Do Cartels Undermine Economic Efficiency?

Andrea Günster
ETH Zurich

Martin Carree
Maastricht University

Mathijs A. van Dijk
Erasmus University Rotterdam

December 2011

Abstract

This paper examines how the formation and termination of cartels affect the performance and efficiency of their member firms. We identify 141 publicly listed firms active in 49 European cartels between 1983 and 2007. We construct empirical measures for the performance of the cartel firms to investigate three types of economic inefficiency: allocative inefficiency (assessed by profitability), productive or x-inefficiency (labor productivity), and dynamic inefficiency (innovation, measured by R&D investments). We find that profitability is higher and productivity and R&D investments are lower during the cartel period. All three types of inefficiency worsen over the cartel period. In sum, cartels are associated with deteriorating allocative, productive, and dynamic efficiency.

Andrea Günster is at the Department of Social Science at ETH Zurich. Martin Carree is at the Department of Organization & Strategy at Maastricht University. Mathijs van Dijk is at the Rotterdam School of Management, Erasmus University Rotterdam. E-mails: aguenster@ethz.ch, m.carree@maastrichtuniversity.nl, and madijk@rsm.nl.
We thank seminar participants at EARIE 2009 (Ljubljana), CLEEN 2010 (Amsterdam), IIOC 2010 (Vancouver), ZEW Conference 2010 (Mannheim), ZEW Seminar Series 2011 (Mannheim), CCP Seminar Series 2011 (Norwich), RAND Corporation Seminar Series (2011) and Philippe Aghion, Jonathan Baker, Michelle Goeree (IIOC discussant), Gordon Klein (ZEW discussant), Stephen Davies, Morten Hviid, Kai-Uwe Kühn, Bruce Lyons, Martin Peitz, Frederic Scherer, and Maarten Pieter Schinkel for valuable comments and discussion. We are indebted to Bastiaan Blokland, Iustin Ivanescu and Rogier Wessels for excellent research assistance.

1. Introduction

Three types of economic inefficiency may arise from the existence of a monopoly. First, monopolies reduce welfare through misallocation of resources (allocative inefficiency). Cournot (1838) and Marshall (1890) argue that the absence of competition leads to an increase in prices accompanied by an output reduction, resulting in a net welfare loss. Second, productive inefficiency (formalized by Leibenstein, 1966, as x-inefficiency) may arise since firms in less competitive environments have fewer incentives to operate efficiently. Third, while Schumpeter (1912) argues that innovation may benefit from monopoly rents, according to Arrow (1962) a lack of competition may result in reduced incentives to innovate (dynamic inefficiency).

Although economic theory on the inefficiencies associated with monopolies is well-developed and it is widely believed that the formation of (temporary) monopolies in the form of cartels is harmful to society, empirical evidence on the effect of cartels on economic efficiency is limited. Do cartels indeed lead to increased prices and profitability? Are they associated with reduced productivity? Does cartel formation result in weaker or stronger incentives to innovate? Research on these questions is hampered by problems to identify cartels and by the lack of available data on profitability, productivity, and innovation. Empirical studies to date focus exclusively on allocative inefficiency. There is virtually no empirical evidence on the productive and dynamic inefficiency of cartel members.

The purpose of this paper is to study the impact of cartel formation and termination on all three types of inefficiency simultaneously. Our encompassing approach allows for a more balanced evaluation of how cartels affect overall economic efficiency and, thereby societal welfare. Furthermore, we analyze a large sample of firms involved in cartels active in a variety of industries and countries over an extended time period. In contrast, most prior research focuses on a limited number of cartels in specific industries and countries during a particular (historic) time period.

We analyze the profitability, productivity, and innovation of cartel members using firm-specific financial data for a sample of 141 publicly listed firms involved in 49 cartels infringing European Union competition law between 1983 and 2007. Our data source allows us to determine reliable formation and termination dates for these cartels. We compare the performance and efficiency of these firms during the cartel period with those in the years before formation and after termination of the cartel. We use return on assets to measure profitability, sales per

employee to measure labor productivity, and investments in research and development (R&D over assets and over sales) to measure innovation.

Our results show a significant increase in profitability over the cartel period. We find that labor productivity is significantly lower during the cartel period. We also uncover a significant reduction in R&D expenditures over the cartel period. Allocative inefficiency and R&D spending worsen over time. Labor productivity shows the most pronounced decrease for the ringleader of the cartel.

2. Related literature

Building on the work of Cournot (1838) and Marshall (1890), Stigler (1964) describes oligopoly behavior in cartelized industries and lays the foundation for subsequent theoretical and empirical studies. A substantial number of empirical studies study the allocative inefficiency of cartel firms, using either data on profitability, prices, or output. Asch and Seneca (1975, 1976) find that collusion is not always profitable and frequently emerges as a consequence of a high debt burden. Porter (1983) concludes that changes in output and prices during the U.S. railroad cartel from 1880 to 1886 are in line with collusive behavior. Finkelstein and Levenbach (1983) and Feinberg (1984a) document price and profit increases during cartels involved in legal antitrust cases. Feinberg (1984b) finds a reduction (increase) of price-cost margins just before the official onset of an antitrust investigation (acquittal). Madhavan, Masson, and Lesser (1994) show that even a large cartel (the U.S. Associated Milk Producers with 30,000 members) can result in increased profit margins, until an antitrust consent. Gupta (1995) and Taylor (2002) provide evidence of output reductions by Indian tea plantation cartels and by cartels formed following the U.S. National Industrial Recovery Act in the 1930s, respectively. Instead of fixing prices or output, Genesove and Mullin (2001) find that the U.S. sugar-refining cartel from 1927 to 1936 merely made price cutting more transparent. Röller and Steen (2006) analyze legal cartels in the Norwegian cement industry and find that cartel members were able to raise profits, but overinvestment in capacity and export directed production eroded those profits. Combe and Monnier (2009) conclude that profits generated on cartel markets in the European Community outweigh imposed fines. In a meta analysis of price fixing cartels over the last 250 years, Connor and Bolotova (2006) report an average overcharge rate of 29%. Bolotova (2006) finds that overcharges are lower when antitrust enforcement is present, when one firm holds a significantly larger marker share than the remaining members, and when the cartel has more members. Also,

prices tend to rise when the cartel lasts longer. In short, there is considerable evidence that cartels are associated with allocative inefficiency, although some research suggests that this conclusion may not hold under all circumstances. Our study adds to this line of research by examining a more comprehensive sample of cartels and by assessing allocative inefficiency jointly with x-inefficiency and dynamic inefficiency. Our measure of allocative inefficiency is profit. As defined by Harberger (1954), deadweight loss, which is the part of welfare not transferred from consumer to producer in a monopoly setting (due to the reduction in supplied quantity), equals a half monopoly profit in the monopoly case.

The x-inefficiency theory of Leibenstein (1966) suggests that lack of competition and entry reduce the monopolist's incentives to work inefficiently. Examples include operating at high marginal costs due to not employing new technologies, being overstaffed or paying above-market wages, overinvestment, empire building or excess capacity. Button and Weyman-Jones (1992) review early research on x-inefficiency, which almost exclusively focuses on measurement issues. Nickell (1996) finds a positive association between competition (measured by the number of competitors and low rents) and total factor productivity growth for 670 manufacturing firms in the U.K. Berger and Hannan (1998) present evidence that the consolidation wave in the U.S. banking industry in the 1980s was associated with reduced cost efficiency of banks. They argue that the x-inefficiency of increased concentration is of greater importance than the allocative inefficiency. Direct evidence on the link between competition and x-inefficiency is scarce, and drawing causal inferences difficult. We are not aware of any paper that examines x-inefficiency in the context of cartels.

Dating back to Schumpeter (1912), economists debate the impact of market structure on the incentive to innovate. Schumpeter points out that the profitability of monopolists allows them to invest in innovation. Arrow (1962) opposes these arguments by showing that only in a competitive environment firms have the incentives to innovate. Demsetz (1969) reconciles both views by arguing that the interplay of profits and incentives determines what market structure is most beneficial for technological progress. One of the earliest empirical studies on the relation between competition and innovation is Grabowski (1968), who shows that small firms and large firms invest less in R&D than medium sized firms. In a similar vein, Geroski (1994) concludes that an oligopolistic market structure leads to the highest investment in R&D, as profits and incentives are present simultaneously. Aghion and Howitt (1992) formalize the complementary argument that firms can only reap the benefits of innovation under less than perfect competition.

Aghion, Bloom, Blundell, Griffith and Howitt (2005) argue in favor of an inverted u-shape between the level of competition and innovation, finding evidence that the highest number of patents produced stems from oligopolistic markets. We are only aware of one empirical paper on the dynamic inefficiency associated with cartels. Symeonidis (2001) does not identify specific cartels, but reports that there is no evidence that the introduction of antitrust law in the U.K. had an impact on the number of commercialized innovations.

3. Data description and methodology

3.1 European antitrust database

We obtain information on cartel cases uncovered in the European Community (EC) from 1957 to 2004 from the decision documents of the European Commission, which were published over the years in the Official Journal as well as the Annual Reports on Competition (Volumes I-XXXIV). The European Commission is the highest authority of competition policy enforcement in Europe and the only one to initiate regulations and modify existing antitrust law implementation. We only investigate horizontal conduct cases (in particular, cartels) infringing Article 101 of the 1957 Treaty of Rome.[1, 2]

An important advantage of our database is that it contains information on the formation and termination dates of each cartel. Since the duration of the cartel is a key determinant of the fine[3] and since convicted firms can file an appeal to the European Court of Justice, the European Commission invests a substantial amount of effort into determining the earliest and latest date the cartel was in place.[4, 5] In many cartel cases, the Commission uses a dawn raid to collect a host of evidence (including, e.g., the diaries of firm executives) to uncover the earliest indication of a collusive agreement. The formation date is justified in the Commission's decision document.

[1] See Motta (2004) and Russo, Schinkel, Günster, and Carree (2010) for an overview of European antitrust policy.

[2] The current enumeration was adopted in the Treaty of Lisbon (2010). Previously, under the Treaty of Amsterdam (1997), the Articles were enumerated 81 and 82.

[3] Commission of the European Communities. 1998. Guidelines on the method of setting fines imposed pursuant to Article 15(2)(a) of Regulation No 17 and Article 65(5) of the ECSC Treaty, Official Journal of the European Union, 14.1.1998, C 9/3

[4] In case of an appeal, we use the duration established by the European Court of Justice ruling. The European Court of Justice clearly states why it reduces the duration.

[5] Two cartel cases in our sample were annulled on appeal. The German bank case (*Bank charges for Exchanging euro-zone currencies – Germany* Commission decision 2003/25/EC [2003] OJ L 15/1, Case COMP/E-1/37.919) was annulled because an employee faxed the documents upside down. In the Vitamins case (*Vitamins* Commission decision 2003/2/EC [2003] OJ L 6/1, Case COMP/E-1/37.512), the Commission did not issue a decision for a former infringement in time. Since the annulments were based on technicalities, we assume the duration of the cartel derived from the Commission decisions to be valid.

Although we expect the listed formation date to be quite accurate, it cannot be ruled out that the cartel was already active before this date, in which case it is less likely that we find a structural break in the performance and efficiency of the cartel members around the formation date.

For 51 per cent of cartel cases, we take the Commission's investigation date as the termination date of the cartel. The termination of a cartel as a result of antitrust action is unlikely to be endogenously related to the performance and efficiency of the member firms, which may allow us to make stronger statements about causality than prior studies – especially those on x-inefficiency and dynamic inefficiency. In 38 per cent of all cases, the Commission concluded that the cartel had already been terminated before the decision and we take this earlier termination date instead. It is not evident that an antitrust conviction leads to the end of the anticompetitive conduct (e.g., Crandall and Winston, 2003). At the same time, there is considerable evidence that convictions have a substantial impact on the profit margins of the convicted firms (Feinberg, 1984b; Madhavan, Masson, and Lesser, 1994). Other studies (e.g., Bosch and Eckard 1991; Günster and van Dijk, 2010) document a significant decline in the stock market value of firms involved in antitrust convictions that is considerably greater than the associated fines and legal costs, which suggests that the market expects a decrease in future profitability. To the extent that the cartels stay in place beyond the termination date identified by the Commission, we bias the results against finding an impact of cartels on economic efficiency.

A second advantage of our database is that a substantial number of firms involved in European cartel infringements over the past few decades are publicly listed, which enables us to obtain detailed information on the performance and efficiency of the cartel members based on their published financial statements. Another interesting aspect of our sample is that – despite the fact that all cartel infringements affected the European market, which is a prerequisite for a Commission's investigation – the firms involved are incorporated in many countries around the world. In total 35 per cent of cartels in our sample are international, in the sense that they are formed by firms incorporated in different countries (See Table 1).

3.2 Sample and data sources

From 1964 to 2004, the Commission formally decided on 301 antitrust infringement cases (Carree, Günster and Schinkel, 2010). In the 301 infringement cases, a total of 1,519 parties were convicted. We discard firms that are not publicly listed. For all unlisted companies, we check whether the company has a parent controlling 100 per cent of the company – in which case we

include the parent in the dataset. We also discard firms that went public or private during the cartel period and firms that were acquired during the cartel period. The coverage of firm-specific financial statement information by Worldscope (part of Thomson One Banker) starts in 1980. Because we require data prior to the cartel period, we exclude cartel cases that started before 1983 so that we can obtain at least 3 years of pre-cartel data. Our final sample includes 141 publicly listed firms involved in 49 European cartel infringements between 1983 and 2004. A total of 44 firms were involved in more than one cartel during our sample period. The firm with the highest count of infringements is Elf Aquitaine SA with a total of five. There is no firm appearing four times. A couple of firms appear twice or three times. Typically, they are active in the chemical sector and formed cartels in multiple submarkets simultaneously (Stephan, 2010). The sample includes firms from 22 different countries active in a wide range of industries. Japanese and American firms constitute the maximum share followed by Germany and France.

We use information on the names of the involved parties, their OECD industry and country of incorporation, the starting date and the duration of the cartel, the date of the final decision, the cartel conduct, the ringleader (the initiating firm in charge of coordination), and the number of firms in the cartel from the Commission's decision documents.

We obtain annual data on the profitability (return on assets, or ROA, computed as net income over total assets), labor productivity (sales over employees), and innovation (R&D expenses over total assets and over sales) of the individual firms involved in the cartel from the financial statement information in Worldscope. To facilitate comparison of labor productivity across firms, we express sales in US$. Currency denominations do not affect our other variables, which are ratios of two variables that are both expressed in monetary units. We note that the theoretical prediction of the impact of cartel formation on sales is ambiguous, as an increase in prices can be fully or partially offset by a decrease in output. But even if sales decrease, the development of sales over employees before, during, and after the cartel is still informative about productive efficiency. Lower sales per employee during the cartel period would indicate reduced productive efficiency through a reluctance of the firms to reduce the number of employees when production decreases. The reason we use investments in R&D rather than R&D output (for example, the number of patents obtained) is that it is harder to uncover a direct link between the results of R&D investments (which often take years to materialize) and the relatively short cartel period. In addition, we are interested in the incentive to innovate which is better represented by spending than by patenting. The latter represents rather the quality or capability of a firm to

undertake research. We present results for both R&D scaled by total assets and by sales to ensure that our findings are not driven by the denominator. As we observe a small number of outliers in return on assets, we winsorize this variable at the 0.5% and the 99.5% level. Our results are not sensitive to removing the winsorization, or to winsorizing at the 1% and the 99% level.

3.3 Methodology

We compare the profitability, productivity, and R&D investments of the cartel members during the cartel period with the same performance measures before the formation and after the termination of the cartel. For each cartel, we include a year in the cartel period only if at least six whole months of the year lie between the formation and the termination date of the cartel. For example, when a cartel was formed in January 2002 and was terminated in May 2003, we only consider the year 2002 as part of the cartel period. We consider the year 2001 as the last pre-cartel year and the year 2003 as the first post-cartel year. For each firm, we take a period of five years (three years minimum) before and after the cartel to benchmark the cartel performance.

The next section presents summary statistics of the average performance and efficiency of the firms involved in the cartels over the whole period, and over the pre-/post-cartel periods and the cartel period separately. However, these initial results can be misleading to the extent that our sample contains a disproportionate number of firm-years in the cartel period for firms with abnormally poor or strong performance, independent of a cartel effect. Due to variation in the duration of the cartel and in the availability of data for the pre- and post-cartel periods, not every firm is represented equally in the cartel and the pre-/post-cartel samples. We also need to account for the possibility that the cartel period observations in our sample disproportionally stem from times of abnormally poor or strong economic conditions.

We control for these effects by estimating panels models for each of our performance measures that include both firm and year fixed effects. We note that firm fixed effects also account for any country and industry effects. We report two different sets of panel results to analyze the impact of cartel formation on the performance measures. The first model includes dummy variables for the pre- and post-cartel periods. The second model includes a dummy variable for the cartel phase as well as a number of additional explanatory variables, such as the number of firms involved, the type of economic conduct, and a dummy variable for the ringleader. All of these additional independent variables are interactions with the cartel dummy.

We also include a trend variable for the cartel period to investigate whether there is any development in the performance of the cartel members over the duration of the cartel.

4. Results

4.1 Summary statistics

Table 1 reports summary statistics on the cartel level providing an overview of cartel duration and report route, number and geographic origin of cartel members, cartel type, and industry and geographic scope of the cartel. The average and median duration of the 49 investigated cartels are seven and six.[6] This is comparable to earlier cartel studies like Bryant and Eckard (1991), Levenstein and Suslow (2006) and Combe et al. (2008) who find mean cartel duration to be between 6 to 7 years.[7] The shortest cartel duration in our sample is two years. The maximum duration amounts to 16 years. Most of the cartel investigations in our sample stem from leniency applications.[8] Consequently, the majority of cartels were active at the onset of the investigation. A total of 28 per cent of cartel infringement is due to Commission investigations initiated by the authority itself.

In total 60 per cent of all cartels is comprised out of only European firms. Cartels consisting of European and non-European firms constitute 35 per cent of our sample. There is one case, where solely Japanese spice producers colluded and jointly exported at higher prices to the European Union.[9] Besides geographical diversity, the sample group also shows a large industrial diversity. The highest cartel activity is shown in the manufacturing sector (see Carree, Günster and Schinkel (2010)) with the largest shares being in chemicals and plastics, rubber and glass production. Next to the manufacturing industry, transportation shows the highest number of detected collusion. We account for sector, nationality, size and inherent firm differences using cross-sectional fixed effects. Although the sample group only covers cartels active in the European Community, the cartels do show different cartel scopes. The vast majority of the cartels are active in more than one Member State of the European Community (European market). The

[6] In case of an appeal, we use the duration established by the European Court of Justice ruling.

[7] Bryant and Eckard (1991) use a hazard rate analysis to study the determinants of cartel duration of investigated cartels by the Department of Justice during 1961 to 1988. Combe, Monier and Legal (2008) repeat the study using European Commission cartel investigations from 1967 to 2003 finding similar results. Levenstein and Suslow (2006) examine determinants of cartel success measured as cartel duration and provide a meta analysis.

[8] Commission Notice on immunity from fines and reduction of fines in cartel cases (Leniency Notice) of 18 July 1996; Commission Notice on immunity from fines and reduction of fines in cartel cases of 19 February 2002; Commission Notice on Immunity from fines and reduction of fines in cartel cases (New Leniency Notice) of 8 December 2006.

[9] *Food Flavor Enhancers* Commission decision 2004/206/EC [2004] OJ L 75/1, Case COMP/C.37.671

remaining cartels are active globally or focus on one European country (National). We identify cartel type according to the classification in Russo, Schinkel, Günster and Carree (2010). Cartels may be of multiple types depending on the complexity of the underlying agreement. Most cartels in our sample involve some type of price-fixing and market sharing agreement.

Table 2 reports the summary statistics for the variables on the firm level. Panel (a) reports the statistics for the entire sample. Panel (b) shows the summary statistics for non-cartel period (combined pre- and post-cartel period). Panel (c) states the summary statistics for the cartel phase. The number of observations for the dependent variables in Panel (a) corresponds to those of the regression outcome. We have full information on all explanatory variables. Since there are missing observations for the series of the dependent variables, the number of observations drops. Missing values appear to be randomly spread across time. The mean of ROA is about three per cent for the larger sample. Sales over employees is almost $400,000 on average. R&D over assets and R&D over sales are also on average around three to four per cent for the firms in our sample.

The cartel phase accounts for 40 per cent of the sample which means that the pre- and post-cartel period is jointly larger than the cartel period. About eleven per cent of all firms are ringleaders whereas in one fourth of all cases a ringleader was defined (see Table 1). Ringleaders are commonly defined by the Commission for determining the fine. They are a reason for aggravating circumstances according to the fining guidelines being a reason for increasing the imposed base fine.[10] A cartel has on average 14 members in our sample. Few of the cartels included in our study is complete in the sense of reporting the performance of all members.

The mean of ROA in Panel (b) is significantly lower than the one in Panel (c) indicating that during the cartel period, ROA is on average higher than during a non-cartel one. The difference is around 0.5 per cent point. Sales over employees is clearly lower during the cartel period. The difference is about $100,000 for the two samples. The means of R&D over assets and R&D over sales are higher during the cartel phase than before and after. R&D over assets is on average 0.3 per cent point lower during the non cartel phase. The means of R&D over sales differ by one per cent. The differences in means in Table 2 may be due to both within and between effects. Between effects are largely that for example in R&D intensive industries it is more common to find a cartel. Consequently, we need regression analysis employing fixed effects on the cross section to overcome the shortcomings of within and between effects in a panel data set.

[10] Commission of the European Communities. 1998. Guidelines on the method of setting fines imposed pursuant to Article 15(2)(a) of Regulation No 17 and Article 65(5) of the ECSC Treaty, Official Journal of the European Union, 14.1.1998, C 9/3.

4.2 Regression results

Table 3 shows the impact of cartel existence for each dependent variable focusing on the pre and post-cartel time. In all four specifications, we account for cross-sectional and year fixed effects explaining the high R^2, especially for the models testing innovation. By using fixed effects for the cross-sectional and the time dimension, we account for changes across firms and in the underlying general economic conditions, respectively. In all models following Table 4, we use one performance measure at the time. We start with an estimation of the determinants of ROA representing profitability, employees over sales representing (labor) efficiency, R&D expenses measuring innovation and include a pre and post-cartel dummy. The second specifications depicted in Tables 3-6 allow for time variation of the variables by introducing a cartel trend. The three models include the cartel dummy and trend as well as three additional explanatory variables: ringleader, number of parties and cartel type. All three variables are zero in the non-cartel period.

The first column of Table 3 presents the pre and post-cartel period effect on profitability at the firm level. The number of observations is 2593. ROA is significantly lower after the end of the cartel and reduced by almost one per cent. Possible reasons for the insignificance of the pre-cartel dummy are that the Commission might not be able to determine the start of the cartel precisely and for the slow rise of cartel prices initiated by the cartel members transferring only gradually into ROA. The significant drop at the end of the cartel phase is supported by Feinberg (1984a). The author finds a significant decrease of the price level after an antitrust investigation which is closed with a prohibition. Studies on the stock market reaction to antitrust prohibition decisions also find a significant drop at the investigation and decision event (Bosch and Eckard, 1981; Günster and van Dijk, 2010).

Columns 2 show the impact of pre and post-cartel indicators on the productivity measure. The column depicts employees over sales for which there are 2541 observations. The adjusted R^2 of the specification is 76 per cent. The post-cartel dummy is significantly positive indicating an increase in efficiency after the cartel. So either a rise in output or a reduction in employees cause the change since an increase in price above the output effect is quite unlikely. Since the cartel start might be more difficult to prove than the end of a cartel for the Commission like with ROA, we find a significantly negative coefficient for the pre cartel period. An alternative explanation might be that the cartel members produce even less efficient before the cartel formation. Possibly

a down turn or restructuring of the industry take place being an incentive to form a cartel in the first place.

Columns 3-4 of Table 3 show the results for the two measures of innovation. The sample size is significantly lower as the one for ROA because of missing observations when retrieving R&D expenses from Worldscope. The adjusted R^2s for both variables are around 90 per cent which is mainly explained by the inclusion of fixed effects for the time and firm dimension. Before and after a cartel phase, R&D expenses over sales are significantly higher than during a cartel phase. Going from a phase without horizontal agreements to a phase with those agreements, decreases the R&D expenses over sales by about 0.2 per cent point. Once the cartel ended R&D expenses over sales rise again by 0.2 per cent on average. R&D over assets are only significantly different from the cartel phase prior to its existence. On average, R&D expenses over assets are 0.2 per cent higher prior to the cartel phase. A possible explanation for the insignificance of the post-cartel dummy for R&D expenses over assets might be the lack in profitability to be invested into R&D caused by a significant reduction in profit. For the latter see the results on ROA.

Table 4 focuses on profitability of cartels extending the analysis by allowing for time varying effects inside the cartel phase (incorporated as a cartel trend) and additional explanatory variables, which are apart from the trend all interaction terms with the cartel dummy. The adjusted R^2 is 36 per cent. In the first model, which focuses on the cartel phase, there is a sizeable impact of 0.5 per cent point during the cartel phase. When adjusting for time variation during the cartel phase, the trend is significant at any common significance level, indicating that a gradual rise of 0.1 cent in cartel profitability might represents cartel outcomes better. The gradual increase may better explain cartel profitability because cartel members might renegotiate prices at higher levels step wise.

The third specification of ROA includes three additional explanatory variables: ringleader, number of parties and cartel type which are all interaction terms with the cartel dummy. When including these additional measures, we find a significant impact of the trend indicating that cartels increase their performance gradually which is in line with the survey of Bulotova (2008). The rise in profitability is 0.1 per cent point per year for all cartel members. The number of parties, the type of cartel agreement and being a ringleader do not significantly contribute to explaining cartel profitability in our study. Focusing on allocative inefficiency, there is some indirect evidence that cartel firms seem to significantly promote this type of inefficiency.

Taking a crude measure defining the dead weight loss as a half profit (Harberger, 1954) indicates that societal welfare decreases by 0.05 per cent over the cartel period.

For productive efficiency, we focus on the determinants sales over employees. Table 5 shows the results of a model with cross-section and time fixed effects included. The adjusted R^2s for the three models is 76 per cent. The base model including only a cartel dummy shows no decrease in terms of productivity and thereby efficiency during the cartel period. We find an impact on productivity when distinguishing for the number of parties, type of cartel, ringleader, cartel and cartel trend. There is a drop by about $100,000 in (labor) productivity. The ringleader reduces either output or the number of employees even further than all other members. Price fixing cartels work more efficiently than all other types of cartels or reduce output less. With prices fixed firms may concentrate upon lowering costs per unit to improve profitability. In analogy, a higher number of parties leads to operating more efficiently or less output reaction, which might be seen as an indication for cheating. Conclusively, Leibenstein's idea about x-inefficiency which in our model relates to a decreased productivity is backed. As with missing incentives to stay competitively by innovating and being cost-conscious, firms in cartels seem to show a 'quiet life' effect in terms of productivity in the absence of tight competition. The 'quiet life' effect is most pronounced for ringleaders, least pronounced for price-fixing cartels and decreasing with the number of cartel members.

Table 6 shows the results of the impact of cartel existence on the amount of R&D investments. Columns indicated with (a) and (b) refer to R&D expenses over assets and R&D expenses over sales, respectively. The numbers of observations are 1619 and 1915 for both samples, respectively, which is significantly smaller than for the other variables because R&D expenses are often not retrievable from Worldscope. The adjusted R^2s for all models are around 90 per cent being mainly due to the incorporation of cross-section and time fixed effects.

R&D expenses over assets drops significantly by 0.2 per cent point during the cartel time horizon. When adding a cartel trend, the two variables offset each other's impact. When adjusting for ringleader, parties, and cartel type, the trend is significantly negative indicating a 0.02 per cent point decline in R&D expenses over assets per year in which the firm is member of a cartel. Firms being part of a price fixing cartel invest even less in R&D than firms in for example market-sharing, quota-setting and export cartels. Having guaranteed prices apparently de-motivates product and/or process innovation.

The results on R&D expenses over sales confirm the results found for R&D expenses over assets partly. During the cartel, R&D expenses over sales drop by 0.2 per cent point which is a little bitmore pronounced change than for R&D expenses over assets. When including a cartel trend, the adjusted R^2 slightly improves and the trend is statistically significant, indicating a gradual decline by 0.06 per cent. When adding the ringleader dummy, the number of parties and the dummy indicating a price fixing cartel, the cartel trend becomes slightly larger. In addition, the number of parties is significant at the five per cent significance level. It has a positive impact on the amount spent on innovation. Since the likelihood of a cartel breakup increases with the number of members, the participating firms might want to be prepared for a potential resolution and consequently, invest more (Stigler 1964; Levenstein and Suslow, 2006). The results on innovative efforts clearly support the conclusion of the model by Arrow (1962) showing that a lack of competition leads to a lack of incentives to innovate. The longer the noncompeting phase lasts, the stronger is the impact of the missing incentive. Consequently, cartels are decreasing social welfare in form of decreasing dynamic efficiency.

5. Conclusions

The main aim of our research concentrates on determining the impact cartels have on profitability, productivity and innovation. Based on existing efficiency theories, three hypotheses concerning cartel formation on profitability, productivity and innovation exist. Profitability should accordingly increase during cartel periods with respect to pre and post-cartel times. Productivity and innovation should decrease as the lack of competition fosters a reduction in competition for innovation and efficiency. The Schumpeterian hypothesis argues for the contrary though in the case of innovation. We test these hypotheses with the help of four different financial indicators representing profitability, the incentive to innovative and productivity.

The first hypothesis predicts an increase in profitability during cartel years. The hypothesis is based on the assumption that firms raise their prices when jointly monopolizing a market. The model explaining ROA provides strong evidence supporting an increase in profitability. Profitability rises over time gradually. The number of parties, the type of cartel and being a ringleader do not seem to influence the rise of profitability during a cartel period.

Secondly, we predict a decrease in productivity during cartel years. The hypothesis is based on the productive efficiency theory assuming a lower level of productivity when firms face less competition because they then have fewer incentives to adopt the most efficient technologies,

produce at minimum costs etc. resulting into x-inefficiency. The regression on the determinants of sales over employees supports this hypothesis. Especially the cartel trend indicates a 'quiet life' effect to be at work. Since we use sales over employees, our study has a limitation. Sales are equal to price times quantity. Hence, changes in our measure may be due to changes in both real productivity (output over employees) and in the price level of products sold. It is likely that the price level goes up during the cartel phase, hence, our measure presumably only underestimates the real productivity decreases during the cartel period.

Finally, we hypothesize a decrease in innovation during cartel years. The hypothesis is based on the dynamic efficiency theory assuming a decrease in innovation when firms face less competition. To test this hypothesis, we investigate two innovation variables: R&D expenses relative to assets and R&D expenses relative to sales. Although these variables do not measure innovation output, they do measure the incentive to invest in new products and technologies. The empirical results for both variables show a decrease during cartel years.

References

Aghion, P. and Howitt, P. (1992). A Model of Growth through Creative Destruction, *Econometrica,* 60, 323-351.

Arrow, K. (1962). Economic Welfare and the Allocation of Resources for Invention, in R.R. Nelson, *The Rate of Inventive Activity*, Princeton University Press, 609-625.

Asch, P., and Seneca, J.J. (1975). Characteristics of Collusive Firms, *Journal of Industrial Economics*, 23, 223-237.

Baker, J.B. (2003). The Case for Antitrust Enforcement. *Journal of Economic Perspectives*, 17, 27-50.

Berger, A.N., and Hannan, T.H. (1998). The Efficiency Cost of Market Power in the Banking Industry: A Test of the Quiet Life and Related Hypotheses, *Review of Economics and Statistics*, 80, 454-465.

Bolotova, Y. (2010). Cartel Overcharges: An Empirical Analysis, *Journal of Economic Behavior and Organization*, forthcoming.

Bosch, J.C., and Eckard, E.W. (1991). The Profitability of Price Fixing: Evidence from Stock Market Reaction to Federal Indictments. *Review of Economics and Statistics*, 73, 309-17.

Bryant, P., and Eckard, E. (1991). Price Fixing: The Probability of Getting Caught, *Review of Economics and Statistics*, 73, 531-536.

Button, K.J., and Weyman-Jones, T.G. (1992). Ownership Structure, Institutional Organization and Measured X-Efficiency, *American Economic Review*, 82, 439-445.

Carree, M., Günster, A., and Schinkel, M.P. (2010). European Antitrust Policy: An Analysis of Commission Decisions, 1964-2004. *Review of Industrial Organization*, 36, 97-131.

Combe, E., Monnier C., and R. Legal, (2008). The Probability of Getting Caught in the European Union, *Working Paper*, Conseille de la Concurrence

Combe, E., and Monier, C. (2009). Fines against Hard Core Cartels in Europe: The Myth of Over Enforcement. *Concurrences*, 4, 41-50.

Connor, J., and Bolotova, Y. (2006). Cartel Overcharges: Survey and Meta-analysis, *International Journal of Industrial Organization*, 24, 1109-1137.

Cournot, A.-A. (1838). *Recherches sur les Principes Mathématiques de la Théorie des Richesses* (In English: *Researches into the Mathematical Principles of the Theory of Wealth*), Dunod.

Crandall, R.W., and Winston, C. (2003). Does Antitrust Policy Improve Consumer Welfare? *Journal of Economic Perspectives*, 17, 3-26.

Demsetz, H. (1969). Information and Efficiency: Another Viewpoint, *Journal of Law and Economics*, 12, 1-12.

Feinberg, R.M. (1984a). The Timing of Antitrust Effects on Pricing, *Applied Economics,* 16, 397-409.

Feinberg, R.M. (1984b). Strategic and Deterrent Pricing Responses to Antitrust Investigations, *International Journal of Industrial Organization*, 2, 75-84.

Finkelstein, M.O., and, Levenbach, H. (1983). Regression Estimates of Damages in Price-Fixing Cases, *Law and Contemporary Problems*, 46, 145-169.

Genesove, D., and Mullin, W.P. (2001). Rules, Communication, and Collusion: Narrative Evidence from the Sugar Institute Case, *American Economic Review*, 91, 379-398.

Geroski, P., (1994), *Market Structure, Corporate Performance and Innovative Activity*, Oxford: Clarendon Press.

Grabowski, H.G. (1968). The Determinants of Industrial Research and Development: A Study of the Chemicals, Drug, and Petroleum Industries, *Journal of Political Economy*, 72, 292-306.

Günster, A., and van Dijk, M.A. (2010). The Impact of European Antitrust Policy: Evidence from the Stock Market, *Working Paper*, ETH Zurich / Erasmus University Rotterdam.

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

Harberger, A. C. (1954). Monopoly and Resource Allocation, *American Economic Review,* 44(2), 77-87.

Levenstein, M., and Suslow V.Y. (2006). What Determines Cartel Success?, *Journal of Economic Literature*, 44, 43–95.

Leibenstein, H. (1966). Allocative Efficiency vs. X-efficiency, *American Economic Review*, 56, 392-415.

Madhavan, A.N., Masson, R.T., and, Lesser, W.H. (1994). Cooperation for Monopolization? An Empirical Analysis of Cartelization, *Review of Economics and Statistics*, 76, 161-175.

Marshall A. (1890). *Principles of Economics*. Ed. 8th. London: Macmillan (1920).

Marshall A. (1892). *Elements of Economics of Industry*. Ed. 3rd. London: Macmillan (1964).

Motta, M. (2004). *Competition Policy: Theory and Practice*, Cambridge: Cambridge University Press.

Nickell, S. (1996). Competition and Corporate Performance, *Journal of Political Economy*, 104, 724-746.

Porter, R.H. (1983). A Study of Cartel Stability: The Joint Executive Committee, 1880-1886, *Bell Journal of Economics*, 14, 301-314.

Röller, L.H., and Steen, F. (2006). On the Workings of a Cartel: Evidence from the Norwegian Cement Industry, *American Economic Review*, 96, 321-38.

Russo, F., Schinkel, M.P., Günster, A., and Carree, M., (2010). *European Commission Decisions on Competition: Economic Perspectives on Landmark Antitrust and Merger Cases*, Cambridge: Cambridge University Press.

Schumpeter, J. (1912). *Theorie der Wirtschaftlichen Entwicklung*, (In English: *Theory of Economic Development*), Leipzig: Duncker & Humblot.

Symeonidis, G. (2001). Price Competition, Innovation and Profitability: Theory and UK Evidence, in Levenstein, M.C., and Salant, S.W. (eds), *Cartels*, The International Library of Critical Writings in Economics series, Edward Elgar, 2007. Also available as CEPR Discussion Paper No. 2816.

Stigler, G. (1964). A Theory of Oligopoly, *Journal of Political Economy*, 72, 44-61.

Taylor, J. (2002). The Output Effects of Government Sponsored Cartels During the New Deal, *Journal of Industrial Economics*, 50, 1-10.

Table 1: Summary statistics of cartel characteristics

This table presents summary statistics on the following characteristics of the 49 cartels between 1980 and 2004 in our sample: the start date and end date of the cartel, the duration, the number of firms involved (in total and in our sample), whether the EC identified a ringleader firm that is in our sample, the economic conduct for which the firms involved were convicted, and the industry and geographic scope of the cartel.

	Mean	Median	Min.	Max.	Std. Dev.	# Obs.
Cartel duration and report route						
Year of formation	1991	1992	1981	2000	4.85	49
Year of termination	1997	1998	1986	2004	4.41	49
Duration (years)	6.71	6	2	16	3.37	49
Notification	0.04	0	0	1	0.20	49
Complaint	0.07	0	0	1	0.25	49
Commission	0.28	0	0	1	0.45	49
Leniency	0.61	1	0	1	0.49	49
Cartel members						
Number of firms involved	10.20	7	2	42	8.80	49
Number of firms in our sample	3.80	3	1	10	2.47	49
Ringleader identified	0.24	0	0	1	0.43	49
Only European firms	0.59	1	0	1	0.50	49
European and non-European firms	0.35	0	0	1	0.48	49
Only non-European firms	0.06	0	0	1	0.24	49
Cartel type						
Price fixing	0.44	0.5	0	1	0.30	49
Market sharing	0.37	0.33	0	1	0.30	49
Information exchange	0.09	0	0	0.5	0.16	49
Standard setting & advertising	0.06	0	0	0.5	0.14	49
Bid rigging	0.02	0	0	0.25	0.06	49
Export	0.02	0	0	1	0.14	49
Industry and geographic scope						
Chemicals	0.29	0	0	1	0.46	49
Plastics, rubber & glass	0.27	0	0	1	0.45	49
Food & drinks	0.14	0	0	1	0.35	49
Metal products & engineering	0.12	0	0	1	0.33	49
Transportation	0.10	0	0	1	0.31	49
Banking	0.06	0	0	1	0.24	49
Electricity & gas	0.02	0	0	1	0.14	49
National market	0.10	0	0	1	0.31	49
European market	0.80	1	0	1	0.41	49
Global market	0.10	0	0	1	0.31	49

Table 2: Summary statistics of cartel performance at the firm-level

This table presents summary statistics of the performance of the 49 cartels between 1980 and 2004 in our sample, measured at the level of the 141 individual firms in our sample that were involved in these cartels. The table includes information on the following performance measures: profitability (return on assets), productivity (sales over employees, expressed in millions of US$), and innovation (R&D expenses over assets and over sales). Panel A of the table shows summary statistics for the full sample, including both the cartel period and the pre- and post-cartel periods. Panel B shows summary statistics for the firm-year observations outside the cartel period (that is, the pre- and post-cartel periods combined). Panel C shows summary statistics for the firm-year observations in the cartel period only.

	Return on assets	**Sales over employees ($m.)**	**R&D expenses over assets**	**R&D expenses over sales**
PANEL A: FULL SAMPLE (CARTEL AND PRE-/POST-CARTEL PERIOD COMBINED)				
Mean	0.03216	0.39112	0.03186	0.03593
Median	0.03072	0.22305	0.02212	0.02522
Maximum	0.16256	6.39737	0.15189	0.18067
Minimum	-0.13317	0.02972	0.00000	0.00000
Std. Dev.	0.03862	0.56875	0.02827	0.03520
# Firm-year obs.	2593	2514	1619	1615
PANEL B: PRE-/POST-CARTEL PERIOD COMBINED				
Mean	0.03030	0.43198	0.03092	0.03522
Median	0.02917	0.24086	0.02121	0.02366
Maximum	0.16256	6.39737	0.15189	0.18067
Minimum	-0.13317	0.02972	0.00000	0.00000
Std. Dev.	0.04023	0.62017	0.02929	0.03645
# Firm-year obs.	1526	1470	935	931
PANEL C: CARTEL PERIOD				
Mean	0.03481	0.33359	0.03315	0.03690
Median	0.03393	0.20529	0.02402	0.02819
Maximum	0.15515	4.87925	0.12935	0.16824
Minimum	-0.13317	0.03188	0.00000	0.00000
Std. Dev.	0.03605	0.48167	0.02677	0.03341
# Firm-year obs.	1067	1044	684	684

Table 3: Panel models of cartel performance: Cartel vs. pre-/post-cartel periods

This table shows the estimation results of panel regressions to explain variation across the pre-cartel, cartel, and post-cartel periods in the following annual performance measures at the firm-level: profitability (return on assets, or ROA), productivity (sales over employees, expressed in millions of Euros), and innovation (R&D expenses over assets and over sales). The explanatory variables are dummy variables that assume a value of 1 during, respectively, the pre-cartel and post-cartel periods (for each of the 141 individual firms that were involved in the 49 cartels between 1980 and 2004 in our sample), and a value of 0 otherwise. The number of firms is 185 due to overlapping cartel activity and repeat offenders. All panel models contain firm and year fixed-effects. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Variable	**ROA**	**Sales/Employees**	**R&D/Assets**	**R&D/Sales**
Pre-cartel dummy	-0.0019	-0.0812***	0.0024**	0.0022***
	(0.0022)	(0.0202)	(0.0010)	(0.0008)
Post-cartel dummy	-0.0087***	0.0517***	0.0017*	0.0009
	(0.0022)	(0.0199)	(0.0010)	(0.0007)
Firm fixed-effects	yes	yes	yes	yes
Year fixed-effects	yes	yes	yes	yes
# Firm-year obs.	2593	2514	1615	1619
R^2	0.4090	0.7827	0.9171	0.9236
Adj. R^2	0.3566	0.7628	0.9076	0.9148

Table 4: Panel models of cartel performance: Profitability

This table shows the estimation results of panel regressions to explain variation in annual profitability (return on assets, or ROA) at the firm-level, for each of the 141 individual firms that were involved in the 49 cartels between 1980 and 2004 in our sample. The number of firms is 185 due to overlapping cartel activity and repeat offenders. The explanatory variables are (i) a dummy variable that assumes a value of 1 during the cartel period and a value of 0 otherwise; (ii) a trend variable that assumes a value equal to the number of years the cartel has been in place during the cartel period, and zero otherwise; (iii) a dummy variable that assumes a value of 1 for the ringleader during the cartel period, and zero otherwise; (iv) a variable that assumes a value equal to the total number of companies involved in the cartel during the cartel period, and zero otherwise; and (v) a dummy variable that assumes a value of 1 for price fixing cartels during the cartel period, and zero otherwise. All panel models contain firm and year fixed-effects. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Variable	**ROA** Model (1)	**ROA** Model (2)	**ROA** Model (3)
Cartel	0.0054***	0.0014	0.0028
	(0.0015)	(0.0020)	(0.0039)
Cartel trend		0.0009***	0.0010***
		(0.0003)	(0.0003)
Ringleader			0.0011
			(0.0033)
Number of firms involved			-0.0006
			(0.0006)
Price fixing			0.0027
			(0.0052)
Firm fixed-effects	yes	yes	yes
Year fixed-effects	yes	yes	yes
# Firm-year obs.	2593	2593	2593
R^2	0.4079	0.4099	0.4102
Adj. R^2	0.3558	0.3576	0.3571

Table 5: Panel models of cartel performance: Productivity

This table shows the estimation results of panel regressions to explain variation in annual productivity (sales over employees, expressed in millions of Euros) at the firm-level, for each of the 141 individual firms that were involved in the 49 cartels between 1980 and 2004 in our sample. The number of firms is 185 due to overlapping cartel activity and repeat offenders. The explanatory variables are (i) a dummy variable that assumes a value of 1 during the cartel period and a value of 0 otherwise; (ii) a trend variable that assumes a value equal to the number of years the cartel has been in place during the cartel period, and zero otherwise; (iii) a dummy variable that assumes a value of 1 for the ringleader during the cartel period, and zero otherwise; (iv) a variable that assumes a value equal to the total number of companies involved in the cartel during the cartel period, and zero otherwise; and (v) a dummy variable that assumes a value of 1 for price fixing cartels during the cartel period, and zero otherwise. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Variable	**Sales/Employees** Model (1)	**Sales/Employees** Model (2)	**Sales/Employees** Model (3)
Cartel	0.0139	0.0179	-0.1061***
	(0.0132)	(0.0185)	(0.0360)
Cartel trend		-0.0009	-0.0004
		(0.0031)	(0.0031)
Ringleader			-0.1120***
			(0.0297)
Number of firms involved			0.0131***
			(0.0052)
Price fixing			0.2296***
			(0.0477)
Firm fixed-effects	yes	yes	yes
Year fixed-effects	yes	yes	yes
# Firm-year obs.	2514	2514	2514
R^2	0.7808	0.7809	0.7846
Adj. R^2	0.7608	0.7608	0.7645

Table 6: Panel models of cartel performance: R&D investment

This table shows the estimation results of panel regressions to explain variation in annual innovation (R&D expenses over assets and over sales) at the firm-level, for each of the 141 individual firms that were involved in the 49 cartels between 1980 and 2004 in our sample. The number of firms is 185 due to overlapping cartel activity and repeat offenders. The explanatory variables are (i) a dummy variable that assumes a value of 1 during the cartel period and a value of 0 otherwise; (ii) a trend variable that assumes a value equal to the number of years the cartel has been in place during the cartel period, and zero otherwise; (iii) a dummy variable that assumes a value of 1 for the ringleader during the cartel period, and zero otherwise; (iv) a variable that assumes a value equal to the total number of companies involved in the cartel during the cartel period, and zero otherwise; and (v) a dummy variable that assumes a value of 1 for price fixing cartels during the cartel period, and zero otherwise. All panel models contain firm and year fixed-effects. Significance at the 1%, 5%, and 10% level is indicated by ***, **, and *, respectively.

Variable	**R&D/Assets** Model (1)	**R&D/Assets** Model (2)	**R&D/Assets** Model (3)	**R&D/Sales** Model (1)	**R&D/Sales** Model (2)	**R&D/Sales** Model (3)
Cartel	-0.0015***	-0.0008	0.0007	-0.0020***	0.0007	-0.0001
	(0.0005)	(0.0007)	(0.0014)	(0.0007)	(0.0009)	(0.0018)
Cartel trend		-0.0002	-0.0002*		-0.0006***	-0.0007***
		(0.0001)	(0.0001)		(0.0001)	(0.0001)
Ringleader			0.0004			0.0018
			(0.0012)			(0.0016)
Number of firms involved			0.0003			0.0006**
			(0.0002)			(0.0003)
Price fixing			-0.0077***			-0.0062**
			(0.0022)			(0.0028)
Firm fixed-effects	yes	yes	yes	yes	yes	yes
Year fixed-effects	yes	yes	yes	yes	yes	yes
# Firm-year obs.	1619	1619	1619	1615	1615	1615
R^2	0.9235	0.9236	0.9244	0.9171	0.9181	0.9191
Adj. R^2	0.9147	0.9148	0.9155	0.9076	0.9088	0.9097