several firms conspired on rigging bids for the sale of frozen seafood to the Defense Personnel Support Center in Philadelphia. The Center purchased this seafood for the Department of Defense. The conspiring firms coordinated their activity on a weekly basis. They communicated by phone and allocated contracts among them. Five companies pled guilty and were fined. It was found that a fairly typical bid-rigging scheme raised prices by over 20% for over 4 years (Froeb, Koyak, & Werden, 1993).

These few examples show that collusive agreements may significantly differ from each other. First, colluding firms may pursue different goals, including cost-efficiency strategies and criminal price-fixing conduct. Second, collusive behavior may take place in domestic markets or reach a global scale. Third, the nature of the transactions may be used to distinguish bid-rigging and other cartels. Finally, a cartel may or may not be successful in achieving its objective, which in many cases is a price increase. Thus, different

characteristics of the cartels and the market environment they operate in may have an impact on the magnitude of cartel overcharges.

## 3. METHODOLOGY

### 3.1 Empirical Model

We specify the following model to evaluate the impact of different cartel characteristics and market environment of cartel operation on the size of overcharges.

$$OVRATEi = \alpha + \phi * FOODi + \theta * DURATIONi$$

$$+ \boldsymbol{\beta} * \boldsymbol{Ci} + \boldsymbol{\gamma} * \boldsymbol{Gi} + \boldsymbol{\varphi} * \boldsymbol{Pi} + \boldsymbol{\mu} * \boldsymbol{Mi} + \boldsymbol{\delta} * \boldsymbol{Si} + \epsilon i$$

The dependent variable is the overcharge rate (OVRATE) imposed during cartel episode $i$. The explanatory variables are an intercept ($\alpha$); a discrete variable representing duration of the cartel episode ($DURATIONi$); three sets of binary variables representing different cartel characteristics ($\boldsymbol{Ci}$), different geographic markets ($\boldsymbol{Gi}$), and different periods of antitrust law regimes ($\boldsymbol{Pi}$); two sets of binary variables characterizing eight methods of overcharge estimation ($\boldsymbol{Mi}$) and seven publication sources ($\boldsymbol{Si}$); and an error term ($\varepsilon i$). A detailed description of all explanatory variables and their expected signs (as discussed in following section) are presented in Table 1.

### 3.2 Hypotheses

We use the theoretical concepts discussed above to formulate the set of testable hypotheses within the framework of our empirical model. We expect that a longer duration of a cartel episode leads to a higher level of overcharge imposed by a cartel. If a cartel is successful in maintaining its price discipline, it can impose a higher price increase by means of a direct price increase or variance control than an unsuccessful cartel. Therefore, successful cartels can operate longer than unsuccessful cartels, which have members that do not follow established price discipline. Thus, a longer duration of a conspiracy episode may lead to a higher level of overcharge imposed by a cartel. One example is the previously mentioned Sugar Institute case (Genesove & Mullin, 2001). An effectively enforced discipline resulted in the price increase due to its variance control, although price or output was not fixed directly.

Cartels that were found or pled guilty are likely to impose lower overcharges than legal cartels. Legal cartels do not have to mask their price-fixing activity from antitrust authorities. In our study legal cartels are represented by cartels operating according to law and cartels that were not subject to antitrust law existing during the time of their operation. Conversely, the overcharges imposed by legal cartels may be the same as overcharges imposed by illegal price-fixing agreements or even lower. Legal cartels are legal because they are required to be registered with a government authority, but they are also self-enforced agreements with an internal mechanism of discipline and supervision. If the members of legal cartels do not follow this discipline, they are not able to raise prices, despite their legal status. Thus, opportunistic behavior of legal cartel members may result in lower rates of overcharge than illegal cartels with strongly enforced discipline. A

TABLE 1. Definition of Explanatory Variables

| Explanatory variable | Definition | Expected sign |
|---|---|---|
| FOOD | Binary variable:<br>=1 if a cartelized product belongs to the food industry. | ?[a] |
| DURATION | Discrete variable in the range of 1–4, characterizing duration of a cartel episode:<br>= 1 if duration is less or equal to 5 years.<br>= 2 if duration is from 6 to 10 years.<br>= 3 if duration is from 11 to 15 years.<br>= 4 if duration is greater than 16 years. | + |
| | Binary variables representing characteristics | |
| DOMESTIC | = 1 if a cartel is domestic | − |
| BIDRIGGING | = 1 if a cartel is bid rigging | + |
| GUILTY | =1 if a cartel was found or pled guilty. | +,−[b] |
| | Binary variables representing geographic markets | |
| US | =1 if overcharge is for the U.S. and Canadian markets. | − |
| EUROPE | =1 if overcharge is for any European country or EU. | − |
| ASIA | =1 if overcharge is for any Asian country or Australia. | +,− |
| ROW | =1 if overcharge is for the ROW including Latin America. | +,− |
| WORLD | =1 if overcharge is for world market. | Reference |
| | Binary variables representing antitrust law regimes | |
| P1 | =1 if cartel episode belongs to the period of 1770–1890. | + |
| P2 | =1 if cartel episode belongs to the period of 1891–1919. | Reference |
| P3 | =1 if cartel episode belongs to the period of 1920–1945. | − |
| P4 | =1 if cartel episode belongs to the period of 1946–1973. | − |
| P5 | =1 if cartel episode belongs to the period of 1974–1990. | − |
| P6 | =1 if cartel episode belongs to the period of 1991–2004. | − |
| | Binary variables, representing estimation methods | |
| OTHER | = 1 if no explanation, others. | ? |
| HISTORICAL | =1 if no explanation, historical case study. | − |
| PRICEBEFORE | =1 if price before cartel is used as the benchmark price. | + |
| PRICEWAR | =1 if price during price war is used as the benchmark price. | + |
| PRICEAFTER | =1 if price after cartel is used as the benchmark price. | Reference |
| YARDSTICK | =1 if yardstick (price for a similar product or in a similar geographic market is used as the benchmark price). | ? |
| COSTPROFIT | =1 if normal profit or total cost. | ? |
| ECONOMETRICS | =1 if econometric methods. | ? |
| | Binary variables, representing publication sources | |
| JOURNAL | =1 if peer reviewed journals. | + |
| EDITBOOK | =1 if chapters in edited books. | + |
| MONOGRAPH | =1 if monographs or books. | Reference |
| GOVREPORT | =1 if official government report. | − |
| COURTDECISION | =1 if court or antitrust authorities source. | ? |
| WORKPAPER | =1 if unpublished working paper. | + |
| SPEECH | =1 if speech or conference presentation proceedings. | + |

[a]? means that we are uncertain about the direction of the effect.

[b]+,− means that we expect either positive or negative sign but not statistically significant from the reference group.

well-known example of legal cartels is the Webb-Pomerene cartels that operated under the umbrella of the Webb-Pomerene Export Trade Act and were self-enforced agreements (Dick, 1996). They could have the same problem with internal discipline as illegal cartels. Thus, the effect of the discipline on the overcharge actually could be the same for both legal and illegal cartels.

International cartels are expected to generate higher overcharges relative to domestic cartels because geographic price/overcharge discrimination is possible. Also, international cartels do not have import competition that domestic cartels may face. Connor (2004) emphasizes that international cartels are more difficult to convict, and as a group they bring more harm to consumer welfare than domestic cartels. In addition, international cartels are difficult to deter because domestic antitrust authorities examine collusive activity in domestic markets only (Evenett, Levenstein, & Suslow, 2001). Therefore, because of the bounded legal power of domestic antitrust enforcement, international cartels have more favorable conditions to exercise their price-fixing activity than domestic cartels.

The potential for bid rigging of transactions is another factor that may impact the magnitude of the overcharge rate. As noted by Stigler (1964), collusion is more effective against buyers who report prices correctly and fully. An example is sealed-bid auctions organized by governments. Theoretically, bid-rigging conspiracies are more effective than private agreements (classic cartels). The 2005 U.S. Federal Sentencing Guidelines consider bid-rigging conspiracies to be more harmful than other conspiracies. The U.S. FSG increase the base offense level by 1 if a cartel submitted noncompetitive bids. Therefore, bid-rigging cartels are expected to have a higher level of overcharge than other types of cartels.

The geographic location of cartel operation may impact the magnitude of the overcharge as well. The markets with strong antitrust law enforcement may have lower levels of overcharges than markets with relatively new antitrust law history or without it at all. Clarke and Evenett (2003) found evidence of such price discrimination in the global vitamins cartel. We expect overcharges imposed in the United States and European countries to be lower than overcharges achieved in Asia and the ROW.

As mentioned above, strongly enforced antitrust law is expected to have a deterrent effect; that is, it is expected to decrease the rate of overcharge and prevent illegal price-fixing behavior in the future. Connor (2005) distinguishes six different antitrust law regimes that existed during the last two centuries. It is assumed that each subsequent regime has stronger antitrust regulations and enforcement than the previous regime as antitrust law evolved all over the world. Therefore, under the assumption that each following regime is more effective, it is expected that the magnitude of overcharge becomes smaller in each subsequent period.

Cartels can be found in any industry. Given that industries differ due to market structure, including demand and supply conditions, barriers to entry and exit, technology, and other factors, the overcharge levels may vary significantly across different industries. Based on the assumption that many food-industry products have relatively inelastic demand in comparison with demand for other industry products, we may expect that the overcharge is higher relative to the benchmark of perfect competition (if the firms did not collude) in the case of the food-industry cartels. However, if the benchmark case is not perfectly competitive, then the degree of market concentration may impact the level of the benchmark price. The latter is also influenced by supply conditions, that is, production technology, entry and exit conditions, sunk costs and others. If the benchmark price is higher

in the food industry relative to the benchmark price in other industries, then this may decrease the size of overcharge imposed by food-industry cartels.

Finally, it is important to note that the overcharge estimates used in our empirical analysis were collected from different publication sources and were estimated with the use of different methods. Consequently, differences among publication sources and estimation methods may contribute to the variability in the overcharge estimates as well. For example, econometric modeling methods may generate higher overcharges, and historical case studies may generate lower overcharges in comparison with all other methods. Overcharges estimated with the use of the price-before-conspiracy method are believed to be higher than overcharges estimated with the use of the price-after-conspiracy method. This is because the conspiracy effect stays on the market for a certain period of time after the conspiracy has been terminated (Connor, 1998). Overcharge estimates published in peer-reviewed journals and edited book chapters may be higher, on average, than the overcharge estimates appearing in other sources, because of editors' willingness to publish more economically significant results.

## 4. DATA SET DESCRIPTION

### 4.1 Selection Procedure

The data set we use in our study is quite different from the data usually employed in economic analysis. To conduct empirical analysis of the overcharges imposed by cartels during different periods of history and in different geographic markets, we use part of the data set compiled by Connor (2005). The data set consists of approximately 900 overcharge estimates for approximately 270 different product markets. The estimates are available for different geographic markets and for different time periods starting from the 18th century. Also, the data set has information on cartel characteristics associated with each overcharge estimate. From the description of the episode and estimation method, in most of cases it is possible to form a judgment on episode duration and on the geographic market for which the overcharge was estimated. Given the product market, we can distinguish between food-industry cartels and cartels in other industries.

For our study we compile a subset of this data set with the use of information presented in Appendix Tables 1 and 2 of Connor (2005). We used the following procedure to select overcharge estimates for this study. First, two types of estimates were available: average and peak overcharges. We decided to analyze the average level of overcharge to conduct the most conservative analysis. Also, the average overcharges are more representative than the peak overcharges. Second, some episodes were represented by more than one overcharge estimate. This happened because the same episode was analyzed in different studies and/or different methods of overcharge estimation were used. In addition to research reported in the academic literature, overcharge estimates became available from court decisions. So, we had to eliminate all redundant estimates to form a data set for this study. Again, to follow the most conservative approach, we included in our data set the lowest overcharge estimate among available alternatives for each episode. As a result, the data set for this study includes 395 observations representing approximately 270 product markets. The same product market may be represented by multiple observations in the case when more than one overcharge estimate is collected for this market. This happens because the same product market may include overcharge estimates belonging to different geographic markets and/or the same cartel may experience more than one episode. Each

observation represents a cartel episode, which in most cases is an uninterrupted period of collusion with a corresponding set of rules and membership.

The overcharge estimates presented in the original data set (Connor, 2005) are calculated as relative price increases. $O = [(Pcollusion - Pbenchmark)/Pbenchmark] * 100\%$, and $O$ is overcharge estimate measured as a price increase over the benchmark price. The latter represents the price that would exist in the market if collusion did not take place. Under the assumption that the market without collusion is competitive, the benchmark price is equal to marginal cost. After having selected the overcharge estimates for our study, we transformed these price increases into Lerner index values. $L = [(Pcollusion - Pbenchmark)/Pcollusion] * 100\%$, where $L$ is the Lerner index under the assumption that the benchmark price is equal to a competitive price. The difference between these two approaches is in the denominator only. Both approaches are equally acceptable to calculate overcharge estimates. There is a simple relationship between these two formulas: $L = [O/(100 + O)] * 100\%$.

The transformation to the Lerner index values is useful for the following reasons. First, the distribution of cartel overcharges is considerably less skewed after the transformation relative to the case when the overcharges are calculated as price increases. Before transformation the mean, median, minimum and maximum values were 28.8, 19, −10, and 322%, respectively. After transformation similar statistics are 18.5, 16, −11.11, and 76.30%, respectively. Second, the Lerner index provides an upper bound on the cartel's market power and indicates the relative size of the monopoly overcharge. Given the Lerner index for a particular case, it is possible to observe how far this market departs from the competitive or monopolistic cases. It should be noted that under cartel action, the Lerner index tends to overstate the market power because cartel agreements are not perfectly enforced (Landes & Posner, 1981). As a result the output tends to be higher and the price tends to be lower than in the monopoly case. Finally, the transformation allows us to compare the overcharge estimates in our sample with various benchmark levels for overcharges established in antitrust laws (OECD reports, 2002, 2003). For example, the 2005 U.S. Federal Sentencing Guidelines presume that the average gain from price-fixing is equal to 10% of the selling price. U.S. FSG recommend using 20% of the affected commerce in lieu of the pecuniary loss. The latter number can be interpreted as 20% of the market (selling) price. A similar approach is used in the antitrust regulations of the European Union. The maximum fine is 10% of the net turnover recorded over the last calendar year completed before the fines are imposed. Individual E.U. country members have similar provisions (Italy, France, etc.). Japan uses a criterion of 6% of the cumulative sales of the good and services subject to cartel duration. Korea uses a threshold of 5% of the turnover. These benchmark levels are used to evaluate damages and to calculate fines.

### 4.2 Descriptive Statistics

Descriptive statistics are represented in Table 2. The data we use were collected through literature survey, and this may introduce additional noise. Given that the total sample size for this study consists of 395 observations, the food-industry cartel group represents 24% of the total sample. The mean overcharge of the total sample is 18.50% and the median is 16%. The minimum value of overcharge is −11.11%, and the maximum value is 76.3%. The mean overcharge for the food-industry cartels is 16% and the median is 14.16%. Food-industry overcharges fall in the range of −5.26 to 37.5%. The mean overcharge for

TABLE 2. Descriptive Statistics

| Variable | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| OVRATE (all cartels) | 18.50 (16.00)[a] | 14.84 | −11.11 | 76.30 |
| OVRATE (food) | 16.00 (14.60) | 9.73 | −5.26 | 37.50 |
| OVRATE (nonfood) | 19.29 (16.67) | 16.04 | −11.11 | 76.30 |
| FOOD | 0.24 | 0.43 | 0.0 | 1.0 |
| DURATION[b] | 8.61 | 11.25 | 0.08 | 98.00 |
| DOMESTIC | 0.47 | 0.50 | 0 | 1 |
| BIDRIGGING | 0.18 | 0.39 | 0 | 1 |
| GUILTY | 0.65 | 0.48 | 0 | 1 |
| US | 0.38 | 0.49 | 0 | 1 |
| EUROPE | 0.31 | 0.46 | 0 | 1 |
| ASIA | 0.09 | 0.28 | 0 | 1 |
| ROW | 0.04 | 0.20 | 0 | 1 |
| P1 (1770–1890) | 0.13 | 0.34 | 0 | 1 |
| P2 (1891–1919) | 0.14 | 0.35 | 0 | 1 |
| P3 (1920–1945) | 0.23 | 0.42 | 0 | 1 |
| P4 (1946–1973) | 0.15 | 0.35 | 0 | 1 |
| P5 (1974–1990) | 0.17 | 0.38 | 0 | 1 |
| P6 (1991–2004) | 0.32 | 0.47 | 0 | 1 |
| OTHER | 0.21 | 0.41 | 0 | 1 |
| HISTORICAL | 0.01 | 0.10 | 0 | 1 |
| PRICEBEFORE | 0.33 | 0.47 | 0 | 1 |
| PRICEWAR | 0.02 | 0.13 | 0 | 1 |
| PRICEAFTER | 0.11 | 0.31 | 0 | 1 |
| YARDSTICK | 0.11 | 0.32 | 0 | 1 |
| COSTPROFIT | 0.06 | 0.23 | 0 | 1 |
| ECONOMETRICS | 0.15 | 0.36 | 0 | 1 |
| JOURNAL | 0.20 | 0.40 | 0 | 1 |
| EDITBOOK | 0.08 | 0.27 | 0 | 1 |
| MONOGRAPH | 0.28 | 0.45 | 0 | 1 |
| GOVREPORT | 0.03 | 0.17 | 0 | 1 |
| COURTDECISION | 0.24 | 0.43 | 0 | 1 |
| WORKPAPER | 0.17 | 0.38 | 0 | 1 |
| SPEECH | 0.01 | 0.09 | 0 | 1 |

[a]The median overcharge is in the parentheses.
[b]In years.

other industry cartels is 19.29%, and the median is 16.67%. The other industry cartel overcharges take values from −11.11 to 76.30%. These three distributions show that food-industry cartels on average impose a lower level of overcharge than cartels in other industries.

The mean duration of cartel episode is approximately 9 years; the range of this variable is from 1 month to 98 years. Domestic cartels represent 47% of the total sample and bid-rigging cartels constitute 18%. Approximately 65% of cartels were found or pled guilty. Most of the overcharge estimates are from the United States (including Canada), Europe, and the world market rather than for Asian markets (including Australia) and the rest of the world (ROW). This is because antitrust law has been enforced in the United

States, Canada, and European countries for a longer period of time than in other countries, thus making more information available. Some Asian counties started enforcing antitrust regulation recently. However, many other countries either do not have antitrust law or similar regulation at all, or have it but do not enforce it. Therefore, overcharge estimates are very rare for these markets. As for the distribution of all cartel episodes across the different antitrust law regimes, the episodes are distributed relatively evenly across six periods covering 1770–2004 with 32% belonging to the last 14 years. Most of the overcharges were estimated with the use of the price before conspiracy method, other methods, and econometric modeling. The majority of overcharge estimates was collected from the chapters in edited books, court decisions, peer reviewed and academic journals, and working papers.

Table 3 presents the average overcharge estimates corresponding to different time periods (antitrust law regimes) by type of cartel characteristics. The data presented in this table reveal a few important patterns characterizing cartel overcharges. First, international cartels impose approximately 4 percentage points higher overcharges than domestic cartels. Second, legal cartels and cartels that were found or pled guilty impose approximately the same level of overcharges, 19.4 and 18%, respectively. During the period of 1891–1919 and 1991–2004, guilty cartels tend to impose higher overcharges than legal cartels. During the rest of the periods, legal cartels achieve higher overcharges. Third, cartels that are bid rigging tend to achieve lower overcharges than cartels that are not bid rigging. This pattern is observed in all time periods except the period of 1891–1919. Finally, the distribution of overcharges presented in the last column of Table 3 suggests that the highest average overcharges were observed in the period 1920–1945. The lowest overcharges are associated with the period of 1946–1973.

The distribution of the number of observations across different intervals of the overcharge estimates along with the average overcharges attributed to these intervals is presented in Table 4. Approximately 10% of all overcharge estimates belong to those cartels that were not able to impact the market price effectively to attain at least some positive level of overcharge. Approximately 53% of all observations characterize cartels that impose overcharges in the interval from 0 to 20%. Approximately 16 and 13% of all overcharges are associated with cartels that impose overcharges in the intervals from 20 to 30 and from 30 to 40%, respectively. Finally, about 8% of all cartels were able to impose overcharges higher than 40% of the market price.

TABLE 3. The Average Overcharge Estimates, by Time Periods and Cartel Characteristics

| | Membership | | Legal status | | Type of business | | |
|---|---|---|---|---|---|---|---|
| | Domestic | International | Legal | Guilty | Non-BDR | BDR | Total |
| Time period | | | | | | | |
| 1780–1890 | 16.05 | 24.59 | 18.16 | 15.09 | 17.32 | 14.60 | 17.09 |
| 1891–1919 | 17.88 | 21.95 | 18.48 | 21.44 | 19.43 | 20.08 | 19.46 |
| 1920–1945 | 14.91 | 21.51 | 20.02 | 19.91 | 20.11 | 17.06 | 19.97 |
| 1946–1973 | 12.72 | 23.02 | 18.20 | 14.51 | 16.56 | 13.85 | 15.72 |
| 1974–1990 | 18.29 | 19.82 | 20.59 | 18.41 | 21.06 | 16.19 | 18.81 |
| 1991–2004 | 17.24 | 17.88 | 14.89 | 17.86 | 18.09 | 16.26 | 17.70 |
| Total | 16.17 | 20.56 | 19.40 | 18.02 | 19.13 | 15.72 | 18.50 |

TABLE 4. Distribution of Overcharge Estimates

| Overcharge intervals | Number of observations | | Average overcharge (%) |
|---|---|---|---|
| | Counts | % of the total | |
| Less or equal to 0 | 38 | 9.62 | −0.46 |
| (0; 10] | 105 | 26.58 | 6.52 |
| (10; 20] | 106 | 26.84 | 15.76 |
| (20; 30] | 63 | 15.95 | 25.16 |
| (30; 40] | 53 | 13.42 | 33.57 |
| Greater than 40 | 30 | 7.59 | 53.58 |
| Total | 395 | 100.00 | 18.50 |

## 5. RESULTS

Given the survey nature of our data set, we do not make any strong assumptions about the error distribution, and we estimate the model with the ordinary least-squares estimator (OLS) as a semiparametric linear regression model. A semiparametric regression model does not require an explicit assumption about the probability distribution of the error component. The semiparametric model assumptions only require that the errors are mean zero and uncorrelated. In our case, we do not make further strong assumptions about the error distribution because we are not aware of any specific distributional properties of the error process. The semiparametric model is appropriate when the error distribution may be skewed, as in our case (see Mittelhammer, Judge, & Miller, 2000, for further details).

We do not conduct any formal tests for the presence of autocorrelation. As the data come from different periods of time, and the overcharges are estimated for different episodes with different length, we cannot organize the data to easily capture dynamics in the time dimension. As the distribution of cartel overcharges is slightly skewed, we examined the data for the presence of influential observations (outliers). First, using the interquartile range, we found that there are no extreme outliers, and there are 11 mild outliers. An observation is classified as a mild outlier if it belongs to the interval between 55.51 and 84.02%, representing the upper inner and upper outer thresholds. Second, we examined the data with the use of a plot to locate these outliers. We find that although there is a group of observations that have higher values, these observations are concentrated very close to all other observations.

To determine if we can pool the food- and nonfood-industry data, we introduce a set of interaction variables in the regression model based on the product of each explanatory variable with the dummy variable FOOD. We then use a Wald test to determine if the interaction effects are jointly significant, which would indicate that we should estimate a separate model based on the food-industry cartels. The resulting Wald statistic is 13.78 with a $p$ value of 0.8791. Therefore, we fail to reject the pooled model and can combine the food- and nonfood-industry data in a single regression model. Finally, there are three negative and 38 zero observations in the sample of 395 overcharge estimates. We considered alternative estimation methods to account for the potential discrete mass point at zero, but this adjustment had little impact on the estimation results. The ordinary least-squares estimation results and diagnostic test statistics are presented in Table 5.

The estimation results show that most of the estimated coefficients have the expected signs and are statistically significant. The explanatory variables explain approximately

TABLE 5. Ordinary Least-Squares Estimation Results

| Variable | Estimated coefficient | Standard error | *Z* statistic |
|---|---|---|---|
| FOOD | −4.50*[a] | 2.00 | −2.25 |
| DURATION | 1.54*[b] | 0.76 | 2.04 |
| DOMESTIC | −5.42*[a] | 2.09 | −2.60 |
| BIDRIGGING | −0.64 | 2.32 | −0.27 |
| GUILTY | −0.53 | 1.99 | −0.26 |
| US | −3.51[a] | 2.49 | −1.41 |
| EUROPE | −5.25*[a] | 2.45 | −2.14 |
| ASIA | −2.30 | 3.68 | −0.62 |
| ROW | −2.20 | 4.25 | −0.52 |
| P1 (1770–1890) | −0.91 | 2.90 | −0.31 |
| P3 (1920–1945) | −1.86 | 2.45 | −0.76 |
| P4 (1946–1973) | −4.58*[a] | 2.73 | −1.68 |
| P5 (1974–1990) | −0.82 | 2.60 | −0.32 |
| P6 (1991–2004) | −4.21[a] | 2.86 | −1.47 |
| OTHER | −1.22 | 2.89 | −0.42 |
| HISTORICAL | −14.10*[a] | 7.75 | −1.82 |
| PRICEBEFORE | 2.45 | 2.60 | 0.94 |
| PRICEWAR | 5.72 | 6.26 | 0.91 |
| YARDSTICK | 2.76 | 3.23 | 0.85 |
| COST–PROFIT | 1.48 | 3.99 | 0.37 |
| ECONOMETRICS | 0.99 | 3.60 | 0.27 |
| JOURNAL | −0.76 | 2.55 | −0.30 |
| EDITBOOK | −2.70 | 3.86 | −0.70 |
| GOVREPORT | −13.33*[a] | 4.62 | −2.88 |
| COURTDECISION | 4.29+ | 2.80 | 1.53 |
| WORKPAPER | 1.27 | 3.14 | 0.40 |
| SPEECH | 1.32 | 9.22 | 0.14 |
| CONSTANT | 24.04*[b] | 3.65 | 6.59 |
| R2 (R2adj) | 0.1233 (0.0588) | | |
| Breusch–Pagan LM St. (*p* value) | | 34.37 (0.1557) | |
| Wald St. (*p* value)/all variables/ | | 51.63 (0.0029) | |
| Wald St. (*p* value)/estimation methods/ | | 8.56 (0.2857) | |
| Wald St. (*p* value)/publication sources/ | | 14.21 (0.0273) | |

*The estimated coefficient is statistically significant at the 10% level of probability of Type-1 error with the use of a two-sided test. Ho: $\beta = 0$ and Ha: $\beta \neq 0$. Rejection regions are $(-\infty;-1.64)$ and $(1.64; \infty)$.

[a]We reject the null hypothesis Ho: $\beta > 0$ in favor of Ha: $\beta \leq 0$ under a one-sided test and 10% significance level. Rejection region is $(-\infty; -1.28]$.

[b]We reject the null hypothesis Ho: $\beta < 0$ in favor of Ha: $\beta \geq 0$ under a one-sided test and 10% significance level. Rejection region is $[1.28; \infty)$.

12% of the variation in dependent variable, the overcharge rate. With the use of a Wald statistic we test whether all explanatory variables (except intercept) are jointly significant. We reject the null hypothesis of no joint effect of all explanatory variables at a *p* value equal to .0029.

The estimated coefficient for FOOD is −4.5 and indicates that food-industry cartels on average impose lower overcharges than other industry cartels, holding all other factors constant. There are a few possible explanations for this outcome. First, as mentioned earlier, the benchmark markets (markets in absence of collusion) in the food industries

may be more concentrated than the benchmark markets in other industries. Industries producing food and feed ingredients such as citric acid or lysine are known to have high exit and entry barriers. Second, the products included in the food-industry group may have more substitutability among them relative to the rest of the industries. These may reduce the overcharge level in the food-industry cartel group. Finally, food-industry cartels may be less durable than those of other industries. The average duration of food-industry cartels is 6.87 years, whereas the average duration of other cartels is 9.16 years. In addition, the estimation results indicate that longer cartel episodes generate higher overcharges. This may partially explain why food-industry cartels tend to achieve lower overcharges than other industry cartels. Furthermore, this may suggest that food-industry cartels are less effective in comparison with other industry cartels. One of the reasons is that food industries are more often affected by demand shocks caused by population growth. It is known that during demand shocks there are incentives for cartel participants to deviate, and this may result in a price war, or lapse or termination of a collusive agreement. Therefore, it may be more difficult for a food-industry cartel to reach a monopolistic price level than for other industry cartels.

The signs of the estimated coefficients for DURATION, DOMESTIC, and GUILTY are as expected, and the sign of the estimated coefficient for BIDRIGGING is opposite to what we expected. Each additional 5 years of cartel operation increases the overcharge by 1.54 percentage points on average. Domestic cartels impose overcharges 5.42 percentage points lower than international cartels. The estimated coefficient for BIDRIGGING is −0.64, indicating that bid-rigging cartels impose slightly lower overcharges than cartels that are not bid rigging. The negative sign on this estimated coefficient is unexpected (see Table 1), but note that the magnitude is not significantly different from zero. Accordingly, we would fail to reject the null hypothesis that the coefficient is positive under a one-sided $Z$ test, which is compatible with our expectations. Cartels that were found or pled guilty impose 0.53 percentage points lower overcharges than legal cartels. This difference is not statistically significant.

As for the hypothesis on geographic price/overcharge discrimination the marginal effects for US, EUROPE, ASIA, and ROW are −3.51, −5.25, −2.30, and −2.20, respectively. These outcomes indicate that cartels impose lower overcharges in all these markets in comparison with the reference group of average world overcharges. As expected overcharges imposed in Asia and the ROW are not statistically significant from the reference group. The estimated coefficients for US and EUROPE exhibit considerably higher level of statistical significance than the estimated coefficients for ASIA and ROW. In addition, the overcharges are marginally lower in Europe than in the United States if compared to the reference world market. These results provide evidence that there is at least some geographic price/overcharge discrimination exercised by cartels. In addition, there is a tendency for cartels to achieve marginally lower overcharges in markets with strongly enforced antitrust laws, such as the United States (and Canada) and European countries than in Asia and the ROW.

The estimated coefficients for the antitrust law regimes provide mixed evidence about the size of the overcharges over time, which may reflect the effectiveness of antitrust law enforcement. For example, the overcharges imposed during 1920–1945 were 1.86 percentage points lower than overcharges imposed in 1891–1919. The overcharges imposed in 1946–1973 were 4.58 percentage points lower than the reference-period overcharges. These two coefficients show that antitrust law enforcement during the fourth period may have been more effective than during the third period relative to the second period. But

the overcharges during 1974–1990 and 1991–2004 were 0.82 and 4.21 percentage points lower than the reference-group overcharges. Therefore, the most recently imposed overcharges were approximately at the same level as the overcharges imposed in 1946–1973. In summary, there is a general tendency for the level of overcharges to decrease as antitrust enforcement becomes stronger in a subsequent period, but that it is not always the case when a longer time horizon is considered.

As the estimation results show, differences in the estimation methods as well as in publication sources explain some variability in the overcharge estimates. Based on the results of the Wald tests, differences in publication sources have a stronger impact on the variability in the overcharge estimates than differences in estimation methods. The reference group for the estimation methods is represented by PRICEAFTER. The overcharge estimates obtained from historical case studies are 14.10 percentage points lower than the overcharges estimated using the reference-group methods. The overcharges recovered with the use of price before conspiracy or price war as a proxy for the competitive price are 2.45 and 5.72 percentage points higher than those obtained using price after conspiracy as this proxy. The signs are as expected.

The overcharge estimates obtained from government official reports are 13.33 percentage points lower than the overcharge estimates collected from the reference-group source represented by monographs. In contrast, the overcharges determined as a result of court or antitrust authority decisions are on average 4.29 percentage points higher than those of the reference group.

## 6. CONCLUSION

The results of our study reveal several tendencies characterizing collusive behavior of private cartels starting in the 1770s and ending today. With the use of econometric procedures we quantified the impact of various cartel characteristics as well as the market and legal environments of cartel operation on the size of overcharge estimates presented in the literature. Our analysis accounts for differences in publication sources and estimation methods used to calculate overcharges. The results of our study have important antitrust policy implications.

The 2005 U.S. Federal Sentencing Guidelines assume that the average gain from a price-fixing conspiracy is 10% of the market price. Antitrust laws of other countries establish similar benchmarks. However, our sample provides evidence that the average level of overcharge imposed by all cartels is 19% and the median overcharge is 16% of the market price. This result suggests that the presumption about the average gain from price-fixing conduct may need to be critically re-evaluated. Food-industry cartels, on average, impose lower overcharges than cartels operating in other industries.

International cartels attain higher overcharges than domestic cartels. This outcome indicates that international cartels are more harmful than domestic cartels. The implication of this finding is that the issue of effective prosecution of international cartels acting across different jurisdictions of the antitrust authorities should be more effectively addressed on both the domestic and international levels.

As cartels grow older they tend to be more successful in manipulating the market price effectively. In contrast to the presumption of 2005 Federal Sentencing Guidelines, our sample evidence indicates that there is no statistically significant difference between overcharges imposed by bid-rigging cartels and other cartels. These results suggest that

cartel duration should be taken into account when the fines are calculated. Actually, antitrust laws of the United States and European Union foresee similar adjustments.

We find some evidence of geographic price/overcharge discrimination exercised by cartels. In addition, overcharges tend to be lower in the countries with the developed antitrust laws (United States, Canada, and European countries) relative to the countries with newly developed antitrust regulation, poorly enforced antitrust laws, or without any antitrust laws (Asia and the ROW). These findings imply that developing countries have to start enforcing antitrust laws to deter collusive conduct effectively.

Our results provide mixed support for the proposition that stronger antitrust enforcement over time would decrease the magnitude of overcharges. In our models we included six antitrust law regimes covering 1770–2004 and assumed that each subsequent regime was characterized by stronger rules and enforcement. We find that by taking two or three subsequent regimes we may find evidence of some decrease in the overcharge level while moving from one regime to another. But considering all six regimes together, we find that the overcharges imposed recently may be about the same magnitude as those imposed before the middle of the last century. In addition we find that guilty cartels tend to attain approximately the same level of overcharges as legal cartels. This suggests that participants of cartels operating illegally are very effective in supervising and enforcing cartel discipline.

Finally, we find that differences in estimation methods used to calculate overcharges and differences in publication sources where overcharge estimates were published have some impact on the magnitude of overcharges. Overcharges estimated as a result of historical case studies tend to be lower and overcharges estimated with the use of price-before-conspiracy, price-war, and yardstick methods tend to be higher than overcharges calculated with the use of a price-after-conspiracy method. As for publication sources, overcharge estimates found in official government sources are lower and overcharge estimates obtained from official court and antitrust authorities decisions are higher than the overcharge estimates reported in monographs.

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