Discussion Paper No. 12-050

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Non-technical summary

During recent decades European antitrust authorities have increasingly focused on the fight against cartels within the European market. Numerous alterations in European competition law, such as leniency programs or extensions of the fine spectrum, have been implemented with the objective to destabilize existing cartels and to deter potential future cartel agreements. In this context, cartel overcharges constitute one important indicator for the success and effectiveness of price-fixing. They are defined as the difference between the collusion price and an artificial competitive benchmark price and capture the mark-up for purchasers due to cartelization. The price overcharge transfers income from purchasers towards cartel members and thereby crucially determines the size of the deadweight loss. For competition authorities it is therefore of primary interest to have a clear understanding of the price setting behavior of cartels and overcharge analysis can provide valuable insights in this respect.

Using a sample of 191 overcharge estimates and several parametric and semiparametric estimation procedures, this paper analyzes in its first part the impact of different cartel characteristics and the market environment on the magnitude of overcharges for the European market. The second part of the paper then focuses on the question whether the fine level according to the current EU Guidelines is sufficient for effective cartel deterrence.

We find that the mean and median overcharge rates are 20.70 percent and 18.37 percent of the selling price and an average cartel duration of 8.35 years. The analysis reveals further that overcharges attained in Western and Northern Europe are significantly lower, and overcharges attained in Southern Europe, Eastern Europe and the UK are not significantly different from reference group overcharges. Regarding different cartel characteristics, empirical evidence suggests that international cartels impose higher overcharges than domestic cartels and that cartel experience in terms of repeated attempts to collude influences the magnitude of overcharges negatively. Estimation results further indicate that bid-rigging cartels obtain higher overcharges than non bid-rigging cartels. In addition, we do not find changes in the overcharge level over time, implying that adjustments in EU competition law during recent decades did not lead to reservation in the price-setting behavior of cartels. Last but not least, a comparison between cartel overcharges and the existing fine level according to the current EU Guidelines shows that collusion has been a lucrative business for most firms from an ex-post perspective. In 67 percent of the cases the gain from price fixing outweighs expected punishments although the calculations are based on maximum values for cartel detection and upper limits of penalty levels. We therefore conclude that further adjustments of the EU Guidelines are indispensable in order to achieve optimal deterrence.

Das Wichtigste in Kürze

In den vergangenen Jahrzehnten hat sich der Fokus europäischer Wettbewerbsbehörden zunehmend auf den Kampf gegen Kartelle innerhalb des europäischen Marktes gerichtet. Zahlreiche Neuerungen im europäischen Kartellrecht, wie zum Beispiel Kronzeugenprogramme oder Anhebungen des Strafniveaus, wurden mit dem Ziel eingeführt bestehende Kartelle zu destabilisieren und potenzielle zukünftige Kartellvereinbarungen abzuschrecken. Kartellpreisaufschläge stellen in diesem Zusammenhang einen wichtigen Indikator für den Erfolg und die Effektivität von Kartellen dar. Sie ergeben sich aus der Differenz zwischen dem Kartellpreis und einem hypothetischen Wettbewerbspreis und erfassen damit die Preiserhöhungen infolge von wettbewerbswidrigen Preisabsprachen. Der Preisaufschlag führt zu einem Einkommenstransfer von den Kartellabnehmern hin zu den Kartellanten und bestimmt damit maßgeblich die Höhe des Wolfahrtsverlustes. Für Wettbewerbsbehörden ist es daher von großem Interesse ein klares Verständnis bezüglich des Preissetzungsverhaltens von Kartellen zu haben und Preisaufschlagsanalysen können in dieser Hinsicht wertvolle Erkenntnisse liefern.

Das vorliegende Papier analysiert im ersten Teil unter Verwendung einer Stichprobe bestehend aus 191 Preisaufschlagsschätzungen sowie mehreren parametrischen und semiparametrischen Schätzverfahren den Einfluss verschiedener Kartelleigenschaften und des Marktumfeldes auf die Höhe des Preisaufschlags in Europa. Im zweiten Teil liegt der Fokus dann auf der Frage, inwiefern die Strafmöglichkeiten in den gegenwärtigen Europäischen Leitlinien ausreichend sind um eine effektive Kartellabschreckung zu erzielen.

Der durchschnittliche Kartellpreisaufschlag sowie der Median betragen 20.70 bzw. 18.37 Prozent des Verkaufspreises und die durchschnittliche Kartelldauer umfasst 8.35 Jahre. Die erzielten Preisaufschläge sind in West- und Nordeuropa signifikant niedriger, und in Südeuropa, Osteuropa und im Vereinigten Königreich nicht signifikant verschieden von den Preisaufschlägen aus der Referenzgruppe. Hinsichtlich verschiedener Kartelleigenschaften zeigt sich, dass internationale Kartelle höhere Preisaufschläge erzielen als inländische Kartelle und dass die Kartellerfahrung im Sinne von wiederholten Kollusionsversuchen die Höhe des Preisaufschlags negativ beeinflusst. Die Schätzergebnisse deuten zudem darauf hin, dass Bieterkartelle höhere Preisaufschläge verlangen als klassische Kartellvereinbarungen. Hinsichtlich zeitlicher Veränderungen zeigen die Ergebnisse keinerlei signifikante Änderungen des Preisaufschlagsniveaus im Zeitverlauf an, was darauf hindeutet dass die Anpassungen im europäischen Wettbewerbsrecht in den letzten Jahrzehnten zu keiner Zurückhaltung im Preissetzungsverhalten der Kartellanten geführt haben. Ein Vergleich zwischen den Kartellpreisaufschlägen und den bestehenden Bußgeldmöglichkeiten gemäß der Europäischen Leitlinien bestätigt, dass die Kartellbildung für die meis-

ten Firmen aus ex-post Perspektive ein lukratives Geschäft war. In 67 Prozent der Fälle übertrifft der Kartellgewinn die erwarteten Bußgeldzahlungen, obwohl die Berechnungen auf maximalen Werten für die Aufdeckungswahrscheinlichkeiten sowie den Obergrenzen der bestehenden Bestrafungsmöglichkeiten basieren. Wir schließen daraus, dass weitere Anpassungen der Europäischen Leitlinien unumgänglich sind um eine optimale Abschreckungswirkung zu erzielen.

Cartel Overcharges and the Deterrent Effect of EU Competition Law

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Abstract

This paper examines cartel overcharges for the European market. Using a sample of 191 overcharge estimates and several parametric and semi-parametric estimation procedures, the impact of different cartel characteristics and the market environment on the magnitude of overcharges is analyzed. The mean and median overcharge rates are found to be 20.70 percent and 18.37 percent of the selling price and the average cartel duration is 8.35 years. Certain cartel characteristics and the geographic region of cartel operation influence the level of overcharges considerably. Furthermore, empirical evidence suggests that the currently existing fine level of the EU Guidelines is too low to achieve optimal deterrence.

Keywords: cartels, overcharges, Europe, fines, deterrence, damages
JEL-codes: L13, L41, L44

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1. Introduction

During recent decades European antitrust authorities have increasingly focused on the fight against hardcore cartels[1] within the European market. Numerous alterations in European competition law, such as leniency programs or extensions of the fine spectrum, have been implemented with the objective to increase the effectiveness of cartel prosecution and to achieve better deterrence. Initial successes regarding a more effective cartel prosecution can be validated with a current statistic of the European commission. Whereas 21 cartel cases were decided by the European Commission between 1990 and 1999, the number increased more than threefold to 66 cases between 2000 and 2009.[2] On the other hand, this increase in discovered cartels could also result from a rising number of active price-fixing agreements, suggesting that cartels are not impressed by recent adjustments in European competition law and that the aim of optimal deterrence is still not achieved.

One important indicator for the success and effectiveness of collusive agreements are cartel overcharges (Bolotova, 2009). They are defined as the difference between the price during collusion and an artificial competitive benchmark price (the so called but for price) and capture the mark-up for purchasers due to collusion. The price overcharge transfers income from purchasers towards cartel members. The higher the price overcharge, the higher the deadweight loss for purchasers and consumers. For antitrust authorities it is therefore of primary interest to have a clear understanding of the price setting behavior of cartels and there are several reasons why overcharge analysis can provide valuable insights in this respect. Firstly, knowing different overcharge patterns in dependence of underlying cartel characteristics allows to identify factors fostering cartel success in terms of overcharge level, cartel life span and repeated attempts to collude. Secondly, certain industries and regional markets may be identified in which outstanding overcharges are attained and more in depth screenings should be implemented. And last, descriptive statistics - in particular average cartel duration and mean overcharge level - can be used in order to assess the success of price-fixing agreements. This enables antitrust authorities to approximate existing fine levels to the point of optimal deterrence.

The empirical literature on cartel overcharges primarily originates from Connor and Bolotova (2006, 2007, 2008 and 2009) and mainly deals with the US and international market. A separate econometric analysis of the European market is new to the best of my knowledge.[3] Using a data set with 191 overcharge estimates

[1] Hardcore cartels are defined as "... a group of firms who have agreed explicitly among themselves to coordinate their activities in order to raise market price - that is, they have entered into some form of price fixing agreement." (Pepall et al., 1999, p. 345).

[2] See the official statistics of the European Commission: http://ec.europa.eu/competition, last accessed on June 6th, 2012.

[3] It is worth noting that Connor and Lande (2006) analyze European overcharges in one section of their paper. However, their analysis is descriptive and targeted on implications for fining policies in the EU and USA. The present paper therefore constitutes the first detailed analysis

solely for the European market, the paper at hand bridges this gap and presents a well-founded econometric analysis in this respect. Even more important than the geographic region is the methodological framework of this study, as in addition to the current parametric procedures two semiparametric regression methods are applied.

Specifically, the following questions that can be important for antitrust authorities in Europe will be clarified in this paper:

1. Which factors influence the size of cartel overcharges in Europe? Do certain cartel characteristics (duration, international or domestic, legal or illegal, number of repeated attempts to collude) as well as the legal and geographic environment of cartel operation have significant impact on the magnitude of overcharges?

2. During recent decades European antitrust policy has experienced a steady process of growth. The foundation of a common European competition policy was laid down in the Treaty of Rome in 1957 (Carree et al., 2010). Since that date European antitrust law has continuously been revised in order to increase efficiency in cartel prosecution and to improve the deterrent effect.
   Did these changes over time (introduction of leniency programs, increase in fine levels) significantly reduce the magnitude of cartel overcharges?

3. In 1998, the European Commission introduced Guidelines on the method of setting fines for the first time. These guidelines were revised in 2006 to increase the deterrent effect. Is the level of punishment according to the current EU Guidelines sufficient for effective deterrence?

The paper is organized as follows. Section 2 contains basics on cartel overcharges and summarizes the existing literature. Information about the data set and the case selection procedure are given in section 3 and descriptive statistics are presented in section 4. The estimation results are discussed in section 5. Section 6 deals with the question whether the current existing fine level of the EU Guidelines is sufficient for effective deterrence. The paper concludes with a summary of the main results in section 7.

of European overcharges that uses multivariate approaches and also captures regional differences within Europe.

2. Cartel overcharges

Cartels are anticompetitive agreements between rivals who collectively attempt to control market prices and/or output quotas. The fundamental incentive for firms to take part in collusive agreements is that they can generate a supra-competitive profit that is higher than the sum of the profits of each potential member absent from collusion. The cartel success in terms of monetary reward thereby crucially depends on two factors, the duration of the period the cartel is able to raise prices above the competitive level without being discovered by antitrust authorities, and the magnitude in which but for profits are exceeded. The latter factor is reflected in the cartel overcharge, which is defined as the difference between the price during collusion and an artificial competitive benchmark price. The benchmark price captures the price purchasers would have been paid without a collusive agreement in the concerned market and is therefore not observable.[4]

In the context of empirical analysis, cartel overcharges are usually not used directly, but in terms of a relative measure. Bolotova et al. (2008) distinguish between two overcharge rates, where the first is calculated as a ratio of the price overcharge to the price during collusion (formula 1) and the second as a ratio of the price overcharge to the benchmark price (formula 2):

$$OvRate(1) = \frac{P_{collusion} - P_{benchmark}}{P_{collusion}}$$

$$OvRate(2) = \frac{P_{collusion} - P_{benchmark}}{P_{benchmark}}.$$

As both approaches depend on the same parameters and only differ regarding the price in the denominator, both formulas can basically be used for estimation purposes. However, the first one has at least two important advantages over the second. Firstly, overcharges calculated with formula 1 have an upper boundary of 100 percent, while overcharges computed with formula 2 would partly yield values far above 100 percent. Secondly, the mean overcharge calculated with formula 1 can be directly compared with the level of cartel sanctions defined in European antitrust law. These sanctions are calculated as a proportion of the value of affected sales, which allows a deduction of evidence concerning the deterrent effect of the existing fine level (Bolotova, 2009). This is the reason why the first overcharge rate is used in the course of this paper.

The existing literature on cartel overcharges can be subdivided in an empirical and a more theoretical oriented part. The theoretical strand of literature - not further considered here - focuses on cartel overcharges as the starting point for damage quantifications in the context of competition law enforcement. In this regard, contributions by Verboven and van Dijk (2009), Han et. al (2009) and Basso and Ross

[4] A summary of different quantitative methods for estimating this "but for price" can be found in Davis and Garces (2010), Chapter 7.

(2010) must be mentioned. By comparison, empirical surveys on cartel overcharges primarily originate from Connor and Bolotova.

Connor and Bolotova (2006) conduct a meta analysis of cartel overcharges in order to determine the impact of different cartel characteristics as well as the method of calculation (yardstick, historical case study, price before/during/after conspiracy as benchmark price etc.) and publication source (journal, court or antitrust authority, monograph etc.) on the magnitude of overcharge rate. Bolotova et al. (2007) consider an empirical analysis of food industry cartels. Bolotova (2009) analyzes the impact of cartel characteristics and the market environment on the magnitude of overcharges attained by cartels in different geographic markets and during six antitrust law regimes. Last but not least, Bolotova et al. (2008) consider this relation in a separate empirical paper solely for the US market.

These surveys yield mean (median) overcharge rates between 20.71 and 28.88 (17.10 and 20) percent, depending on the type of overcharge rate, the data used and the case selection procedure. Regarding the impact of cartel characteristics and the market environment on the magnitude of overcharges, all estimations mainly show a consistent tendency. International cartels impose significantly higher overcharges than domestic cartels. Cartel duration and cartel market share also seem to influence the magnitude of overcharges positively. On the other hand, overcharges enforced by bid-rigging or guilty cartels are not significantly different from overcharges attained by non bid-rigging or legal cartels. Moreover, their results suggest that overcharges realized in the US and European markets are lower than in the reference market (Rest of the world) and that the lowest overcharges are associated with the latest antitrust law period.

In this investigation the same data basis as in the articles by Connor and Bolotova is used, but there are at least three important differences that should be mentioned. Firstly, we solely concentrate on the European market, whereas Connor and Bolotova either use US overcharges or overcharges from all over the world. A separate analysis for the European market is important as it enables us to capture regional variations in Europe. This facilitates to identify geographic areas within Europe where surpassing overcharges are attained and thus contain lucrative framework conditions for cartels. Secondly, a separate European study allows to compare the mean overcharge level enforced by cartels in the European market with the existing fine level according to the current EU guidelines. We will use such a comparison in order to decide whether the sanctions are sufficient for optimal deterrence or further adjustments are indispensable. Thirdly, in addition to current parametric estimation methods two semiparametric procedures (Censored Least Absolute Deviations, Symmetrically Censored Least Squares) are used in this paper in order to account for non-normality problems of the error terms. In addition, comparing the results between parametric and semiparametric procedures as well as among semiparametric

methods enables robustness checks regarding significance and validity of the results.

3. Data set and case selection procedure

We use part of the data provided by Connor (2010) in the Appendix Tables 1 and 2 of his paper. The original data set contains 1517 overcharge estimates referring to 381 product markets. The data were collected from approximately 600 sources and refer to the period between 1770 and 2009. They originate from court and commission decisions, OECD reports, peer-reviewed journals, books, dissertations, government reports and other sources. In most cases these sources already contain overcharge calculations, in the rest of the cases, Connor used price data to estimate them on his own. The cartel overcharges were calculated using different methods (before-and-after, yardstick etc.) and are stated as overcharge rates pursuant to formula 2 (ratio of the price overcharge to the benchmark price). To analyze cartel overcharges for the European market, we use part of this data and employ the following case selection procedure.

First of all, we solely select cartel overcharges that are related to the European market.[5] In most cases the geographic location of the cartel participants coincide with the concerned market.

Furthermore, the original data set contains two types of overcharge estimates, average and peak overcharges. The latter usually refer to the most successful period during cartel activity. According to Bolotova (2009) we chose the average level of overcharge, as it represents the cartel impact over the full period of conspiracy.[6] Since the overcharges are stated as overcharge rates pursuant to formula 2 they were transformed into overcharge rates as percentage of price during collusion (formula 1).[7]

Analogous to Bolotova (2009) and Bolotova et al. (2008) every observation in the sample represents one cartel episode, whereas one cartel episode is regarded as an uninterrupted period of collusion with a corresponding set of rules and membership. It is possible that some cartels are represented by more than one cartel episode and therefore contribute multiple observations to the data set. Reasons for this are temporary breakdowns due to opportunistic behavior of cartel members, changes in the market environment or changes in the internal structure of cartel agreements (Bolotova, 2009). Consequently, it is assumed that the overcharges of several episodes

[5] The European market is composed of member states of the EU and countries that geographically belong to Europe (Swiss, Norway, Iceland etc.).

[6] There are a few cases in which only peak overcharges are available. In order to compile a data set for Europe as large as possible, we checked these peaks in detail and incorporate ten into the sample. These observations do not represent outliers.

[7] Apart from the mentioned advantages of formula 1 over formula 2, this is also useful for another reason. Before the transformation, the minimum, maximum, mean and median overcharge values were 0, 450, 33.44 and 21 percent, afterwards these values are 0, 81.82, 20.7 and 18.37 percent. That is, the distribution of cartel overcharges is less skewed after the transformation.

of the same cartel differ due to theses aspects. This is the reason why each cartel episode is treated as one observation unit in the data set.[8]

For some cartel episodes several overcharge estimates are available. This is due to the fact that the same cartel episode was analyzed by a number of authors or multiple estimation methods were used in a single survey. In such cases the median overcharge estimate was selected. Altogether the data set consists of 191 overcharge estimates for the European market.

Apart from the geographic region and magnitude of overcharges, the Appendix Tables in Connor (2010) also contain information on cartel membership (domestic or international), cartel legal status (illegal or legal), cartel beginning and ending dates and whether it is a bid-rigging cartel or not. All this information is included in the data set and used in the upcoming descriptive statistics and econometric analysis.

4. Descriptive statistics

Table 1 contains descriptive statistics for the entire data set. The mean cartel overcharge in the European market is 20.70 percent and the median is 18.37 percent of the selling price. Regarding cartel durability the average cartel duration is 8.35 years and the corresponding median is 5 years. The shortest cartel merely existed a few weeks and the longest almost survived 71 years.

The average cartel experience in terms of the number of repeated attempts to collude is 0.52.[9]

Table 1: Descriptive statistics.

Variable	Mean	S.D.	Variable	Mean	S.D.
Overcharge (%)	20.70	15.63	Eastern Europe	0.01	0.10
Duration	8.35	11.10	Southern Europe	0.06	0.23
Experience	0.52	1.30	Northern Europe	0.07	0.25
Domestic	0.48	0.50	P1 (until 1945)	0.41	0.49
Bid-rigging	0.20	0.40	P2 (1946-1956)	0.08	0.27
Legal	0.28	0.45	P3 (1957-1977)	0.08	0.28
Europe	0.33	0.47	P4 (1978-1989)	0.10	0.29
United Kingdom	0.31	0.46	P5 (1990-2009)	0.33	0.47
Western Europe	0.22	0.42			

[8] For econometric estimations the observations were clustered among cases. The overall data set consists of 191 overcharge estimates that refer to 129 cartel cases.

[9] The number of repeated attempts to collude (experience) for one observation is calculated as the number of cartel episode of the underlying observation minus one.

48 percent of the cartels are domestic in membership and 52 percent are international. In this survey a cartel is assigned to the domestic group, if all members belong to the same country. If two or more members originate from different countries, the cartel is considered as international. 20 percent of the observations in the sample represent bid-rigging cartels and 28 percent legal cartels. Legal cartels are those that predate antitrust laws or that were authorized by a government authority, illegal conspiracies in contrast are those that were found or pled guilty (Bolotova, 2009).

The geographical distribution of the observations is as follows. One third of the overcharges refer to several European countries or alternatively to several member states of the EU and 31 percent to the United Kingdom. Overcharges that relate to one single country within Western Europe represent 22 percent of the data. Of these, solely 80 percent are allotted to Germany and France. The rates for single countries within Northern, Southern and Eastern Europe are 7, 6 and 1 percent.[10]

In order to evaluate the success of European antitrust policy, five periods of time were defined. Every single period represents a more effective and severe antitrust law in comparison to its predecessor and each observation is assigned to the period in which the beginning date of the cartel episode lies.[11] 41 percent of the cartel episodes start in the period until 1945 and 33 percent in the period between 1990 and 2009. With 8 and 10 percent the remaining overcharges are almost evenly spread among periods 2 (1946-1956), 3 (1957-1977) and 4 (1978-1989).

As the overcharge estimates were collected from numerous different sources it is essential to check the origins more detailed in order to ensure adequate data quality (see Table 2).

Table 2: Data sources.

Variable	Mean	S.D.	Variable	Mean	S.D.
Book/Monograph	0.22	0.42	OECD	0.07	0.25
Journal	0.13	0.34	Nat. antitrust authority	0.12	0.33
Paper	0.09	0.29	Several sources	0.10	0.30
EC	0.21	0.41	Other sources	0.06	0.23

22 percent of the overcharge estimates were collected from books and 13 percent originate from articles of scientific journals. Papers from scientific institutions, reports by the European Commission and OECD articles represent 9, 21 and 7 percent and national antitrust authorities provide 12 percent of the observations. 10 percent of the data come from several sources and can not explicitly be allotted to one

[10] The allocation in Western, Eastern, Northern and Southern Europe is based on the Classification of the United Nations Statistics Division. The only difference is that the UK is treated separately and not as part of Northern Europe.

[11] The periods will be discussed in detail in chapter 5.1.

category.[12] The remaining observations derive from other sources (presentations on conferences, speeches etc.) and merely represent 6 percent. Hence, altogether at least 84 percent of the data either originate from scientific sources or other reliable institutions, indicating that the quality of the underlying data basis is sufficient for estimation purposes.

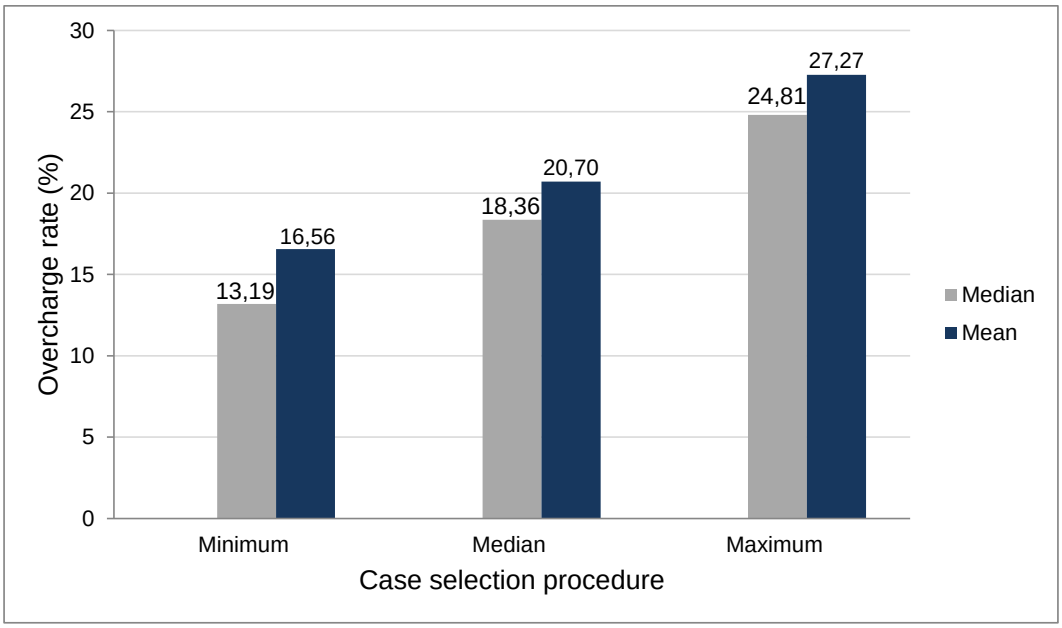

Figure 1: Mean and median overcharge rates for different case selection procedures.

As previously mentioned, the mean and median overcharge values (20.70 and 18.37 percent) are based on the median principle in the course of the case selection procedure. That is, the median value has been selected when multiple overcharge estimates for a single episode were available. To illustrate the impact of the case selection procedure on the magnitude of mean and median overcharge rates, Figure 1 contains these values for the minimum and maximum case selection procedures. If the minimum estimate is chosen instead of the median (Minimum principle), the mean and median cartel overcharges for the European market amount to 16.56 and 13.19 percent of the selling price. Conversely, if solely peak overcharges for Europe are chosen (Maximum principle), the corresponding values are 27.27 and 24.81 percent. The use of the median principle in this survey can be justified in that it describes the cartel impact more suitably. Minimum and maximum principle would probably under- and overestimate the true impact.

Figure 2 illustrates the Kernel density estimation as well as the distribution of the overcharge rates in 5-percentage-point ranges. As with increasing overcharge intervals the number of observations tends to decline, the distribution can generally be

[12] This is due to the fact that the median overcharge is used if several overcharge estimates are available for one cartel episode. Thus, in case of an even number of overcharge estimates for a single episode the median is calculated out of two values and these usually originate from different sources.

characterized as left skewed. 30 observations are associated with the smallest interval between 0 and 5 percent. Of these, 15 observations have zero values indicating that approximately 8 percent of ineffective cartel episodes existed in which cartelists were not able to raise prices above the competitive level. With 162 observations (85 percent) most of the overcharge rates fall within the range between 0 and 35 percent. The interval with the highest overcharge rates (80-85 percent) merely contains 2 observations, in which 81.82 percent of the selling price is the maximum value.

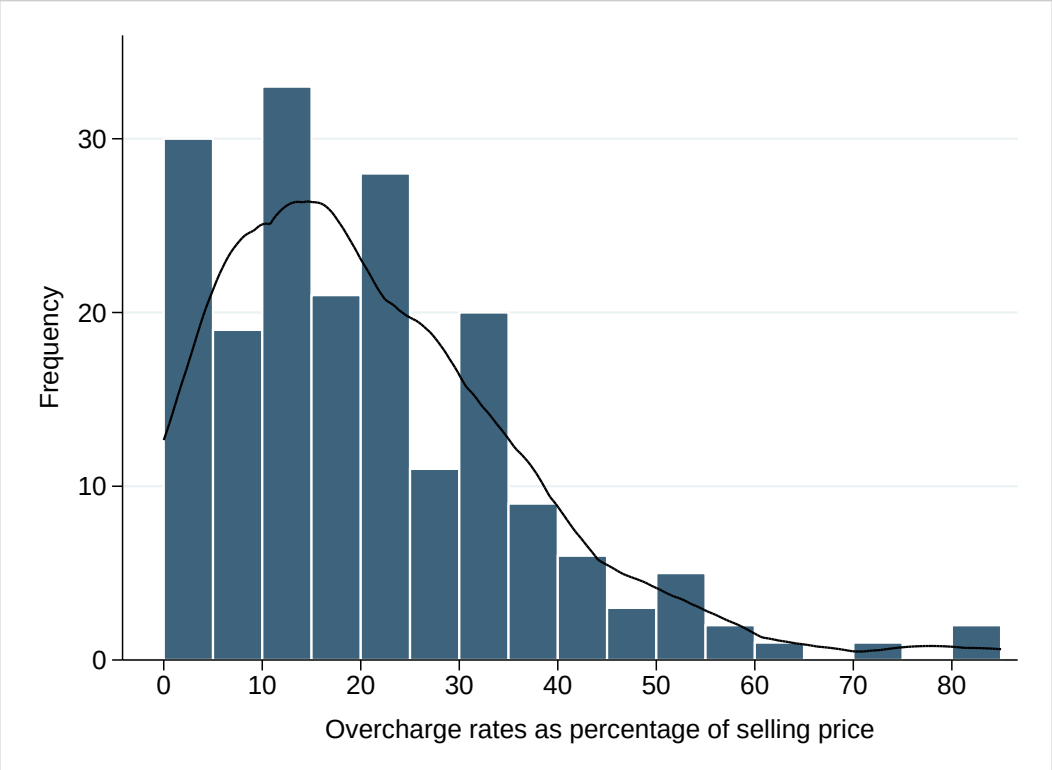

Figure 2: Distribution of overcharge intervals (5-percentage-point ranges) and Kernel density estimation.

Figure 3 illustrates the mean overcharges depending on different cartel characteristics. With 20.61 and 20.73 percent the difference in the magnitude of mean overcharges between bid-rigging and non bid-rigging cartels is negligible. The mean overcharge rate of illegal conspiracies (21.42) is 2.59 percentage points greater than for legal cartels (18.83). This seems surprising as legal cartels predate antitrust laws or were authorized by a government authority and illegal cartels in contrast can not impose exorbitant overcharges without catching attention of antitrust authorities to themselves. Nevertheless, illegal cartels are confronted with additional costs in order to coordinate their behavior in secret and this could be reflected in the higher overcharge rate. The most obvious difference regarding the magnitude of the overcharge rate is cognizable between domestic (16.39) and international (24.71) cartels. The latter ones imposed overcharges that are more than 8 percentage points greater than their domestic counterparts and 4 percentage points greater than the average overcharge rate of the entire sample. This indicates that international cartels are

particulary harmful for purchasers and consumers.

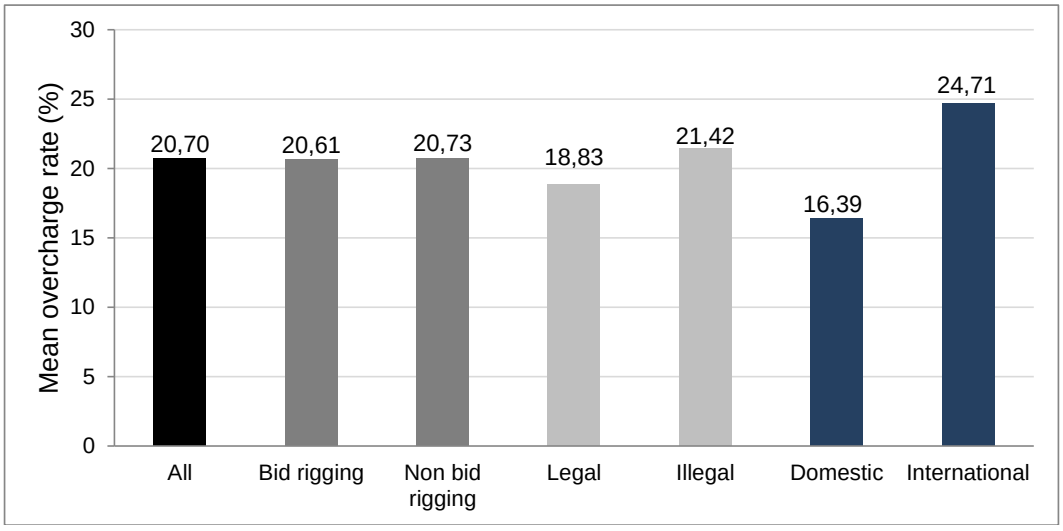

Figure 3: Mean overcharge rates by cartel type.

Figure 4 summarizes the mean overcharge rate and average cartel duration within different geographic regions of Europe.[13] It can be seen that in Southern and Eastern Europe the highest overcharges emerge (26.94 and 24.67 percent).[14] Simultaneously,

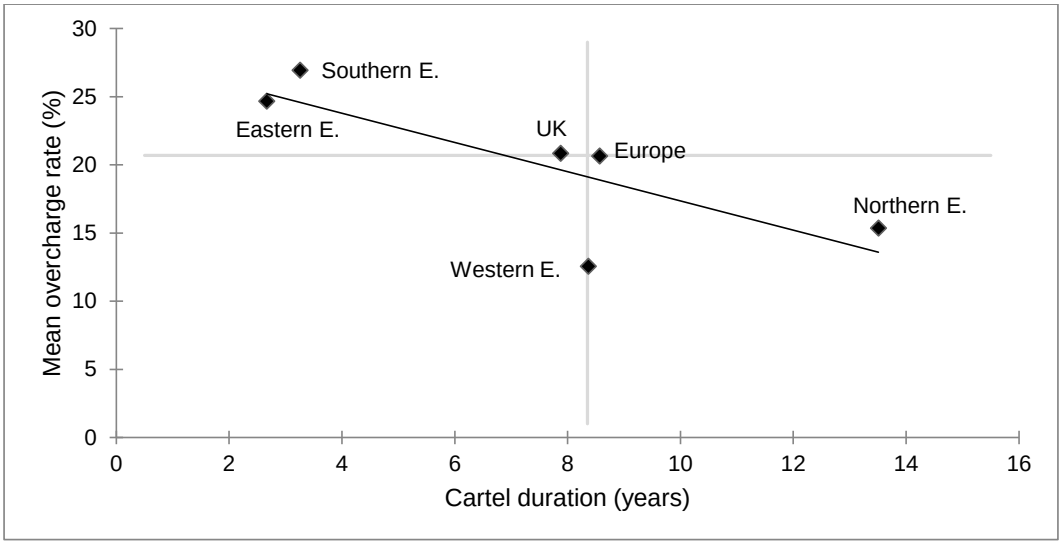

Figure 4: Mean overcharge rates and average cartel duration within different geographic regions of Europe.

the cartel duration in these regions is clearly below average (3.26 and 2.67 years). On the other hand, Northern Europe shows up the longest average cartel duration (13.51 years) and coevally the second lowest overcharge rate (15.36 percent). These

[13] In this Figure Europe contains all observations of single countries within Western, Eastern, Northern and Southern Europe as well as those observations that refer to several European countries (excluding the UK).

[14] Due to the small number of observations for Northern Europe, the result for this area should be considered with caution.

results suggest that high overcharges alert antitrust authorities early on and vice versa.[15]

Western Europe is characterized by the lowest mean overcharge rate (12.56 percent) and a cartel duration almost according to the average (8.37 years). Cartels in this region seem to have the most unfavorable framework conditions.

The comparison between Europe and UK shows, that the mean overcharge rate in both regions is almost identical and the variation in the average cartel duration merely yields 0.69 years (8.57 years for Europe and 7.88 years for the UK).

5. Econometric analysis

5.1. Empirical Model and Hypotheses

In order to analyze the impact of different cartel characteristics as well as the legal environment on the magnitude of cartel overcharges for the European market, the following model is estimated:

$$OvRate_i = \alpha + \beta C_i + \gamma P_i + \varphi G_i + \epsilon_i.$$

The dependent variable is the overcharge rate according to formula 1 and depends on several vectors, each containing a number of independent variables. C_i is composed of two continuous and three binary variables representing cartel characteristics. These include cartel duration, cartel experience, cartel membership, whether the cartel is legal or not and whether it is a bid-rigging cartel or not. P_i consists of four binary variables representing four antitrust law periods and describing the evolution of European antitrust law. Vector G_i contains five binary variables characterizing different geographic regions within the European market (Western E., Eastern E., Northern E., Southern E. and UK).[16]

Cartel characteristics

Cartel duration is one indicator for the stability and effectiveness of collusive agreements. The longer a cartel operates without being discovered by antitrust authorities or facing a cartel breakdown (internally) the more successful it is. In principle the relation between cartel duration and magnitude of overcharges is conceivable in both directions. On the one hand it is assumed that cartels with longer lifetimes tend to realize lower overcharges, as reservation in price policy reduces the probability of detection. Furthermore, with increasing cartel duration the danger of market entries

[15] This is also reflected in the trend line, which shows a negative slope.

[16] It is worth noting that we do not include a set of industry dummy variables to control for differences in market structures. This is due to the fact that including them results in insignificance for almost all coefficients and a F-test yields that the set of industry binary variables is not jointly significant. Furthermore, comparing the two model specifications (with and without industry dummies) regarding different information criterions (BIC, AIC, CAIC) as well as applying a Likelihood-ratio test confirms that the latter version should be used.

of new competitors increases. Due to the continuously high price level, rivals may try to catch demand by underselling the cartelized product. Hence, the cartel could temporarily be forced to revise the price downwards in order to prevent market entries. On the other hand, cartels with a longer life span are more experienced and can have a stronger impact on the price variance control than a less successful and stable cartel (Bolotova, 2009). This would indicate a positive relation between cartel duration and overcharge rate. Nevertheless we expect the estimated coefficient to be negative.

International cartels are likely to obtain higher overcharges than domestic cartels. Resulting from the bounded legal power of domestic antitrust authorities, cartels with members from two or more different countries are more difficult to prosecute than their domestic counterparts (Bolotova, 2009). Moreover, international cartels often eliminate import competition that domestic cartels are subjected to. On the contrary, due to the geographic distance and cultural differences, international cartels could be faced with communication and coordination problems and this probably counteracts success (Bolotova, 2009). Altogether, the estimated coefficient for domestic cartels is expected to be negative.

Collusive agreements on the basis of public tenders (bid-rigging cartels) are expected to attain higher overcharges than other types of collusive conducts. Members of bid-rigging cartels can use the reported information in order to monitor the behavior of the other participants and to detect cheating (Bolotova, 2009). This improves cartel stability and cartel success and the corresponding coefficient is therefore expected to be positive.

In contrast to illegal conspiracies, legal cartels need not conceal their behavior from antitrust authorities. Hence, it can be assumed that legal cartels impose higher overcharges than those that operate illegally. On the contrary, illegal cartels are confronted with additional costs in order to coordinate their behavior in secret. These higher costs could be reflected in higher overcharges and this would counteract the first effect. In summary, we expect no significant difference between legal and illegal cartels regarding the magnitude of overcharges.

Cartels often experience more than one cartel episode and the number of repeated attempts to collude indicates cartel stability and efficiency in that regard.[17] Another attempt to collude signalizes that the cartel has not been successful in raising the price to the targeted level in the preceding period(s) (Bolotova, 2009). Therefore, we expect the sign of the estimated coefficient regarding cartel experience to be negative.

[17] Reasons for temporary breakdowns are e.g. opportunistic behavior of cartel members, changes in the market environment or changes in the internal structure of cartel agreements (Bolotova, 2009).

Legal environment

Apart from cartel characteristics we expect that the legal environment influences the magnitude of overcharges. We take the legal environment into account by means of two factors, the geographic region and the date of collusion.

Concerning the geographic region we expect the overcharges to be lower in countries with more severe antitrust laws and more efficient antitrust authorities, as cartels in these regions find less attractive framework conditions for their machinations and are stronger deterred by comparison. Within Europe, antitrust authorities located in Germany, France and the UK are commonly seen as the most developed and progressive ones. Following this reasoning we expect the overcharges in Western Europe and the UK to be significantly lower, and the overcharges attained in Southern and Eastern Europe to be significantly larger than the overcharges of the reference group. For Northern Europe no significant difference from reference group overcharges is expected. The reference group is represented by overcharges that refer to several countries within Europe and that can not be explicitly attributed to one of the before mentioned regions.

In order to evaluate the success of European antitrust policy, five periods of time were defined. Every single period represents a more effective and more severe antitrust law regime in comparison to its predecessor. During the first period of time (until 1945) cartels could almost act undisturbed in Europe, as neither in single European countries nor at pan-European level effective antitrust authorities existed. Hence, we expect the highest overcharges in this period and it represents the reference group for the following antitrust law regimes.

The second period between 1946 and 1956 is characterized by initial antitrust ideas that were established by law within single European countries. In Germany this happened in 1947 and in the UK not before 1956 (Connor, 2010). The Treaty of Paris which established the European Coal and Steel Community in 1951 can also be allotted to this period. Apart from the main objective to create a common market for these products, articles 60, 65 and 66 also included prohibitions of discrimination, cartels and mergers (Schmidt, 2005).

The starting point of the third period (1957-1977) is 1957, in which the Treaty of Rome followed on the Treaty of Paris. With this convention the European Economic Community has been established and it is considered to be the date of founding of European competition policy. This is reflected in Article 3(1)(g) of the Treaty which defines as one of the main objectives the accomplishment of a system ensuring that competition in the internal market is not distorted (Carree et al., 2010). Aside from that, the German Bundestag passed the Act against Restraints of Competition (GWB) in 1957 and one year later the German Federal Cartel Office was established. Furthermore, the first illegal cartel was successfully convicted by the European Commission in 1969 (Connor, 1999).

The fourth period between 1978 and 1989 is characterized by a considerable increase of discovered cartels. While only five cartels were punished by the European Commission in the seventies, the number rose to 16 cases during the eighties (Connor, 1999). The year 1989 in which the European Council passed the Merger Control Regulation builds the end of this period.

The latest antitrust law regime spans from 1990 to 2009 and contains numerous alterations in European antitrust law that have been implemented with the objective to increase the effectiveness of cartel prosecution and to achieve better deterrence. They include amongst others the European leniency program, which has been introduced in 1996 and closer adjusted to its US counterpart in 2002 and the European Guidelines on the method of setting fines, that have been introduced in 1998 and revised in 2006. Furthermore, this period is characterized by a well-directed focus of decision making on the basis of recent findings in theoretical Industrial Organization, leading to a "more economic approach" in European competition law.

Under the assumption that each antitrust law regime represents a less favorable and more deterrent environment compared to its predecessor(s) and that cartels react to these changes via price restraints, the signs of the estimated coefficients for periods 2, 3, 4 and 5 should be negative and decreasing relative to the reference period 1 (until 1945). On the other hand it is also thinkable that some firms are deterred by these antitrust law changes and therefore refuse cartel participation at all, whereas those who agree deliberately respond to increasing fines via rising overcharges in order to make expected profits more lucrative. This would suggest a positive impact. Altogether, we expect the first effect to dominate and therefore a decreasing trend in the overcharge level over time.

5.2. Estimation Procedures and Data Issues

We estimate the empirical model using two parametric (OLS, Tobit) and two semiparametric (CLAD, SCLS) procedures. As eight percent of the overcharges are corner solutions with zero values, Tobit seems to be an appropriate alternative to OLS. However, Tobit needs homoscedastic and normal distributed errors and testing these assumptions results in violations. To account for these problems, Censored Least Absolute Deviations and Symmetrically Censored Least Squares are used as alternatives to Tobit. The CLAD estimator is only based on the "zero median" assumption and therefore neither needs homoscedasticity nor normal or symmetric distributed errors for consistency. SCLS in contrast is restricted to error terms symmetrically distributed around zero, which implies that both median and mean are zero (Chay and Powell, 2001).[18]

Furthermore, due to the type of data used in this survey, there are at least two problems that should be discussed. Firstly, the sample solely contains overcharges that were selected by the author and that refer to discovered cartels on which infor-

[18]For contentual and technical details on CLAD and SCLS, see Powell (1984) and Powell (1986).

mation is available. Therefore, the data set has features of a non-random sample and this could bias results. Undiscovered cartels are likely to attain lower overcharges and do not attract attention of antitrust authorities to themselves for that reason. Hence, the mean overcharge level of this sample is probably greater than in a perfect random sample.

The second issue concerns omitted variables. As the overcharges originate from numerous different sources it is difficult to collect information about the same explanatory variables for each case. This means that several variables that are likely to affect the magnitude of overcharges (number of members, market share) are omitted and this could also bias estimation results via endogeneity.[19]

Due to the illegal nature of cartels and the general problem of gathering information about them, we have to accept these issues. Nevertheless, the signs and significance of the estimated coefficients should have priority and the exact magnitude of them should not be overinterpreted.

5.3. Estimation results

Table 3 summarizes the estimation results.[20] The OLS results suggest that more experienced cartels attain lower overcharges. On average, another attempt to collude decreases the magnitude of overcharges by 1.37 percentage points, even though this effect is only significant at the ten percent level using a one-sided test. The negative sign confirms expectation, as a higher number of repeated attempts to collude implies less stability and therefore less cartel success.

Domestic cartels achieve overcharges that are almost 8 percentage points lower than overcharges obtained by international cartels. This effect is highly significant and confirms expectation that international cartels with participants located in different countries show a clearly higher overcharge pattern and are therefore particulary harmful for consumers. Moreover, estimation results indicate that bid-rigging cartels attain overcharges that are 4.71 percentage points higher than those of non bid-rigging cartels. On the contrary, there is no significant difference between cartels that were found or pled guilty and legal cartels. The impact of cartel duration on the magnitude of overcharge rate is also not statistically significant. It seems that the mentioned effects cancel out each other to such an extent, that the negative impact (a higher overcharge rate increases the probability of detection and lowers

[19] E.g. the number of cartel members (omitted variable) is assumed to be negatively correlated with cartel duration (endogenous variable). Coincidentally, the number of cartel members is also assumed to be negatively correlated with the magnitude of overcharges. Thus, cartel duration is overestimated in the present survey.

[20] Standard errors are reported in parentheses. For OLS, robust standard errors were generated. The standard errors for CLAD and SCLS were calculated using bootstrap techniques (1000 repetitions). In order to make OLS and Tobit results comparable, the marginal effects are reported for Tobit. As one observation represents one cartel episode and not necessarily one cartel case, the observations were clustered among cases.

Table 3: Estimation results.

Variable	OLS		Tobit		CLAD		SCLS	
Duration	-0.04	(0.10)	-0.06	(0.11)	-0.01	(0.16)	-0.12	(0.24)
Experience	-1.37*	(0.97)	-1.32*	(0.97)	-1.43*	(1.1)	-1.28	(3.34)
Domestic	-7.78***	(3.45)	-8.39***	(3.47)	-9.37**	(4.82)	-13.41*	(9.95)
Bid-rigging	4.71*	(3.69)	5.25*	(3.72)	6.01*	(3.90)	5.57	(5.45)
Legal	3.67	(4.60)	2.36	(4.63)	5.26	(5.54)	6.49	(6.73)
P2 (1946-1956)	-8.00	(7.23)	-7.28	(7.26)	-9.72*	(7.08)	-12.30	(15.13)
P3 (1957-1977)	0.56	(3.76)	1.64	(3.52)	3.21	(5.70)	4.17	(10.58)
P4 (1978-1989)	-1.03	(4.43)	-0.86	(4.58)	3.65	(7.91)	-1.50	(11.53)
P5 (1990-2009)	-1.27	(4.34)	-1.11	(4.18)	1.65	(6.49)	-0.16	(11.12)
Western Europe	-12.39***	(3.13)	-13.60***	(3.25)	-15.17***	(4.26)	-16.15***	(6.00)
Eastern Europe	-3.09	(7.41)	-3.60	(7.00)	-	-	-2.83	(7.37)
Northern Europe	-9.08***	(4.28)	-9.68***	(4.42)	-11.32***	(5.66)	-6.86	(8.29)
Southern Europe	-2.77	(9.28)	-3.81	(9.45)	-1.22	(11.59)	-5.62	(7.86)
United Kingdom	3.00	(5.03)	3.15	(4.97)	4.10	(7.41)	9.26	(8.14)
Constant	26.80***	(4.41)	-	-	23.76***	(6.51)	25.19***	(12.65)
R^2	0.21		0.22		0.15		0.35	

***Significant at the 5%-level using a two-sided test.

**Significant at the 10%-level using a two-sided test.

*Significant at the 10%-level using a one-sided test.

cartel duration) does not prevail as expected.

Regarding different antitrust law regimes, the results contradict expectations. Although periods 2, 4 and 5 show negative signs, the estimated coefficients are not statistically significant. Thus, more severe antitrust regulations do not seem to lead to reservation in the price-setting behavior of cartels.

This finding is surprising and indicates that cartels acting in Europe are not deterred by recent adjustments of national and pan-European antitrust laws. However, as mentioned before one could also argue that exactly these fine adjustments in preceding years encouraged cartel participants to increase their overcharge level. As the fine level becomes higher some firms might decide to either reject collusion at all (optimal deterrence) or to start collusion and demand exorbitant overcharges in order to outweigh expected punishments. Following the latter reasoning as well and taking both arguments together, the insignificant changes in the overcharge level during the five antitrust law periods are not unexpected.

Nevertheless, one should keep in mind that the change in the magnitude of overcharges is only one indicator for deterrent effects of antitrust law adjustments. Other factors such as cartel stability in terms of cartel duration, number of repeated attempts to collude or internal uncertainties due to leniency programs must be taken in to account as well. In this context it is worth noting that both cartel duration

and repeated attempts to collude decreased noticeably in the latest two antitrust law periods, indicating destabilization and deterrent effects of antitrust law changes over time.

Cartel overcharges considerably differ regarding the geographic region of cartel operation. Overcharges that refer to single countries within Western Europe are 12.39 percentage points lower on average than overcharges of the reference group and the corresponding coefficient is highly significant. A similar result is observed for single countries within Northern Europe. It seems that antitrust authorities and antitrust laws in these two regions are more effective by comparison. In contrast, overcharges attained in single countries within Southern Europe, Eastern Europe or the UK are not significantly different from reference group overcharges. Cartels in these locations seem to have more attractive framework conditions by comparison. Testing the null hypothesis of no statistically significant differences among overcharges attained in these five geographic markets results in rejection (p-value is 0.000). Altogether, the geographic market of cartel operation within Europe seems to be an important determinant of the overcharge level.

The results of the Tobit estimation merely show marginal differences to OLS. Both significance and values of the estimated coefficients mostly coincide with OLS, which implies that the eight percent of corner solution outcomes only have little impact. Nevertheless, Tobit estimation requires homoscedastic and normal distributed error terms for consistency and both assumptions are violated. That is, we have to use CLAD and SCLS as alternatives to Tobit. Both estimation procedures neither need homoscedasticity nor normal distributed errors for consistency and the results slightly differ from the parametric estimation procedures. The standard errors rise, which is probably due to the resampling method (bootstrapping). As a consequence, significance of some explanatory variables (especially SCLS) decreases.

The conspicuous differences in the magnitude of coefficient estimates between parametric and semiparametric procedures as well as between CLAD and SCLS can be used as a sort of specification check following Chay and Powell (2001). The CLAD estimators serve as benchmark in that regard, as they neither need homoscedasticity nor symmetrically and normal distributed errors for consistency. The differences in the magnitude of estimates between CLAD and SCLS on the one side and Tobit Maximum Likelihood estimation on the other side suggest, that non-normal errors are one source of bias in the Tobit results. The conspicuous deviations between CLAD and SCLS further imply that asymmetric distributed errors also lead to misspecifications in Tobit and SCLS estimations.

Nevertheless, comparing the values of the estimated coefficients between OLS, Tobit, CLAD and SCLS, all procedures show the same tendency. With the exception of two insignificant coefficients (period 4 and 5), the signs of all explanatory variables coincide and significance of OLS, Tobit and CLAD is limited to the same group of regressors. Consequently, we can deduce meaningful statements regarding the impact

of cartel characteristics and the legal environment on the magnitude of overcharges. The exact values of the estimators however should not be overinterpreted due to the data and specification issues mentioned above.

6. The deterrent effect of EU competition law

The adjustments of European antitrust law during recent decades have been implemented with the main objective to increase the effectiveness of cartel prosecution and to achieve better deterrence. Especially the introduction of leniency programs and the increase in fine levels since 1996 were targeted on a destabilizing impact on existing cartels and a more deterrent effect for potential future cartel agreements. At this point it is important to investigate whether the current existing fine level is sufficient for optimal deterrence or further future adjustments are indispensable to achieve this aim.

In general, it is not straightforward to answer the question of optimal deterrence since a number of observable and unobservable factors must be taken into account. However, with given information on the average cartel overcharge level in the European market and the given penalty levels according to EU competition law we try to shed some light into this issue by concentrating on the economic decision situation a cartel is confronted with when thinking about collusion.

If firms exclusively think about collusion as an economic decision to increase profits and refrain from ethical principles, the question to be answered is whether the gain from price fixing outweighs expected punishments. Hence, it is obvious to compare the imposed cartel overcharges with the current penalty level of the EU Guidelines. To consider this issue formally, let π be the probability of detection, $P_{collusion}$ the price during collusion, x the amount of sold goods, $OvRate(1)$ the average overcharge rate over the entire cartel period based on formula 1 derived above and φ the maximum possible fine level per year of cartel operation, which is defined as a proportion of affected sales in the EU Guidelines. For existing fine level to deter firms from collusion, the gain from price-fixing must be smaller than the expected fine. Hence,

$$OvRate(1) \cdot (P_{collusion} \cdot x) < \pi \cdot \varphi \cdot (P_{collusion} \cdot x) \tag{1}$$

must be fulfilled, where

$$\varphi = 30\% + (25\% \div cartel\ duration).$$

According to the current EU Guidelines on the method of setting fines, φ is composed of a base fine and a so called "entry fee". The base fine can amount up to 30 percent of the value of affected sales of the firm during the last full business year of its participation in the infringement, multiplied by the number of years of partici-

pation.[21] The entry fee is between 15 and 25 percent of the value of affected sales, irrespective of the duration of the undertaking's participation in the infringement.[22] This penalty level can then be adjusted either upwards or downwards depending on whether aggravating or/and mitigating circumstances exist. Aggravating circumstances comprise recidivism, refusal to cooperate and role of leader in (or instigator of) the infringement.[23] For recidivism, the penalty "will be increased by up to 100 percent for each such infringement established".[24] Although this can basically lead to penalty levels that are a multiple of φ, the upward adjustment by the commission has never exceeded 100 percent in reality so far. According to Veljanovski (2011) "only one firm (Akzo in Calcium Carbide) was surcharged 100 percent for four previous offenses, which could have attracted a maximum uplift of 400 percent".

Now reducing the turnover in (1) leads to the following condition:[25]

$$OvRate(1) < \pi \cdot \varphi \quad . \tag{2}$$

If the average overcharge rate is smaller than the expected fine, firms will not participate in a collusive agreement. Such a direct comparison is only possible because the fines in European antitrust law are specified as a proportion of affected sales and the overcharge rate is defined as a percentage of selling price. That is, both sides of the inequation are related to the price during collusion and therefore comparable.

In order to apply term (2) to the given cartel data set, we need additional information regarding the probability of detection in Europe.

Economic theory suggest that only 10-33 percent of illegal cartels are caught. Connor and Lande (2006) cite several surveys that state probabilities of detection between 10 and 33 percent. A survey by Combe et al. (2008) for the European market results in probabilities between 12.9 and 13.3 percent. They use a sample consisting of data for all cartels that have been convicted by the European Commission since 1969.

We can put these information together and check whether the above given inequation is fulfilled or not. In this context one should think about which overcharge level

[21] See Guidelines on the method of setting Fines imposed pursuant to Article 23(2)(a) of Regulation No 1/2003, (2006/C 210/02), paragraph 21.

[22] Id. at 21, paragraph 25.

[23] Id. at 21, paragraph 28.

[24] Id. at 23.

[25] It is worth noting that this approach compares annual gains from price-fixing with the expected fine that has to be paid per year of cartel participation. Thus, both overcharge rate and turnover on the left hand side of inequation (1) are annual average values over the entire cartel period. The turnover on the right hand side by contrast refers to the last full business year of cartel operation. The approach is therefore based on the assumption that the average turnover equals the turnover of this last business year which should not be a very crucial issue. Furthermore, we neglect aggravating circumstances at this point and abstract from the possibility of private damage claims which probably increases deterrence. This issue is at least indirectly taken into account by using a probability of detection of 33 percent instead of 12.9 or 13.3 percent calculated by Combe et al. (2008) for Europe.

and average cartel duration to use. As we draw the comparison of gain from price fixing and expected punishments on the current situation in Europe, it is reasonable to use the mean overcharge rate and average cartel duration of more recent price fixing agreements instead of the whole sample. Thus, average cartel duration (5.7 years) and mean overcharge rate (21.9%) for illegal cartels of the latest antitrust law regime (1990-2009) is employed.

Now given the average cartel that has been active for 5.7 years and calculating with the upper limits of fine and probability of detection, the expected fine (right-hand side of inequation (2)) for this average cartel can amount up to a maximum of $0.33 \cdot [30\% + (25\% \div 5.7)] = 11.46\%$ of affected sales per year over the entire cartel period. With a mean overcharge rate of 21.9 percent of selling price per year (left-hand side of inequation (2)), the currently existing fine level seems to be too low to achieve optimal deterrence.

Apart from this aggregate examination, we can also apply inequation (2) to each individual cartel case. If we take all illegal cartels from the entire sample as basis, in 67 percent of these cases the cartel overcharges exceed the corresponding maximum possible fine levels.[26] Thus, for more than two out of three cartels, price-fixing has been a lucrative business from an ex-post perspective although the underlying calculations are based on maximum values for probability of detection and fine levels. This is remarkable and confirms the insufficient status quo of cartel deterrence.

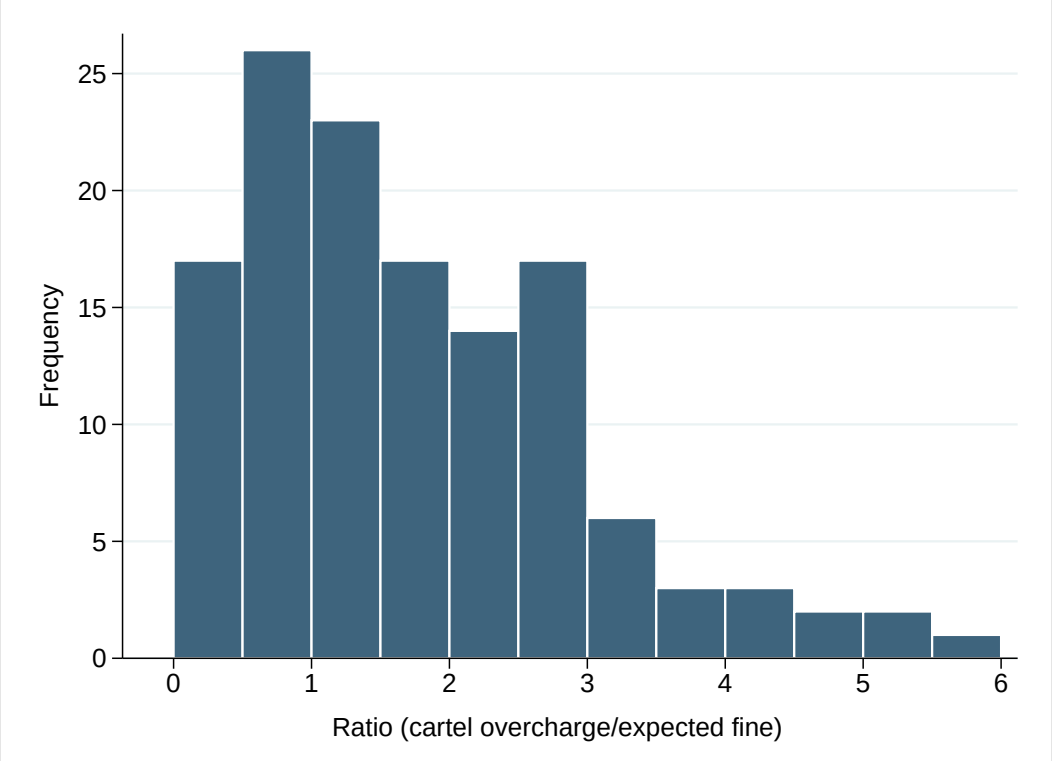

Figure 5: Ratio of cartel overcharge to expected fine.

[26] If we use all illegal cartels that were active after 1989 as basis, this proportion is 67 percent as well.

In order to get an intuition how far cartel gains exceed expected punishments, Figure 5 contains the distribution of the ratios of overcharge rate to maximum possible fine level for all illegal cartels from the sample. It is apparent that there is a substantial fraction (37 percent) of cartels which attained price-fixing profits to the extent that they are more than double as high as the expected sanction. Those cartels would not be deterred even if the fine would have been increased by 100 percent due to recidivism. In 17 cases (13 percent of the observations) the overcharge level is even at least three times higher than the underlying maximum possible fine level. If one were to target on deterring those firms from collusion, the probability of detection, the levels of sanction or both parameters must be increased substantially.

A similar result regarding the insufficient deterrent effect of EU antitrust fines can be attained following an approach of Connor and Lande (2006). The European Guidelines restrict the just mentioned fine level to the effect, that the fine can only amount to a maximum of 10% of the total turnover in the preceding business year. Calculating with a probability of detection of 33%, a mean cartel overcharge of 21.9% and an average cartel duration of 5.7 years, the optimal fine for an average cartel should amount to $(3 \cdot 5.7 \cdot 21.9\%) = 374.49\%$ of affected sales. Such a level of fine seems to be unattainable with the limitation to 10% of the total turnover in the preceding business year. To sum up, the incentives to take part in collusive agreements still appear to be too high in order to achieve optimal deterrence.

7. Conclusion

This paper provides empirical evidence that certain cartel characteristics as well as the geographic location of cartel operation are important determinants of the overcharge level in the European market and that the current existing EU Guidelines on the method of setting fines are insufficient for effective cartel deterrence.

The mean and median overcharge rates are 20.70 and 18.37 percent of the selling price and the average cartel duration is 8.35 years. International cartels impose higher overcharges than domestic cartels. Cartel experience in terms of repeated attempts to collude influences the magnitude of overcharge rate negatively; the opposite effect is observed for bid rigging cartels. OLS and Tobit estimation results indicate that bid-rigging cartels attained significantly higher overcharges than non bid-rigging cartels. This is important to that effect that the European Guidelines do not explicitly differentiate between bid-rigging and non bid-rigging cartels. By contrast, the US Guidelines contain such a distinction (bid-rigging cartels are punished with higher fines) and estimation results of Bolotova et al. (2008) for the US market show no significant difference between bid rigging and non bid rigging cartels regarding the magnitude of overcharge level. Thus, an adjustment of the European Guidelines to its US model concerning this point should be investigated in more

detail.

Overcharges achieved in Western and Northern Europe are significantly lower, and overcharges attained in Southern Europe, Eastern Europe and the UK are not significantly different from reference group overcharges. Cartels operating in the two latter regions therefore seem to have more attractive framework conditions for their illegal behavior.

Results on the success of European antitrust policy during recent decades are contrary to expectation. We do not find empirical evidence that more severe antitrust regulations lead to reservation in the pricing policy of cartels. Nevertheless, for unambiguous statements regarding this point other factors like cartel duration and cartel stability - not discussed here - should be taken into account as well.

Last but not least, empirical evidence suggests that the current existing fine level of the EU Guidelines is too low in order to effectively prevent firms from cartel participation. Cartel sanctions should be based on the principle of deterrence, implying that expected punishments should outweigh the gains from price-fixing. With given information on overcharge levels and cartel durations of recent illegal cartels in Europe and results on the probability of detection from other sources we come to the conclusion that this is not the case. Hence, effective deterrence is not achievable with the current level of fines, suggesting further adjustments of the European Guidelines.

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Appendix

Definitions of explanatory variables

Explanatory variable	Definition
Cartel characteristics	
Duration	Cartel duration in years
Experience	Number of repeated attempts to collude
Domestic	=1 if cartel is domestic in membership
Bid rigging	=1 if cartel is bid rigging
Legal	=1 if cartel is legal
Antitrust law periods	
P1 (Until 1945)	=1 if cartel episode starts in the period until 1945
P2 (1946-1956)	=1 if cartel episode starts in the period of 1946-1956
P3 (1957-1977)	=1 if cartel episode starts in the period of 1957-1977
P4 (1978-1989)	=1 if cartel episode starts in the period of 1978-1989
P5 (1990-2009)	=1 if cartel episode starts in the period of 1990-2009
Geographic markets	
Europe	=1 if overcharge refers to several European countries
UK	=1 if overcharge refers to the United Kingdom
Northern Europe	=1 if overcharge refers to one single country within N. E.
Southern Europe	=1 if overcharge refers to one single country within S. E.
Western Europe	=1 if overcharge refers to one single country within W. E.
Eastern Europe	=1 if overcharge refers to one single country within E. E.