

Corporate Governance and Anti-Trust Behavior*

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Abstract

Theoretical research shows that not only potential profits from price fixing but also management incentives problems may be related to a firm's decision to participate in a cartel. Such a decision is typically taken at the very top level of a firm's hierarchy. Hence, the executive board and board of directors, which are also at the center of the recent corporate governance discussions, are directly involved in potential collusive price fixing agreements. Consequently, certain governance mechanisms may facilitate or prevent collusive agreements. In this paper, we use a sample of 1,148 observations on 182 different U.S. cartels from 1987 to 2009 to empirically investigate the relation between the probability of participating in a cartel and various corporate governance variables, product market competition, and financial controls. Our results show that large, mature, low-growth firms in concentrated industries are most likely to participate in a cartel. We do not find an overall positive or negative relation between corporate governance and the probability of being part of a cartel. However, several governance mechanisms, such as for example the E-Index, board size, and block ownership are significantly related to the probability of participating in a cartel. We also investigate the relation between cartel membership and firm performance and find cartel firm-years to be associated with a higher Tobin's Q. Finally, we investigate whether cartel firms differ significantly from non-cartelists in their investment behavior and find that cartel firms invest less in risky R&D than other firms.

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1. Introduction

In the 1980s, antitrust authorities started to pay more attention to collusive behavior of firms engaging in price fixing agreements (or cartels). In the early 2000s, world wide corporate penalties for firms participating in such cartels stabilized at or above \$2 billion per year. More than 40% of those penalties can be attributed to settlements in private suits. The remaining 60% are mainly fines imposed by U.S. and European Union antitrust authorities (Connor and Helmers, 2007). Following Connor and Helmers (2007) we define a cartel as follows: “A cartel is an association of legally independent firms that aims to raise their joint profits through explicit agreements. Hard-core cartels aim to control prices or restrict supply (or both).”

Previous theoretical literature shows that not just potential profits from price fixing but also management incentives problems may be significantly related to the decision of a firm to participate in a cartel (e.g., Levenstein and Suslow, 2006; Spagnolo, 2005). Spagnolo (2005) adds managerial incentives schemes to a supergame-theoretical model of dynamic competition and shows that when managers have a preference for smooth time paths of profits and when their contracts have capped incentive provisions (e.g., common bonus plans or termination contracts with substantial incumbency rates), manager-led firms can sustain collusive agreement at lower discount factors. His models shows that even though income smoothing is costly, shareholders tolerate this cost as they are compensated by higher collusive profits.

Buccirossi and Spagnolo (2008) show based on a classical model of repeated oligopoly that the stability of a tacit collusive agreements is also expected to be positively correlated with performance-based incentives provided to top management. In general, there are mainly two problems cartels have to overcome to succeed: cheating and the entry of new firms (Levenstein and Suslow, 2006). If a firm deviates from collusive agreement (e.g., by lowering prices), the resulting additional earnings have to be disclosed in the firm’s financial state-

ments. Suspicious partner cartelists are likely to detect those exceptional earnings and could react by starting a price war which will then result in lower profits and stock prices. Moreover, a price war can be indicative of a prior collusive agreement and draw attention from anti-trust authorities. The resulting (future) costs may be so large in present value terms that defection from collusive behavior is not attractive. Another big challenge for cartels is that other firms enter the industry and destroy the collusive equilibrium. Thus, successful cartels are often located in concentrated industries which facilitate collusive conduct (Bolotova, Connor, and Miller, 2008).

The decision to form a cartel is typically taken at the very top level of the firms' hierarchy (Harrington, 2006) and then implemented by the intermediate management (Spagnolo, 2005). Hence, the same corporate entities which are at the center of the recent corporate governance discussions, i.e., the CEO and top management team and the board of directors, are also directly involved in potential collusive price fixing agreements of their firms. Thus, the question arises whether corporate governance is significantly related to the probability that a firm participates in a cartel. Specifically, certain corporate governance structures may facilitate or prevent collusive agreements and membership in a hard-core cartel. For example, a high concentration of power at the top level, a weak board of directors, or strong pay-for-performance incentives provided to top managers (Spagnolo, 2005) may facilitate participation in a cartel. To the best of our knowledge, there is no empirical literature so far that investigates the relation between firm-level corporate governance and cartelistic behavior.

This paper aims at filling this gap by investigating the relationship between the probability that a firm participates in a cartel and various firm characteristics, market concentration, and corporate governance mechanisms. Moreover, we investigate the relation between cartel membership and firm performance as measured by Tobin's Q, return on assets (ROA), and stock excess returns as measured by an alpha from a Carhart (1997) four-factor model. Given

the recent evidence of a significant effect of product market competition on the relation between corporate governance and firm performance (e.g., Allan and Gale, 2000; Giroud and Mueller, 2010, 2011) and the expected relation between collusive conduct and market concentration and therefore competition, we account for both corporate governance and competition in this analysis. Finally, we investigate whether cartel firms differ significantly from non-cartelists in their investment behavior as measured by capital expenditures (CAPX), research and development (R&D) expenditures, and acquisition spending. As overcharges resulting from charging above market prices artificially increase the economic rents, we may expect that cartel firms invest less, especially in risky R&D.

We use data on a sample of 1,148 firm years on 182 U.S. firms participating in a hardcore cartel between 1987 and 2009. We define a cartel firm-year as year in which the given cartel has been involved in price fixing. The starting point and duration of the cartels in our sample are determined by the antitrust authorities.¹ We compare these cartel firm-year observations to two alternative sets of control variables. The first set of control firms consists of the complete Compustat universe where non-cartel years of firms that appear at some time in the cartel-sample are excluded. The second set of control firms includes a set of size- and industry-matched firms which are drawn from the first set of control firms.

Our results show that larger and more mature firms and firms which experienced a relatively low sales growth over the last few years are more likely to form or participate in a cartel. Also, more concentrated – that is less competitive – product markets seem to facilitate collusive agreements to fix prices and are positively related to the probability that a firm participates in a cartel. As for the corporate governance measures, we do not find an overall clear positive or negative relation between what is generally considered to be good corporate governance in the literature and the probability of being part of a cartel. However, several of the

¹ As the majority of other empirical studies on cartels, our sample is subject to a selection bias as we are only able to consider discovered and indicted cartels (e.g., see Connor, 2010).

individual corporate governance mechanisms are significantly related to the probability of participating in a cartel. For example, the E-Index is significantly negatively related to the probability that a firm participates in a cartel. As a higher E-Index indicates stronger takeover protection, a possible explanation for this finding may be that firms, which are better protected from the market of corporate control, worry less about profitability and therefore are less likely to participate in a cartel. The relation between board size and the probability to participate in a cartel is positive and significant. A possible reason for this finding may be that larger boards are less efficient and less effective monitors (e.g., Lipton and Lorsch, 1992; Jensen, 1993; Yermack, 1996). Furthermore, a larger board of directors gives more opportunities to connect to other firms.² As a final example, CEO tenure is positively related to the probability that a firm participates in a cartel. The tenure of a CEO is a measure for both the power of a CEO and how well he is connected within the firm and also in the industry. With respect to the valuation effect of cartel membership, we find cartel firm-years to be associated with a significantly higher Tobin's Q. Consistent with Habib and Ljungqvist (2005), we also find a positive relation between product market competition and firm value. Both results hold when corporate governance and various financial control variables are accounted for. In contrast, we find no significant relation between cartel membership and ROA and between cartel membership and alpha. Finally, we find that cartel firms in fact invest less in risky R&D than other firms controlling for growth opportunities, product market competition, firm age and size and other financial controls.

The remainder of the paper is organized as follows. Section 2 describes the sample and variables. Section 3 reports the results from the empirical analysis. Section 4 concludes.

² Even though directors may profit financially from price fixing, for example through their stock and option holdings, they may be subject to personal charges when their company is indicted and therefore disapprove of their firm participating in a cartel agreement.

2. Data and variables

2.1 Sample selection

This section gives a description of the data and variables used in this study. We use the same cartel data of Connor (2010), a hand collected sample of 648 international hard-core cartels whose members were subject to government or private legal actions. The dataset comprises the firms' names, the country of incorporation, the market(s) and continent(s) on which collusion and price fixing took place, the lead jurisdiction, the duration of the collusive agreement, and – if known – the fines (including leniency) and the estimated overcharges. The information is collected from different sources, mainly filings, documents, reports and press releases from the antitrust authorities. Another source of information are newspaper and magazine articles which are available through search engines like Factiva or LexisNexis. For more details on the method of data collection we refer to Connor (2010). Specifically, we define a cartel firm-year as year in which the given cartelist has been involved in price fixing. The starting point and duration of the cartels in our sample is determined by the antitrust authorities. As a simple check of the appropriateness of this classification, we report the yearly return on assets (ROA) over a symmetric window of five years around the year which has been determined as the starting point of the cartel in Figure 1. In fact, the figure shows that profitability monotonously decreases over the five years before a firm enters into a cartel and then nearly monotonously increases over the subsequent five years. Like most other empirical studies on cartels, we are only able to consider discovered and indicted cartels. Thus, our study may suffer from sample selection bias. Connor and Helmers (2007) estimate that only approximately 10% to 30% of all price-fixing conspirations are discovered.

The starting point of our sample consists of all 819 U.S. cartel members included in the above dataset. We exclude all cartels which started before 1987 and all firms which are not covered by Compustat and CRSP which substantially reduces sample size to 182 firms. Over-

all, we obtain data on 1,148 firm-year observations of these 182 different firms. In some of our analyses, we also merge these 182 firms to the RiskMetrics Governance and Directors databases (formerly Investors Responsibility Research Center (IRRC)) and Thomson Financial's CDA/Spectrum database, which further reduces samples size. Recidivism is known as major problem in cartel enforcement (Connor, 2010). Thus, 58 out of our 182 firms attempted more than once to increase profits through explicit price agreements.

We use two control groups in our study. The first consists of all firms in the Compustat database from 1987 to 2009 which never appear in our cartel dataset. Depending on the analysis, we additionally require data availability on CRSP and/or the different corporate governance databases. We obtain 78,268 observations on 9,796 different firms. The second control group consists of a set of firms matched to the cartelists and drawn from the set of firms in first control group. Our matching approach is similar to the one used in Eckbo and Norli (2005). We match on the firms' industry, as defined by the first two digits of the Standard Industry Classification (SIC) code, and firm size as measured by total assets. For every cartel-ist we create a subset of all non-cartelist firms which share the first two digits of the SIC code at the end of the year before the collusive agreement started. Out of this subset we select the firm which is closest in size to the cartel-ist in the respective year. Matched firms are included for the whole period of the collusive agreement or until they are delisted. In case of a delisting of a matched firm, the second best match from the original list of matching firms is chosen and included as of the year of delisting of the first matching firm. Cartel-ists with no appropriate match are excluded. There are two reasons for excluding firms. First, in some years there are more cartel-ist than non-cartelist firms in some two-digit SIC codes. We do not match more than one cartel-ist firm to the same control firm and therefore drop cartel-ist firms without matching control firm from this analysis. We drop those firms which are the worst matches with respect to firm size. The second reason is that there is no data available on the cartel firm

for the first year of the cartel. The matched sample includes a total of 999 cartel firm-years on 137 cartel firms and 997 non-cartel firm-years on 190 matching firms.

2.2 *Variable definition*

To measure corporate governance, we use a large set of individual corporate governance mechanisms stemming from different data sources. First, to account for the firms' anti-takeover protection, we use the Entrenchment Index (E-Index) proposed by Bebchuk, Cohen, and Ferrell (2009) which concentrates on the six most important provisions included in the well-known G-Index (Gompers, Ishii, and Metrick, 2003).³ A high E-Index (or G-Index) implies more takeover defenses and therefore lower shareholder rights as the managers are better protected from the market for corporate control.⁴ The data is obtained from the RiskMetrics Governance database. Since data is only available for every second or third year, we follow previous research (e.g., Gompers, Ishii, and Metrick, 2003) and assume that the firms' governance attributes as reported in a given RiskMetrics series remain unchanged until publication of the subsequent series.

In addition to the E-Index, we include five variables related to the board of directors: Board size (Yermack, 1996), the percentage of directors who are independent outsiders (Rosenstein and Wyatt, 1990), the percentage of directors who attend less than 75% of the board meetings (Adams and Ferreira, 2009), a dummy variable the CEO is also the chairman of the board and the only inside director on the board (Adams, Almeida, and Ferreira, 2005), and a dummy variable whether a majority of the outside directors holds three or more directorships (Fich and Shivdasani, 2006) are all obtained from the RiskMetrics database. Three additional corporate governance variables which measure CEO power and compensation are obtained

³ The six provisions included in the E-Index are dummy variables for a staggered board, limitations on amending bylaws, limitations on amending the charter, a supermajority requirement to approve a merger, golden parachutes, and poison pills.

⁴ In fact, we find the results to be substantially weaker when we use the G-Index instead of the E-Index in unreported robustness tests. Results based on the G-Index are reported in Column 2 of Table 2 only.

from the ExecuComp database: The percentage of shares owned by the CEO (Mehran, 1995), the tenure of the CEO, and the CEO pay-for-performance sensitivity (Jensen and Murphy, 1990). The pay-for-performance sensitivity is calculated as stock related compensation (i.e., the value of stock and option awards) over salary and bonuses. Finally, we attempt to account for the ownership structure and include the ownership by blockholders which hold more than 5% of the firm's equity (Shleifer and Vishny, 1986). This variable is obtained from Thomson Financial's CDA/ Spectrum database.

The financial data is obtained from Compustat and CRSP. As a measure of product market competition we use the Herfindahl-Hirschman Index (HHI). The HHI is computed as the sum of the squared market shares of all firms in a given industry. Firms are assigned to an industry by their full 4 digit SIC industry codes. In order to deal with the known shortcomings of the HHI (e.g., see Masulis, Wang, and Xie, 2007) we use for robustness tests the competition measure proposed by Titman and Wessels (1988), i.e., the industry median ratio of selling expenses over sales. We measure firm value by the simple approximation to Tobin's Q often used in the literature (e.g., Agrawal and Knoeber, 1996; Gompers, Ishii, and Metrick, 2003) and defined as total assets minus the book value of equity plus the market value of equity over total assets. As a proxy for firm age we use the natural logarithm of the number of years since a company is first included in the CRSP database. We calculate the annual alpha of the firms by conducting a 24-months rolling window regression of the Carhart (1997) four-factor model:

$$R_t^{Ex} = \alpha + \beta_1 \times MKT_t + \beta_2 \times SMB_t + \beta_3 \times HML_t + \beta_4 \times UMD_t + \varepsilon_t,$$

where R_t^{Ex} is the excess return of the stock, MKT is the market return in excess of the risk-free rate, SMB is the size factor, HML the book-to-market factor and UMD is the momentum factor. The abnormal return is the intercept (alpha) of the above regression. We use the annual-

ized December returns as regression input. Bolotova, Connor, and Miller (2008) explain that concentrated markets are usually characterized by high barriers to entry and exit and that firms in those markets are confronted with high fixed costs. We therefore include capital expenditure over total assets in our analysis. We further use the following financial variables: firms size (log of total assets), leverage, research and development expenditures scaled by sales (R&D), return on assets, the past three year growth in sales, and a dummy variable whether the firm pays a dividend. We winsorize several of our financial variables at the 1st and 99th level: leverage, Tobin's Q, R&D/Sales, return on assets, the percentage of block ownership, and the percentage of shares owned by the CEO.

2.3 *Descriptive statistics*

Panel A of Table 1 provides descriptive statistics of the main variables for the cartelists and the main control group. Panel B reports descriptive statistics for the cartelists and the control group of matching firms. The results in both panels show that cartel firms operate in more concentrated markets than the control firms. This finding is expected as collusive agreements are easier to make and maintain in more concentrated markets where a relatively small number of firms have a relatively large market power. Consistently, cartel firms are larger, older, and more profitable than the firms in the two control groups. Also, Tobin's Q is slightly higher for cartel firm-years than control firm-years. Table 1 gives mixed indications whether firms, which commit antitrust agreements have a better corporate governance structure than our control firms. For example, cartel firm-years are characterized by larger boards, more independent boards, a lower E-Index, lower CEO ownership, higher block ownership, a higher incidence of a combined CEO-chairman position, and more busy directors on the board. Some of these differences in corporate governance between cartel and control firm-years are likely to be due to the substantial difference in firm size between the two groups. Hence, it is

important to investigate the relationship between collusive conduct and corporate governance in a multivariate setup.

3. Empirical Results

3.1 Antitrust behavior and corporate governance

We first investigate whether there are certain firm characteristics which are significantly related to the probability of a firm engaging in price fixing agreements. We estimate a probit model with a dummy variable which equals one for all years in which an identified cartelist firm was involved in price fixing as dependent variable. As the duration of the cartel in our sample is determined by the antitrust authorities and therefore depends on the evidence found in their investigations, we exclude all firm-years of identified cartelist firms in which these firms – to our knowledge – were not engaged in collusive agreements from the sample of control firms. Hence, the sample includes all firm-years of cartelist firms in which they were presumably involved in price fixing and all firms with available data on Compustat which never appear in our dataset of cartelist firms. In unreported robustness checks, we additionally include the firm-year of cartelist firms before the price fixing effectively started in our analysis to account for a potential time lag between the decision making process and negotiations to form a cartel and the actual price fixing. Including these years in general strengthens the significance of our results. All regression specifications include industry and year fixed effects to account for potential omitted variables which are industry or year specific. We classify industries based on the first digit of the SIC industry codes.⁵

In the first specification, we include a number of financial variables as independent variables. These variables include the natural logarithm of total asset to control for firm size, the

⁵ In unreported robustness tests, we use the Fama and French (1997, FF) industry classifications. We assign firms to the 12 FF industries by matching the SIC codes to the 12 FF industries using the conversion tables provided on Kenneth French's website. Our results remain virtually unchanged when using this alternative industry classification.

HHI to control for competition in an industry, and sales growth over the past three years to take growth opportunities into account. Moreover, we account for the entry fixed cost in a market by including capital expenditure over total assets. As additional control variables, we include leverage, firm age, return on assets, R&D expenditures, and a dummy variable whether the firm is paying a dividend. In the second specification, we additionally include the full set of corporate governance variables as outlined above. In the third specification, we replace the G-Index by the E-Index. In the fourth specification, we additionally include the tenure of the CEO as a measure of CEO power. The inclusion of this variable results in a further reduction in sample size.

Table 2 reports the results. The coefficients on total assets, leverage, the dividend dummy variable, and firm age are all positive and significant at the 1% level. Hence, larger and more mature firms seem to be more likely to form or participate in a cartel. As expected, the positive and significant coefficient on the HHI shows that cartel firms are more likely to be active in concentrated industries which facilitates collusive agreements to fix prices. These findings are consistent with Connor (2010) who explains that most of the cartel members are international conglomerates which have a division operating in industrial goods (e.g., manufacturing sector, chemical intermediates, or non-metallic minerals). These are typically highly concentrated industries. The coefficient on CAPX/total assets, our proxy for fixed costs, points to the expected direction, however, is not significant. The coefficient on past sales growth is negative and significant at the 1% level. This finding is consistent with Figure 1 and indicates that firms are more likely to fix prices after low sales growth. Including the governance variables in our model in Columns 2 to 4, leaves the coefficients on the control variables virtually unchanged with three exceptions. The coefficients on leverage change signs and are now negative and only borderline significant. The coefficient on CAPX/total assets turns significant at the 5% level and firm age becomes insignificant.

As for the governance measures, the results show that both the G-Index and the E-Index have negative coefficients. However, the coefficients on the E-Index in Columns 3 and 4 are significant at the 5% level while the coefficient on the G-Index in Column 2 is insignificant. A higher E-Index indicates stronger takeover protection. Hence, a possible explanation for this finding may be that better protected firms worry less about profitability and therefore are less likely to participate in a cartel. The coefficient of blockholder ownership is positive and significant at the 1% level in all three specifications. Hence, blockholders are either not reluctant to invest in cartel firms or are not aware of price fixing taking place in these firms. There is some evidence that collusive agreements are of advantage to shareholders as profits are expected to increase if not detected. And even if detected and convicted, Connor (2010) argues that penalties usually correspond to the overcharges resulting from above market prices and therefore result in a zero sum game. Hence, the expected payoff from participating in a cartel is positive (Levenstein and Suslow, 2006). This is also confirmed by a high incidence of recidivists (Connor, 2010). As the rate of detection is unknown, however, it is difficult to assess the magnitude of such a payoff. Managers and directors may be personally liable and can be sentenced to imprisonment. In contrast, outside blockholders, which may not be subject to personal charges, are likely to have a positive expected value from investing in firms participating in collusive agreements. The coefficient on board size is positive and significant indicating that larger boards of directors are positively related to the probability of forming a cartel. A possible reason for this finding may be that larger boards are less efficient and less effective monitors (e.g., Lipton and Lorsch, 1992; Jensen, 1993; Yermack, 1996). While the directors may also profit financially from price fixing, for example through their stock and option holdings, they may be subject to personal charges when their company is indicted. Furthermore, a larger board of directors gives more opportunities to connect to other firms. The coefficient on CEO tenure in Column 4 is positive and significant at the 5% level. The tenure

of a CEO is a measure for both the power of a CEO and how well he is connected within the firm and also in the industry. Hence, there is some evidence that firms are more likely to participate in a cartel if their CEO is more powerful and the board is presumably less effective in monitoring the CEO, i.e., is larger and has more attendance problems. This is also confirmed by some of the less or not significant coefficients. The coefficient on board independence is always negative and borderline significant in Column 2 indicating that more independent outside directors on the board are associated with a lower probability of participating in a cartel. In contrast, more busy directors and a combined CEO-chairman position are mostly positively related to the probability of participating in a cartel. In contrast, the coefficient on the percentage of shares held by the CEO is negative and significant. Also, and in contrast to our expectations, the coefficient on the measure of director attendance rates is negative and significant at the 10% level in all three specifications indicating that firms with boards with attendance problems are less likely to participate in a cartel.

3.2 Antitrust behavior, corporate governance, and firm performance

In this sub-section, we investigate the relationship between collusive agreements and different measures of firm performance. The three measures of firm performance we use are Tobin's Q as a measure of firm valuation, ROA as a measure of operating performance, and an alpha from a 24-months rolling window regression based on a Carhart (1997) four-factor model as a measure of stock price performance. We estimate two types of regressions. The first includes only a dummy variable for cartel firm-years and financial control variables as explanatory variables, the second type additionally includes corporate governance control variables. As before, we exclude non-cartel years of the cartel firms from the analysis. All regressions include industry and year fixed effects. Since the observations for one specific firm (for different years) are clearly not independent (within correlation), we compute cluster-

robust standard errors and treat each firm as a cluster. The set of financial control variables is based on previous research (e.g., Yermack, 1996; Gompers, Ishii, and Metrick, 2003).

The results are reported in Table 3. Most importantly, the results in the first two columns show that cartel firm-years are characterized by a significantly higher Tobin's Q. Also, competition as measured by the industry concentration index, has a positive effect on firm value. This finding may be surprising at first sight. However, Griffith (2001) argues that the direction of the effect that product market competition should have on firm value is ambiguous as competition lowers a firm's profits and thus reduces incentives to exert effort (i.e., the Schumpeterian effect) but on the other hand it reduces agency costs and therefore increases incentives to exert effort. In fact, the sparse previous literature on the valuation effect of competition finds contradicting results. Habib and Ljungqvist (2005) report a positive relation between product market competition and firm value and Beiner, Schmid, and Wanzenried (2011) a negative relation between competition and firm value. In Column 2, only two of the eight corporate governance variables have significant coefficients. Consistent with previous research, the coefficient on the E-Index is negative and significant indicating a lower valuation for firms with stronger anti-takeover protection and weaker shareholder rights. The coefficient on block ownership is also positive and significant indicating that more monitoring by large investors positively affects firm value (e.g., Shleifer and Vishny, 1986). The coefficients on the other governance variables show the expected signs but are not significant.

The results in Column 3 with ROA as dependent variable show that controlling for other firm characteristics and industry effects, cartel-firms years are characterized by a lower profitability which may be one of the reasons for participating in a cartel in the first place. Consistent with previous research (e.g., Beiner, Schmid, and Wanzenried, 2011), competition has a negative effect on profitability by decreasing economic rents. When corporate governance variables are accounted for, the coefficients on both variables turn insignificant, however.

Moreover, the results in Column 4 show that the coefficient on the E-Index is not significant anymore. However, there is evidence of a positive and concave relation between CEO ownership and profitability and a positive relation between block ownership and profitability. The coefficient on board size is also positive and significant which seems surprising as previous research rather indicates a negative relation between board size and firm value (e.g., Yermack, 1996) which is also confirmed by the negative coefficient in Column 2 (Tobin's Q) and negative and significant coefficient in Column 6 (alpha) of Table 3.

In Columns 5 and 6, with alpha as dependent variable, the coefficients on both the cartel dummy variable and the HHI are insignificant. Hence, the stock returns seem neither to be affected by participating in a cartel nor by the competition in the stock market. However, the results on Tobin's Q show that both cartel membership and competition seem to be reflected in the valuation levels.

3.3 The matching firm approach

In the analysis so far, we use the full set of non-cartelist firms as control group. Table 1, however, shows that cartel firms differ substantially with respect to non-cartelist firms. Moreover, we compare a relatively small number of cartel firm-years to a very large sample of control firm-years. For example, in the first column of Table 2, the sample of the probit regression only including financial controls consists of 1,033 cartel firm-years (1.8%) and 57,124 non-cartel firm-years (98.2%). Once, we include the corporate governance variables the percentage of cartel firm-years somewhat increases due to the better availability of governance data for larger firms. For example, in Column 2 of Table 2 the sample includes 611 cartel firm-years (5.8%) and 9,955 non-cartel firm-years (94.2%). Therefore, in this subsection, we use a matched firm approach as outlined in Section 2.1, to obtain a sample of comparable matched control firms of a similar size as the sample of cartel firm-years. Even

though our industry- and size matching algorithm aims at matching the cartelists to equally sized firms within the same industry, the cartelists often are the largest firms in their industry. This makes intuitively sense as substantial market power is necessary to be able to influence prices. To cope with this problem, we keep the natural logarithm of the total assets as a control variable in our regressions.

We replicate the analysis reported in Tables 2 and 3 and replace the full set of non-cartelist firm-years covered in the Compustat database by the sample of matched control firm-years. Table 4 reports the results of the probit regressions reported in Table 2. We drop Column 2, which includes the G- instead of the E-Index from Table 4 as the coefficient on the G-Index again is insignificant while the other coefficients are virtually identical to those reported in the subsequent columns. In general, the results in Table 4 are similar to those reported in Table 2 but somewhat weaker with respect to statistical significance. As many of the reported coefficients, however, increase in size, this likely to be due to the substantially smaller sample size in Table 4. Most importantly, the results in Table 4 confirm a positive relation between competition and the probability of participating in a cartel. The coefficient on the HHI is positive and significant in Columns 1 and 3 and borderline insignificant in Column 2. As for the corporate governance variables, there is only little change. The E-Index remains negative and significant in all specifications and block ownership and board size positive and significant. Also CEO tenure, our measure of CEO power and connectedness, is still positive and significant. However, the negative coefficients on CEO ownership and the attendance problems variable are now insignificant while the measure of board busyness is now positive and significant, confirming that a more busy board which presumably spends less time on advising and monitoring the firms' managers, which increases the CEO's power, is related to a higher probability of participating in a cartel. Moreover, as the decision to participate in a cartel is

typically taken at top level of a firm's hierarchy (e.g., Harrington, 2006), better connected directors may facilitate negotiations with other firms to enter a collusive agreement.

So far, we analyzed the whole lifetime of a cartel as defined by the antitrust authorities. One potential problem of this approach is that we capture firm characteristics which increase the likelihood to enter collusive agreements in the first years of a cartel and characteristics which are rather related to the break-up of a cartel towards the end of a cartel's lifespan (e.g., changes in the firms' leadership or governance structure). To account for this problem and focus on the cartel formation, we re-estimate the probit regressions of Tables 2 and 4 and replace the dependent variable by a dummy variable which equals one only in the first year of a cartel. We exclude all subsequent observations from cartel firms. Hence, the sample in this analysis only includes the first cartel-years of all cartelists in the sample of matched control firm-years. The results are reported in Columns 1 to 3 of Table 5. In Column 4, we reestimate the specification in Column 3 but lag the explanatory variables by one year to account for a possible time delay from the point in time when the collusive agreement was negotiated to the point in time when it became effective. Overall, the results are similar to those in Table 4 but even weaker with respect to statistical significance. The negative effect of competition on the probability to participate in a cartel is significant only in Columns 1 and 3. Moreover, out of the set of eight corporate governance variables only the E-Index is consistently significant across all specifications. Moreover, CEO tenure is positive and significant in Columns 3 and 4. In contrast to Table 4, both board size and block ownership are now insignificant in all specifications. While independent outside directors often are considered to be better monitors of the CEO as compared to inside or gray directors (e.g., Weisbach, 1988), there is increasing evidence that independent outside directors (e.g., Duchin, Matsusaka and Ozbas, 2010; Masulis and Mobbs, 2011) may not have enough information and knowledge to monitor the firm's

management in an efficient way.⁶ In fact, empirical evidence on the valuation effect of independent outside directors provides mixed and mostly insignificant results (e.g., Yermack, 1996). From a juridical point of view, it may even be better for directors not to know about collusive behavior in their firm as non-knowledge can prevent them from becoming personally liable.

Column 5 of Table 5 reports the results from an OLS regression of the life time of a cartel, measured as the natural logarithm of the number of months a cartel was determined to be effective by the antitrust authorities, on the same set of explanatory variables plus the CEO's pay-for-performance sensitivity. Spagnolo (2000) and Buccirosi and Spagnolo (2008) show, based on theoretical models, that the stability of a cartel is positively related to the pay-for-performance sensitivity. Hence, we would expect a positive relationship between the pay-for-performance sensitivity and the life time of a cartel. In fact, the results in Column 5 show that the coefficient on the CEO's pay-for-performance sensitivity is positive and significant. In contrast, and consistent with Table 2, the coefficient on CEO ownership is negative and significant. The only other significant coefficient is the negative coefficient on block ownership.

Table 6 reports the results of the OLS regressions reported in Table 3 for the reduced sample of cartel firm-years of the identified cartel firms and matched control firms. Again, the results in Table 6 are similar but weaker with respect to their statistical significance as compared to Table 3. The most important differences are the following. In Column 3, with ROA as dependent variable, the coefficients on both the cartel dummy variable and the HHI are now insignificant. The E-Index is now only (borderline) significant in the Q-regression but not the alpha-regression in Column 6. The coefficient on board size is not significant anymore in all specifications and block ownership is only significant in Column 6. In contrast, the

⁶ Consistently, Ravina and Sapienza (2010) examine the relative profitability of trades in their companies' stocks made by outsiders and insiders and find that both types of directors have access to inside information but that outsiders' information is strictly worse than that of insiders'.

coefficient on attendance problems is now significant at the 10% level in Column 4 indicating that attendance problems are associated with lower profitability and the coefficient on a combined CEO-chairman position is now positive and significant at the 5% level in Column 6 indicating that alpha is positively related to a combined leadership structure. This latter finding is consistent with Dey, Engel, and Liu (2009).

3.4 Antitrust behavior and investment decisions

In this section, we investigate whether the investment behavior differs between cartel firms and non-cartel firms. As overcharges resulting from charging above market prices artificially increase the economic rents, we may expect that cartel firms invest less especially in risky R&D. However, as cartel firms are much larger, older, and more profitable and all of these characteristics have been shown to be negatively related to R&D investments, we attempt to control for such firm characteristics.

Specifically, we regress three alternative measures related to the firms' investment behavior on the cartel dummy variable and a number of financial control variables including Tobin's Q and past sales growth to proxy for growth opportunities, the HHI to proxy for competition on the product markets, firm age and size to proxy for the firms' maturity, the dividend dummy to proxy for the availability of internal funds which makes it unlikely that a firm is capitally constrained, and leverage. The results are reported in Table 7. The three measures for a firm's investment behavior that we use are CAPX/total assets (Column 1), R&D/sales (Column 2), and money spent on acquisitions divided by the market capitalization (Column 3). Most importantly, the results show that the coefficient on the cartel dummy variable in Column 2 is negative and significant at the 5% level indicating that cartel firms in fact invest less in R&D than other firms holding everything else constant. In contrast, the coefficients on the cartel dummy variable are insignificant in both Columns 1 and 3. The coefficients on the

financial controls indicate that both better growth opportunities and more competition are associated with higher investments (both R&D and CAPX). Also, younger firms invest significantly more. R&D investments are significantly higher for smaller firms and lower for firms which pay a dividend. Finally, leverage is negatively related to R&D expenditures. This makes sense as highly leveraged firms may be less willing and able to undertake a lot of risky investments in R&D. The results of the regression of money spent on acquisitions divided by the market capitalization is insignificant for all variables including our cartel dummy. The r-squared of the regression is just 0.1%.⁷

4. Conclusion

Using a data sample of 182 U.S. firms which participated in hard-core cartels between 1987 and 2009 we analyze empirically the relation between corporate governance and the probability of being engaged in collusive conduct. We compare the cartelists to two alternative sets of control firms: the complete Compustat universe and a set of control firms matched on size and industry. Our results show that larger and more mature firms and firms which experienced a relatively low sales growth are more likely to participate in a cartel. Also, we are able to confirm prior research which has identified certain industry characteristics which facilitate collusive agreements. We try to establish relationships between board characteristics, the ownership structure, variables which measure CEO power and compensation and collusive behavior. With regards to these corporate governance measures we cannot identify an overall clear positive or negative relationship between the probability of being part in a cartel and what in the literature is typically known as good or bad corporate governance. However, we find that some of our governance measures are statistically significantly related to price fixing agreements. We find a negative relationship between the E-Index (a measure for takeover

⁷ We replicate the analysis in Table 7 for the sample of cartel firm-years and matched control firms instead of including the complete Compustat universe as control firms. The results are qualitatively similar, albeit slightly weaker with respect to statistical significance again most likely due to a substantial reduction in sample size.

protection) and the likelihood to participate in a cartel. Further, we show that board size and CEO tenure is positively related to the likelihood of entering collusive agreements. In the last part of our analysis we show a positive valuation effect of cartel membership. When it comes to investment decision we find that cartel firms invest in less risky R&D than firms in our control groups.

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Table 1: Descriptive statistics

The table presents descriptive statistics for all variables used in the study. Panel A reports the descriptive statistics for the sample of all cartel firm-years and a sample of control firms which includes all firms covered by Compustat which never appear in the dataset of cartelists. Panel B reports the descriptive statistics for the sample of cartel firms and matched control firms. To match cartel to control firms, we create for every cartel a subset of all non-cartel firms, which share the first two digits of the SIC code at the end of the year before the collusive agreement started. Out of this subset we select the firm which is closest in size to the cartel in the respective year. Matched firms are included for the whole period of the collusive agreement or until they are delisted. In case of a delisting of a matched firm, the second best match from the original list of matching firms is chosen and included as of the year of delisting of the first matching firm. Cartelists with no appropriate match are excluded. All variables are defined in Section 2.2 of the main text. The equality of means is tested using a standard *t*-test and the equality of medians using a Wilcoxon signed rank test. ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Panel A: Cartelists and control firms

	Cartelists				Control firms				Differences			
	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev	Obs.	Difference Mean		Difference Median	
Competition (HHI)	0.2447	0.1749	0.2177	1,134	0.1925	0.1434	0.1732	77,780	0.0522	***	0.0316	***
Leverage	0.6458	0.6361	0.1923	1,138	0.5237	0.5238	0.2635	78,268	0.1221	***	0.1123	***
Total Assets	74,473	8,271	216,364	1,139	4,713	265	50,013	78,268	69,761	***	8,005	***
R&D/Sales	0.0342	0.0094	0.0628	1,148	0.1505	0.0000	0.6980	78,268	-0.1163	***	0.0094	***
Dividend (dummy)	0.8563	1.0000	0.3510	1,148	0.4772	0.0000	0.4995	78,268	0.3791	***	1.0000	***
ROA	0.0516	0.0506	0.0758	1,139	-0.0149	0.0236	0.1930	78,144	0.0665	***	0.0270	***
Past sales growth	0.2170	0.1500	0.4495	1,103	2.2768	0.2174	110.1338	68,879	-2.0600		-0.0674	***
CAPX/total assets	0.0508	0.0447	0.0381	1,099	0.0557	0.0344	0.0716	69,490	-0.0049	**	0.0103	***
Firm age	12.5902	13.0000	6.4135	1,125	8.2074	7.0000	6.2697	74,385	4.3837	***	6.0000	***
Q	2.0210	1.5094	1.4516	1,135	1.9341	1.3103	1.7282	77,399	0.0868	*	0.1991	***
Alpha (annual)	0.0370	0.0358	0.2490	1,069	0.0581	0.0351	0.4188	62,617	-0.0211		0.0007	
G-Index	9.5740	9.0000	2.7503	906	8.9775	9.0000	2.7107	19,263	0.5968	***	0.0000	***
E-Index	2.0812	2.0000	1.3803	862	2.3099	2.0000	1.4288	16,669	-0.2284	***	0.0000	***
Shares CEO	0.0075	0.0009	0.0288	861	0.0297	0.0044	0.0635	18,652	-0.0221	***	-0.0034	***
Block Ownership	0.6101	0.6350	0.2102	1,148	0.3620	0.3069	0.2873	78,268	0.2482	***	0.3280	***
Board size	11.4649	11.0000	2.8790	712	9.1173	9.0000	2.8448	13,536	2.3475	***	2.0000	***
% Indep. outsiders	0.7241	0.7500	0.1516	712	0.6719	0.7000	0.1840	13,536	0.0523	***	0.0500	***
Combined CEO-chairman	0.8666	1.0000	0.3403	712	0.7061	1.0000	0.4556	13,536	0.1604	***	0.0000	***
Attendance problems	0.0137	0.0000	0.0390	712	0.0169	0.0000	0.0501	13,536	-0.0033	*	0.0000	
Busy board	0.3834	0.0000	0.4866	712	0.1534	0.0000	0.3604	13,536	0.2302	***	0.0000	***
CEO Tenure	6.1030	4.0000	6.1993	903	7.3024	5.0000	7.4527	19,047	-1.2001	***	-1.0000	***

Table 1 – Continued

Panel B: Cartelists and matched firms

	Cartelists				Matched firms				Differences			
	Mean	Median	Std. Dev.	Obs.	Mean	Median	Std. Dev.	Obs.	Difference Mean		Difference Median	
Competition (HHI)	0.2488	0.1777	0.2236	999	0.2057	0.1534	0.1700	997	0.0431	***	0.0243	***
Leverage	0.6483	0.6370	0.1909	998	0.6057	0.6128	0.2117	997	0.0427	***	0.0242	***
Total Assets	82,346	9,331	229,570	999	32,934	3,672	122,788	997	49,412	***	5,659	***
R&D/Sales	0.0355	0.0136	0.0559	999	0.0508	0.0039	0.2293	997	-0.0153	**	0.0097	***
Dividend (dummy)	0.8799	1.0000	0.3253	999	0.7944	1.0000	0.4044	997	0.0855	***	0.0000	***
ROA	0.0531	0.0512	0.0755	999	0.0491	0.0508	0.0771	997	0.0039		0.0004	
Past sales growth	0.2077	0.1526	0.4428	974	0.2628	0.1676	0.7223	971	-0.0551	**	-0.0150	***
CAPX/total assets	0.0515	0.0457	0.0388	960	0.0497	0.0384	0.0441	981	0.0018		0.0073	***
Firm age	13.3128	14.0000	0.6364	988	11.8173	11.0000	5.9596	974	1.4955	***	3.0000	***
Q	2.0803	1.5289	1.5126	998	1.9627	1.5447	1.3349	990	0.1176	*	-0.0158	
Alpha (annual)	0.0408	0.0406	0.2452	968	0.0513	0.0430	0.2616	952	-0.0105		-0.0024	
G-Index	9.6470	10.0000	2.7611	847	9.7216	10.0000	2.6534	668	-0.0746		0.0000	
E-Index	2.0813	2.0000	1.3837	800	2.4943	3.0000	1.2550	611	-0.4130	***	-1.0000	***
Shares CEO	0.0063	0.0009	0.0219	764	0.0181	0.0022	0.0413	579	-0.0118	***	-0.0013	***
Block Ownership	0.6211	0.6429	0.1921	999	0.5037	0.5476	0.2748	997	0.1174	***	0.0953	***
Board size	11.5675	11.0000	2.7927	659	10.0750	10.0000	2.3902	467	1.4926	***	1.0000	***
% Indep. outsiders	0.7299	0.7500	0.1454	659	0.6812	0.7143	0.1889	467	0.0487	***	0.0357	***
Combined CEO-chairman	0.8832	1.0000	0.3215	659	0.7602	1.0000	0.4274	467	0.1230	***	0.0000	***
Attendance problems	0.0126	0.0000	0.0363	659	0.0166	0.0000	0.0451	467	-0.0041	*	0.0000	
Busy board	0.3809	0.0000	0.4860	659	0.2206	0.0000	0.4151	467	0.1603	***	0.0000	***
CEO Tenure	6.2896	4.0000	6.3862	801	5.9016	4.0000	6.5789	569	0.3881		0.0000	

Table 2: Probit regressions of cartel year dummy variable on financial and corporate governance variables

The table reports the results of probit regressions of a dummy variable whether a firm participates in a cartel agreement in this respective year as dependent variable on a number of financial and corporate governance variables. Firm-years in which cartel firms, i.e., firms that at one point in time during our sample period are part of a cartel agreement, are not participating in a cartel, are excluded from this analysis. In all four specifications, we include year and industry fixed effects (not reported for space reasons). Industry classification is based on the first digit of the SIC code. z-statistics are reported in parentheses. ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Dependent variable: Cartel dummy variable				
	(1)	(2)	(3)	(4)
Constant	-4.429 *** (-44.462)	-7.132 *** (-17.850)	-6.701 *** (-16.964)	-6.697 *** (-16.646)
Competition (HHI)	0.408 *** (4.874)	0.404 *** (2.988)	0.359 *** (2.598)	0.440 *** (3.151)
Leverage	0.314 *** (3.262)	-0.297 * (-1.731)	-0.252 (-1.432)	-0.300 * (-1.677)
ln(Total Assets)	0.306 *** (32.340)	0.464 *** (19.636)	0.438 *** (17.999)	0.440 *** (17.868)
R&D/sales	-0.029 (-0.383)	0.118 (0.493)	0.130 (0.559)	0.091 (0.365)
Dividend (dummy)	0.112 *** (2.680)	0.185 ** (2.538)	0.183 ** (2.493)	0.167 ** (2.248)
ROA	1.081 *** (4.272)	1.728 *** (3.775)	1.798 *** (3.805)	1.856 *** (3.893)
Past sales growth	-0.059 *** (-2.837)	-0.275 *** (-3.656)	-0.296 *** (-3.809)	-0.290 *** (-3.696)
CAPX/total assets	0.155 (0.436)	1.529 ** (2.299)	1.482 ** (2.123)	1.686 ** (2.413)
ln(Firm age)	0.072 *** (3.294)	0.039 (0.624)	-0.058 (-0.985)	-0.084 (-1.416)
G-Index		-0.003 (-0.262)		
E- Index			-0.051 ** (-2.466)	-0.039 * (-1.851)
Shares CEO		-1.944 ** (-2.466)	-2.482 *** (-2.872)	-3.575 *** (-3.502)
Block Ownership		0.851 *** (4.558)	0.900 *** (4.767)	0.840 *** (4.362)
ln(Board size)		0.276 ** (2.287)	0.358 *** (2.935)	0.334 *** (2.693)
% Indep. outsiders		-0.308 * (-1.768)	-0.216 (-1.227)	-0.093 (-0.513)
Combined CEO-chairman		0.021 (0.317)	0.010 (0.138)	-0.007 (-0.104)
Attendance problems		-1.104 * (-1.857)	-1.043 * (-1.760)	-0.987 * (-1.651)
Busy board		0.060 (1.035)	0.046 (0.765)	0.070 (1.158)
CEO Tenure				0.009 ** (2.234)
Obs.	58,157	10,566	9,825	9,575
Pseudo r-squared	0.3029	0.3092	0.3029	0.3069

Table 3: Regressions of Tobin's Q, return on assets, and alpha on a cartel dummy and controls

The table reports the regression results of OLS regressions of Tobin's Q (Columns 1 and 2), return on assets (Columns 3 and 4), and alpha (Columns 5 and 6) on a dummy variable whether a firm participates in a cartel agreement in the respective year. Firm-years in which cartel firms, i.e., firms that at one point in time during our sample period are part of a cartel agreement, are not participating in a cartel, are excluded from this analysis. All six specifications include industry and year fixed effects (not reported for space reasons). Industry classification is based on the first digit of the SIC code. The *t*-statistics (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Dependent variable:	Q		Q		ROA		ROA		Alpha		Alpha	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Constant	2.918 *** (38.467)	2.300 *** (7.794)	-0.053 *** (-8.403)	-0.049 *** (-2.582)	0.077 *** (6.316)	-0.034 (-0.618)						
Cartel dummy	0.440 *** (4.106)	0.321 ** (2.136)	-0.019 *** (-3.337)	0.006 (1.020)	-0.011 (-1.072)	-0.012 (-0.909)						
Competition (HHI)	-0.178 ** (-2.142)	-0.012 (-0.065)	0.026 *** (3.874)	0.009 (0.894)	-0.011 (-0.881)	-0.029 (-1.359)						
Leverage	-1.450 *** (-19.287)	-2.195 *** (-11.413)	-0.175 *** (-32.732)	-0.157 *** (-14.972)	-0.143 *** (-11.939)	-0.133 *** (-5.792)						
ln(Total Assets)	-0.013 (-1.055)	0.107 *** (3.558)	0.023 *** (25.998)	0.008 *** (5.103)	-0.000 (-0.284)	0.013 *** (3.867)						
R&D/sales	0.373 *** (10.465)	0.725 *** (4.214)	-0.120 *** (-38.337)	-0.178 *** (-5.690)	-0.002 (-0.349)	0.089 *** (3.766)						
Dividend (dummy)	0.024 (0.741)	0.027 (0.395)	0.025 *** (10.279)	0.026 *** (7.027)	-0.010 * (-1.913)	0.009 (0.891)						
Past sales growth	0.000 ** (2.149)	0.200 * (1.886)	-0.000 *** (-3.213)	0.002 (0.548)	0.000 ** (2.456)	0.033 (1.555)						
CAPX/total assets	1.670 *** (9.485)	2.402 *** (4.504)	0.097 *** (6.235)	0.139 *** (4.969)	0.328 *** (8.484)	0.160 * (1.944)						
ln(Firm age)	-0.134 *** (-8.606)	-0.070 (-1.264)	0.013 *** (10.128)	0.001 (0.405)	0.008 ** (2.339)	-0.005 (-0.659)						
E-Index		-0.068 *** (-3.557)		0.000 (0.129)		-0.005 * (-1.928)						
Shares CEO		2.576 (1.640)		0.261 *** (3.571)		0.181 (0.850)						
Shares CEO squared		-5.150 (-1.027)		-0.579 ** (-2.382)		-0.205 (-0.283)						
Block Ownership		0.406 *** (2.782)		0.071 *** (7.083)		0.199 *** (7.063)						
ln(Board size)		-0.105 (-1.001)		0.011 ** (2.213)		-0.039 ** (-2.394)						
% Indep. outsiders		0.209 (1.292)		0.007 (0.955)		-0.028 (-1.131)						
Combined CEO-chairman		-0.026 (-0.557)		-0.002 (-0.709)		0.001 (0.089)						
Attendance problems		-0.070 (-0.211)		-0.008 (-0.375)		0.038 (0.530)						
Busy board		0.068 (1.350)		-0.001 (-0.240)		-0.011 (-1.337)						
Obs.	60,295	10,065	60,443	10,066	53,065	9,966						
r-squared	0.160	0.254	0.316	0.256	0.030	0.062						

Table 4: Probit regressions of cartel year dummy variable on financial and corporate governance variables for the sample of cartel and matched control firms

The table reports the results of probit regressions of a dummy variable whether a firm participates in a cartel agreement in this respective year as dependent variable on a number of financial and corporate governance variables for the sample of cartel firms and matched control firms. To match cartel to control firms, we create for every cartel a subset of all non-cartel firms, which share the first two digits of the SIC code at the end of the year before the collusive agreement started. Out of this subset we select the firm which is closest in size to the cartel in the respective year. Matched firms are included for the whole period of the collusive agreement or until they are delisted. In case of a delisting of a matched firm, the second best match from the original list of matching firms is chosen and included as of the year of delisting of the first matching firm. Cartelists with no appropriate match are excluded. Also, firm-years in which cartel firms, i.e., firms that at one point in time during our sample period are part of a cartel agreement, are not participating in a cartel are excluded from this analysis. In all four specifications, we include year and industry fixed effects (not reported for space reasons). Industry classification is based on the first digit of the SIC code. *z*-statistics are reported in parentheses. ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Dependent variable: Cartel dummy variable			
	(1)	(2)	(3)
Constant	-2.203 *** (-9.820)	-5.277 *** (-6.072)	-5.235 *** (-5.748)
Competition (HHI)	0.732 *** (4.195)	0.456 (1.577)	0.668 ** (2.175)
Leverage	0.291 (1.440)	-0.411 (-1.165)	-0.553 (-1.520)
ln(Total Assets)	0.154 *** (7.872)	0.304 *** (6.075)	0.335 *** (6.448)
R&D/sales	-0.302 (-0.707)	-0.238 (-0.254)	-0.499 (-0.524)
Dividend (dummy)	0.027 (0.289)	0.317 ** (2.172)	0.294 ** (1.977)
ROA	0.547 (1.147)	1.745 ** (2.166)	1.655 ** (2.004)
Past sales growth	-0.045 (-0.866)	-0.220 ** (-1.999)	-0.239 ** (-2.083)
CAPX/total assets	1.646 * (1.841)	4.988 *** (3.026)	5.826 *** (3.429)
ln(Firm age)	0.231 *** (4.067)	-0.248 * (-1.919)	-0.307 ** (-2.317)
E-Index		-0.206 *** (-4.789)	-0.197 *** (-4.477)
Shares CEO		-2.386 (-1.179)	-4.009 (-1.537)
Block Ownership		2.133 *** (5.297)	1.967 *** (4.720)
ln(Board size)		0.711 *** (2.960)	0.592 ** (2.359)
% Indep. outsiders		0.199 (0.589)	0.570 (1.631)
Combined CEO-chairman		0.204 (1.546)	0.061 (0.435)
Attendance problems		-1.064 (-0.908)	-0.914 (-0.764)
Busy board		0.183 * (1.646)	0.238 ** (2.096)
Tenure			0.033 *** (3.723)
Obs.	1,860	941	898
Pseudo r-squared	0.0638	0.1904	0.2039

Table 5: Regressions of cartel first year dummy and cartel lifetime on controls for the sample of cartel list and matched control firms

The first four columns of the table report the results of probit regressions of a dummy variable whether a firm enters a cartel agreement in this respective year as dependent variable on a number of financial and corporate governance variables. Column 5 reports the results of an OLS regression of the cartel lifetime, measured as the natural logarithm of the number of months as determined by the antitrust authorities. Columns 1 to 4 use the sample of cartel list firms and matched control firms. To match cartel list to control firms, we create for every cartel list a subset of all non-cartelist firms, which share the first two digits of the SIC code at the end of the year before the collusive agreement started. Out of this subset we select the firm which is closest in size to the cartel list in the respective year. Matched firms are included for the whole period of the collusive agreement or until they are delisted. In case of a delisting of a matched firm, the second best match from the original list of matching firms is chosen and included as of the year of delisting of the first matching firm. Cartelists with no appropriate match are excluded. Also, firm-years in which cartel list firms, i.e., firms that at one point in time during our sample period are part of a cartel agreement, are not participating in a cartel, are excluded from this analysis. In Column 4 the independent variables are lagged by one year to account for a possible time delay from the agreement to fix prices until the agreement becomes effective. Column 5 only includes the first year of the first cartel in which the cartelists in our sample participate. In all five specifications, we include year and industry fixed effects (not reported for space reasons). Industry classification is based on the first digit of the SIC code. In Columns 1 to 4, z -statistics are reported in parentheses. In Column 5, t -statistics based on the cluster-robust variant of the Huber-White sandwich estimator are reported in parentheses. ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Dependent variable:	Cartel first year dummy				ln(Cartel months)
	(1)	(2)	(3)	(4)	(5)
Constant	-1.851 *** (-4.599)	-5.721 (-0.040)	-5.344 (-0.033)	-5.646 (-0.041)	7.969 ** (2.546)
Competition (HHI)	0.812 ** (2.305)	0.796 (1.164)	1.574 ** (2.088)	0.840 (1.072)	1.640 (1.064)
Leverage	-0.197 (-0.525)	-1.633 ** (-2.245)	-1.856 ** (-2.388)	-2.443 ** (-2.496)	-0.532 (-0.429)
ln(Total Assets)	0.099 *** (2.694)	0.243 ** (2.567)	0.259 *** (2.586)	0.283 ** (2.511)	-0.040 (-0.263)
R&D/sales	-0.475 (-0.546)	-2.101 (-0.983)	-2.714 (-1.189)	-6.875 ** (-2.340)	-4.939 (-1.350)
Dividend (dummy)	0.158 (0.906)	0.253 (0.836)	0.376 (1.165)	0.192 (0.521)	0.539 (1.172)
ROA	-0.811 (-0.924)	-0.804 (-0.490)	-1.985 (-1.118)	-2.854 * (-1.768)	4.144 (1.083)
Past sales growth	0.051 (0.752)	-0.102 (-0.437)	-0.138 (-0.457)	0.129 (0.492)	-0.375 (-0.893)
CAPX/total assets	1.147 (0.688)	4.379 (1.347)	5.539 (1.617)	2.570 (0.690)	-7.275 (-0.978)
ln(Firm age)	-0.118 (-1.340)	-0.259 (-1.100)	-0.379 (-1.520)	-0.143 (-0.458)	-0.289 (-1.186)
E-Index		-0.237 *** (-2.604)	-0.270 *** (-2.831)	-0.269 *** (-2.917)	-0.071 (-0.495)
Shares CEO		-3.188 (-0.852)	-6.673 (-1.431)	-6.228 (-1.253)	-24.874 * (-1.806)
Block Ownership		0.966 (1.318)	0.537 (0.673)	-0.536 (-0.646)	-2.933 ** (-2.148)
ln(Board size)		-0.351 (-0.774)	-0.719 (-1.447)	-0.631 (-1.067)	-0.957 (-1.196)
% Indep. outsiders		0.847 (1.227)	1.434 ** (1.989)	1.761 ** (2.292)	1.537 (1.476)
Combined CEO-chairman		-0.141 (-0.563)	-0.487 * (-1.784)	-0.346 (-1.035)	-0.709 (-1.039)
Attendance problems		-5.937 * (-1.808)	-6.078 * (-1.766)	1.292 (0.489)	0.523 (0.042)

Busy board		0.332 (1.534)	0.403 * (1.748)	0.184 (0.735)	-0.153 (-0.504)
CEO Tenure			0.067 *** (3.666)	0.081 *** (3.951)	0.040 (1.335)
CEO Pay-Performance					1.587 ** (2.387)
Obs.	1,045	433	415	371	51
pseudo r-squared	0.081	0.212	0.265	0.262	-
r-squared	-	-	-	-	0.725

Table 6: Regression on Tobin's Q, return on asset and the annual alpha for the sample of cartel and matched control firms

The table reports the regression results of OLS regressions of Tobin's Q (Columns 1 and 2), return on assets (Columns 3 and 4), and alpha (Columns 5 and 6) on a dummy variable whether a firm participates in a cartel agreement in the respective year. To match cartel to control firms, we create for every cartel a subset of all non-cartelist firms, which share the first two digits of the SIC code at the end of the year before the collusive agreement started. Out of this subset we select the firm which is closest in size to the cartel in the respective year. Matched firms are included for the whole period of the collusive agreement or until they are delisted. In case of a delisting of a matched firm, the second best match from the original list of matching firms is chosen and included as of the year of delisting of the first matching firm. Cartelists with no appropriate match are excluded. Also, firm-years in which cartel firms, i.e., firms that at one point in time during our sample period are part of a cartel agreement, are not participating in a cartel, are excluded from this analysis. All six specifications include industry and year fixed effects (not reported for space reasons). Industry classification is based on the first digit of the SIC code. The *t*-statistics (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Dependent variable:	Q		Q		ROA		ROA		Alpha		Alpha	
	(1)		(2)		(3)		(4)		(5)		(6)	
Constant	3.155 *** (7.671)		4.441 *** (3.103)		0.094 *** (4.518)		0.182 *** (2.923)		0.228 *** (4.183)		0.241 (1.364)	
Cartel dummy	0.242 * (1.734)		0.291 * (1.737)		0.004 (0.590)		0.009 (1.285)		0.007 (0.493)		-0.009 (-0.428)	
Competition (HHI)	-0.462 * (-1.746)		-0.200 (-0.611)		0.007 (0.554)		0.009 (0.703)		0.015 (0.433)		-0.032 (-0.611)	
Leverage	-2.713 *** (-6.381)		-2.390 *** (-3.281)		-0.158 *** (-8.556)		-0.163 *** (-7.159)		-0.164 *** (-2.739)		-0.169 *** (-2.739)	
ln(Total Assets)	0.090 ** (2.283)		-0.108 (-1.297)		0.005 *** (2.728)		-0.001 (-0.494)		-0.005 (-1.154)		-0.003 (-0.336)	
R&D/sales	0.382 (0.685)		7.174 *** (4.075)		-0.094 *** (-5.250)		-0.081 (-1.351)		0.068 (1.473)		-0.010 (-0.064)	
Dividend (dummy)	-0.160 (-0.791)		0.226 (0.948)		0.027 *** (3.089)		0.021 ** (2.028)		-0.007 (-0.273)		0.024 (0.699)	
Past sales growth	0.231 ** (2.562)		0.328 * (1.792)		0.005 (0.986)		0.013 (1.449)		0.044 ** (2.503)		0.072 *** (3.501)	
CAPX/total assets	0.886 (0.671)		1.746 (0.587)		0.081 (1.084)		-0.081 (-0.554)		0.002 (0.010)		-0.212 (-0.642)	
ln(Firm age)	-0.110 (-0.838)		-0.236 (-0.887)		0.002 (0.378)		-0.004 (-0.552)		-0.028 * (-1.688)		-0.052 *** (-2.690)	
E-Index			-0.109 * (-1.724)				-0.001 (-0.187)				-0.008 (-0.964)	
Shares CEO			-5.242 (-1.151)				-0.074 (-0.382)				0.499 (0.861)	
Shares CEO squared			1.440 (0.079)				-0.274 (-0.384)				-3.685 * (-1.790)	
Block Ownership			-0.597 (-0.970)				-0.037 (-1.308)				0.175 ** (1.980)	
ln(Board size)			0.288 (0.639)				0.005 (0.271)				-0.003 (-0.065)	
% Indep. outsiders			0.068 (0.120)				0.024 (1.233)				-0.060 (-0.952)	
Combined CEO-chairman			0.122 (0.694)				-0.006 (-0.918)				0.051 (2.261) **	
Attendance problems			-1.870 (-1.418)				-0.075 * (-1.671)				0.191 (0.996)	
Busy board			0.146 (1.148)				0.007 (1.072)				0.009 (0.452)	
Obs.	1,853		941		1,860		941		1,823		932	
r-squared	0.263		0.346		0.245		0.266		0.052		0.118	

Table 7: Regressions of CAPX, R&D expenditures and acquisition expenses on a cartel dummy and controls

The table reports the regression results of OLS regressions of CAPX/Total assets (Columns 1), R&D/Sales (Columns 2) and expenses for acquisitions/market capitalization (Columns 3) on a dummy variable whether a firm participates in a cartel agreement in the respective year. Firm-years in which cartel firms, i.e., firms that at one point in time during our sample period are part of a cartel agreement, are not participating in a cartel, are excluded from this analysis. All three specifications include industry and year fixed effects (not reported for space reasons). Industry classification is based on the first digit of the SIC code. The *t*-statistics (in parentheses) are based on the cluster-robust variant of the Huber-White sandwich estimator, which accounts for the dependence of observations within clusters (different year-observations for one specific firm). ***, **, * indicates statistical significance at the 1%, 5%, 10% level.

Dependent variable:	CAPX (1)	R&D (2)	Acqui. (3)
Constant	0.067 *** (27.615)	0.855 *** (16.782)	-0.292 (-0.982)
Cartel dummy	0.002 (0.758)	-0.070 ** (-2.495)	-0.510 (-1.014)
Q	0.003 *** (10.082)	0.063 *** (9.036)	-0.034 (-1.181)
Competition (HHI)	-0.013 *** (-4.173)	-0.305 *** (-12.017)	-0.063 (-0.759)
Leverage	-0.001 (-0.373)	-0.170 *** (-6.992)	-0.045 (-0.353)
ln(Total Assets)	0.000 (0.273)	-0.027 *** (-8.570)	0.159 (1.011)
Dividend (dummy)	-0.000 (-0.330)	-0.088 *** (-9.056)	-0.001 (-0.039)
Past sales growth	0.000 (0.414)	0.000 (0.030)	-0.000 (-0.862)
R&D/sales	-0.007 *** (-12.761)		0.016 (0.737)
CAPX/total assets		-0.740 *** (-10.934)	-0.891 (-1.188)
ln(Firm age)	-0.007 *** (-11.344)	-0.052 *** (-8.107)	-0.247 (-1.032)
Obs.	60,295	60,295	58,170
r-squared	0.215	0.153	0.001

Figure 1: Yearly return on assets

We report the mean of the yearly return on assets (ROA) over a symmetric window of five years around the year which has been determined as the starting point of the cartel.

