Anatomy of Cartel Contracts*

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Abstract

We study contracts of 898 legal Finnish cartels to uncover hitherto unknown facts. We find a sectoral division: Manufacturing cartels allocate markets more often than contract on prices; the reverse holds for non-manufacturing cartels. Cartels in the two sectors differ in how they combine contract clauses. Price- and market allocation cartels in manufacturing differ in how they deal with internal stability, external threats, and in their organization. Quota cartels are rare but use complex contracts. A common yet unconventional cartel contract stipulates that members specialize or agree not to compete. Price-based and quota cartels change their contracts more often.

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Keywords: cartels, contracts, antitrust, competition policy, industry heterogeneity.

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1 Introduction

Theoretical modelling of cartels rests on limited empirical evidence, as many elementary questions still need an answer: What is the most typical mode of cartelization? For example, are cartels that restrict pricing more common than cartels that allocate markets? Which agreed features appear together? Are some types of contracts changed more often? Addressing these questions calls for detailed data on the agreements of a large number of cartels, operating in a shared institutional environment. We have generated such a data set through archive work, enabling us to characterize an anatomy of cartel "contracts" (i.e., their stylized facts) for a large number of cartels in much more detail than has been possible before.[1] This anatomy is useful for policy as it shows what hardcore cartels agree on. This understanding increases the likelihood that authorities make correct decisions in cartel cases.

While insightful, a drawback of many earlier quantitative studies on cartel contracts surveyed by Levenstein and Suslow (2006) is that they had relatively limited information on what the cartels tried to agree on. They also cover a heterogeneous set of episodes and institutional environments, or refer to (possibly quite peculiar, large) international or prosecuted cartels (see Appendix A).[2] More recent work has only partially overcome these drawbacks. Harrington (2006) provides a detailed qualitative account of 23 case studies, based on detected cartels in the EU. Taylor (2007) uses data on seven contract clauses of US cartels that registered their activities in the early 1930s due to the National Industrial Recovery Act, but contracting on prices, or on certain type of market allocation,

[1] We use term "contract" in the meaning of (intended) "agreement", not in its strict formal legal meaning.

[2] We present a summary of previous quantitative analyses of cartel contracts at the beginning of each main subsection (and in Appendix A). The survey of Levenstein and Suslow (2006) covers a number of important earlier papers, including those by Posner (1970), Frass and Greer (1977), Hay and Kelley (1974), Gallo et al. (2000) and Suslow (2005), as well as a large number of case studies. The internal workings of individual cartels are studied in Porter and Zona (1993, 1999), Pesendorfer (2000), Genesove and Mullin (2001), Röller and Steen (2006) and Asker (2010).

was not formally allowed. Bouwens and Dankers (2010) have data on five contract dimensions of Dutch legal cartels. Levenstein and Suslow (2011) use six features of cartel contracts for 81 international cartels to predict their duration (see also Suslow 2005).

To go beyond the prior research, we use data from the Finnish Competition Authority's (FCA) archive of cartels. These data allow us to describe quantitatively the systematic contracting patterns by which collusion is pursued; to characterize the ways in which cartels have tried to ensure internal compliance (i.e., self-policing); and to analyze the interaction of these two contract dimensions. These contracting choices influence cartels' behavior, their effectiveness and competition authorities' ability to detect them. For example, if semicollusion is a problem (e.g., Fershtman and Gandal 1994), cartels would need complementary contracting choices, such as agreeing on both prices and quotas. Similarly, a pricing cartel may need rules on how to admit new members (Bos and Harrington 2010, 2015), whereas a cartel allocating geographic markets might do without. In terms of policy, if geographic market allocation was popular among manufacturing cartels, the competition authority should view behavior reminiscent of market allocation with suspicion in manufacturing, but not necessarily in other sectors.

Our data cover the period from the introduction of the first Finnish competition law of 1958, under which cartels continued to be legal, to the introduction of a modern competition law of 1993, which made cartels illegal. The archive contains quantitative information on the key contracting features of about 900 manufacturing and non-manufacturing cartels, and some information on their subsequent behavior. Besides larger size, a strength of our data set is that it contains richer information on cartels' price-fixing and market allocation schemes than those data used in the prior studies. We complement these data with further information on detailed contracting features for a subsample of 109 nationwide manufacturing cartels. For these cartels we observe additional 14 contract clauses, which have to do with the internal stability of the cartel (e.g., monitoring); the

organization of the cartel (e.g., number of meetings); the external threats faced by the cartel (e.g., entry) and production-related issues (e.g., sharing of technology).

A key feature of our data is that the cartels we study were legal, but self-policing. These features are crucial for two reasons. First, there were no restrictions on communication. Unlike illegal cartels, legal cartels do not have to worry about the consequences of explicitly writing down their intentions and agreements. We can thus observe an "unobservable", i.e., what illegal cartels would like to write down, if doing so would not have adverse legal consequences.[3,4] Second, a self-policing legal cartel has an incentive to coordinate on actions and to meet the incentive compatibility constraint (see the next section), just like an illegal cartel would.

A contribution of ours is to document a clear sectoral division in the primary mode of cartelization: In manufacturing industries, cartels that allocate markets (*Market allocation–based* cartels) are more common (2/3) than cartels that agree on one or more dimensions of pricing (1/3) (*Price–based* cartels). These shares are reversed for non-manufacturing cartels. *Price–based* cartels have more members than *Market allocation–based* cartels in both sectors. Another new finding is that the two most commonly used contracts are simple in terms of how members coordinate to raise profits. In line with evidence from legal and illegal US cartels, but in contrast to evidence from international cartels, quota cartels are relatively rare in manufacturing and, unsurprisingly, nearly non-existent in non-manufacturing. There exists a common yet unconventional *Market allocation–*

[3] Related to this, Harrington and Wei (2016) study how to infer the duration of cartels from the observed duration of detected illegal cartels. The detected cartels are a selected sample of all cartels. Hyytinen, Steen and Toivanen (2016a) provide a related empirical analysis.

[4] The very fact that cartels are illegal leads to endogenous incompleteness of cartel contracts, because the contracting parties have a strong incentive both to reduce the ability of a court to verify the intended and contracted actions and to make unverifiable what is observable.

based cartel that stipulates that the members specialize or just agree not to compete.[5] As far as we know, we are the first to document how cartels combine the different ways to raise profits and how this differs across sectors.

We go further beyond prior research by documenting how cartels ensure internal compliance and how contract dimensions interact: We find that in manufacturing, *Price-based* cartels have more often a formal organizational structure, including e.g. a voting scheme. They also have more often rules on admitting new members than *Market allocation-based* cartels. Further, quota cartels stand out, as they use more complex contracts for self-policing, which include for example clauses on monitoring, enforcement and fines. In contrast, cartels that allocate markets spatially or specialize in serving certain customers prefer simpler contracts than other types of cartels, but they do have mechanisms in place for entry, dispute resolution and for dealing with supply from sources external to the cartel.

In further analysis we study how frequently cartels adjust their initial contracts. We find that being a pricing or a quota cartel predicts more contract adjustments and that making such adjustments predicts longer duration in our sample of legal cartels. Dynamics of contract changes is policy relevant, because arguably cartels that need to make many changes leave more traces for competition authorities to detect.

Several other countries, among them Austria, Australia, Norway, the Netherlands and Sweden, also had legal cartels in the post-WWII era, and registries similar to the Finnish one. In a closely related paper, Fink et al. (2016) analyze Austrian data on 80 legally binding horizontal cartel agreements, most of which are in manufacturing. We compare our findings to theirs in the conclusions.

[5] This is in line with what has been reported for the US (Posner 1970, Gallo et al. 2000), Germany (Audretsch 1989 and Haucap et al. 2010), the Netherlands (Bouwens and Dankers 2010) and cartels caught by the European Commission (Harrington 2006).

Section 2 describes the institutional environment and data sources. We ask how cartels tried to raise profits in Section 3. We then ask in Section 4 how cartels maintained compliance. In Section 5 we link the initial contracting features to subsequent contract changes and to duration of cartels. Our findings have potentially implications for cartel theory and competition policy. We discuss these in the concluding section.

2 The institutional environment and data

This section describes both the institutional environment in which our cartels operated and our sources of data.

2.1 The institutional environment

The development of Finnish competition policy after the Second World War follows closely developments in other European countries, and Sweden in particular. There was no competition policy before the war (see Fellman 2008, 2010). The first cartel law was implemented in 1958. The central idea was to collect information on cartels that operate in the domestic market rather than to deter collusive activities. For this purpose, a (predecessor of the) Finnish competition authority (CA) was set up and given the task to register cartels. Only bidding rings were outlawed.

The CA began registrations in March 1959. The Registry was active, sending out thousands of inquiries and registering several hundred cartels already during the first three years. Registration was contingent on the CA contacting the suspected cartel members. Contacted firms had an obligation to inform the Registry of competition restrictions. In 1964 the law was revised: Cartels with a formal organization (such as an association) now had to register on their own and failing to register could result in a (small) fine. In 1973 the registration requirements were again somewhat tightened. In the 1980s Finland finally edged towards a modern competition law, as the work of a committee established in 1985 resulted in a new law taking effect in 1988, with cartels becoming illegal in 1993.

Based on conversations and written accounts, the costs of registering were minor. It also seems that there were some benefits. The former and current Director Generals of the Finnish CA (Purasjoki and Jokinen, 2001) sum up the environment concerning those collusive practices that were legal: "*Time was such that there seemed no need to intervene even in clear-cut cases, especially if they had been registered. Registration had been transformed into a sign of acceptability of the [cartel] agreement, at least for the parties involved [in the cartel]*".

2.2 Legal vs. illegal cartels

Even though cartels in our sample were legal, they had to rely mostly on self-policing, in line with what was the case elsewhere. Suslow (2005, p. 709) writes: "[…] *although European law took a tolerant attitude towards cartels during this period, the legal tolerance did not translate into cartel enforceability; cartel contracts were still self-enforcing."* Supporting this view, the primary motivation for the law change in 1980s was the only known law suit based on a cartel contract from early 1980s that led to damages being awarded.[6] This incident suggests that there was – similar to the case of the US Sugar Institute (Genesove and Mullin 2001, pp. 385) – *ex ante* uncertainty as to the enforceability of these contracts in court. Taking your fellow cartel member to court seems to have carried the risk of affecting the legal environment.

In contrast, *illegal* cartels need to conceal their agreements, leading to endogenous incompleteness of contracts. Participants have a strong incentive to strategically reduce the ability of a legal court to verify their concerted actions (see Kvaløy and Olsen 2009 and Kaplow 2011a, pp. 758-765). The contracts we study are the type of contracts that

[6] We have interviewed people with a long working history in the Finnish Competition Authority. They could recall only one case from the early 1980s. According to the Director General of the Finnish Competition Authority, Juhani Jokinen (private exchange), this case lead to the law change in 1988 making sanctions in cartel contracts void. Note however that several of the cartel agreements stated that conflicts were to be solved by the parties meeting for the Finnish Chamber of Commerce. Since these arbitrations are not known to the public in retrospect we do not know to which extent this option was used.

illegal cartels might like to write, had that no legal consequences. The profit, incentive and organizational issues that illegal cartel face, as well as those relating to changes in the external environment, are similar to those faced by self-policing legal cartels.

2.3 Data

Our data consist of information on clauses of the registered cartel contracts, the number of adjustments of the initial contracts, and cartel duration (see Appendix B for more details). All the data on the cartels and their contracts is based on our archive work in the Registry.[7] The Registry contains some 900 manufacturing and non-manufacturing cartels. For each registered cartel, the Registry established a folder which contains a concise description of the cartel, and all the correspondence between the Registry and the cartel.

The cartel listing allows us to identify whether a given cartel tried to collude by agreeing on prices and/or by allocating markets. These data are available for 359 of manufacturing and 539 non-manufacturing cartels. The non-manufacturing cartels are heterogeneous, but around 60% of them are goods and service retailers, or wholesalers. We collected more information on nationwide manufacturing cartels by going through the folders of 109 such cartels in detail, collecting information on 14 further contract clauses. We conduct our empirical analysis using both the larger sample(s) of manufacturing and non-manufacturing cartels (Section 3 and 5) and using the smaller sample of nationwide manufacturing cartels for which we have more detailed information (Section 4).

We also have a set of variables characterizing the cartels and their operating environment. For each cartel, we know the sector, whether it was nationwide, and (for most) the number of members. We also record the changes in competition law, the year a cartel entered the registry, and whether the cartel was registered right after a positive or negative GDP shock.

[7] See Hyytinen, Steen Toivanen (2016b) for details of the coding of contract clauses.

3 How do cartels raise profits?

In this section, we answer the following fundamental questions: Are cartels that restrict pricing more common than cartels that allocate markets? To what extent does the primary mode of cartelization depend on the sector in which the cartels operate? How do cartels combine different ways of achieving collusive profits? As we show below, the existing literature has either provided incomplete answers to these questions, or has not analyzed them at all.

3.1 Measurement of main contract clauses

The two most important ways for cartels to coordinate is to agree on prices and/or allocate markets (Stigler 1964, Levenstein and Suslow 2006, Harrington 2006, Taylor 2007). *Price-based* cartels can agree on prices and/or payment-related issues in various ways, depending for example on the need to control rebates, effects of product differentiation, and so on. *Market allocation -based* cartels can e.g. follow geographical lines, be agreed on a product-line basis, or use quotas.

The FCA collected information on how the cartels tried to raise profits, i.e., their *main contract clauses.* As shown in Table 1, we classify as *Price-based* those cartels that agreed on price-setting via *Pricing* clauses, and those that restricted use of discount rules and/or rules of delivery and payment by having clauses for *Payment rules.* We classify as *Market allocation-based* those cartels that agreed on sales quotas or market shares using the *Quota* clause; those that had an explicit reference to a spatial distribution, such as exclusive territories or home market principle, in an *Area-based market allocation* clause; and those that relied on a *Non-area-based market allocation* scheme. In these latter cartels, the members partitioned the production of goods in some way (e.g., specialization via the sale of a production line or via a party ceasing production of certain variants of the goods in question) or in some cases, just by agreeing not to compete in a given market.

Table 1: Main contract clauses used by cartels to raise profits

Clause descriptions	
Price -based	
Pricing	= 1 if the contract refers to prices and/or pricing rules.
Payment rules	= 1 if the contract refers to discount rules and/or rules of delivery and payment.
Market allocation -based	
Quotas	= 1 if the contract refers to sales quotas or market shares.
Area-based	= 1 if the contract refers to exclusive territories or home market principle.
Non-area -based	= 1 if the contract refers to allocation of customers among the members or it stipulates that the members are to specialize in one way or the other, or agree to "not compete" in a given market.

NOTES: The definitions of the clauses are meant to be descriptive of the broad content of each clause. The data contain also other wordings but those have a meaning that is economically similar to what is described in this table. We use term "contract clause" in the meaning of "intended or agreed practice in an agreement", not in its strict formal legal meaning.

When reading Table 1 (and our subsequent figures and tables), it is important to keep in mind that the main contract clauses are *not* mutually exclusive: An example of a cartel using more than one main clause is the brewing and soft drinks cartel, which used both pricing clauses. It had an oral agreement on practices towards retailers, which included both prices at the level of cases of bottles and (standardized) bottles (*Pricing*), and rebate tables, terms of delivery and the treatment of transport costs (*Payment rules*).

3.2 Prior literature: What do we know?

The existing literature using quantitative data on cartel contracts relies on eight different data sources (for a detailed account, see Appendix A), but no study reports systematically data on the joint use of all five main contract clauses listed in Table 1.[8] Four early papers study detected US cartels (Posner 1970, Hay and Kelley 1974, Frass and Greer 1977 and Gallo et al. 2000); Dick (1996) studies legal US export cartels and Taylor (2007) legal US cartels from the 1930s National Industrial Recovery Act. Audretsch (1989) and Haucap et al. (2010) study legal and illegal German cartels, again with overlap in the data, whereas Bouwens and Dankers (2010) explore Dutch legal cartels. Suslow (2005), Levenstein and Suslow (2011) and Harrington (2006) study (mostly) detected international cartels, all three using different data. The companion work of Fink et al. (2016) is much

[8] There are two exceptions. Harrington (2006) studies the five main contract clauses without providing statistics. Bouwens and Dankers (2010) explore Dutch legal cartels and gentlemen's agreements. They report the use of individual clauses (see their Table 1).

closer to us; they analyze four collusion methods that are similar to our five measures, but aggregate area-based and non-area-based cartels into a specialization category.

It is hard to infer the main mode of cartelization from the prior literature, let alone sectoral differences in it (see Appendix A). Some studies mention clauses without providing quantitative information on their actual use, or are forced to focus on a subset due to the regulatory environment or data availability. For example, while Posner (1970) provides information on all three *Market allocation-based* clauses, it is unclear as to whether each cartel in his data used *Pricing* or not. Taylor's (2007) US cartel data are not entirely representative of "*those that would be passed by an unrestricted cartel*" (ibid p. 610), because, as he carefully describes, "*administration's code-writing procedure imposed restrictions on explicitly collusive activity such as direct price-fixing and, with a few exceptions, did not generally allow industries to impose production quotas*" (ibid, p. 600). Moreover, while some of the prior papers have data on both manufacturing and non-manufacturing cartels, they do not report statistics on whether the mode of cartelization varies by sector. There is also considerable variation in the reported numbers and the sectors covered (see Appendix A).

Cartels may need to contract on several dimensions simultaneously to avoid competition along non-contracted dimensions (e.g. Stigler 1964, 1968, Harrington 2006). For example, the Norwegian cement cartel studied by Röller and Steen (2006) ran into trouble because of overinvestments in capacity, despite it having an explicit cartel agreement on prices. This example and more broadly the literature on semi-collusion suggest that it is important to identify complementary dimensions they try to agree on (e.g., Fershtman and Gandal 1994; Steen and Sørgard, 2009). In similar vein, some main clauses may be substitutes in some industries and hence only one or the other is needed. To better understand these phenomena one needs to look at the joint use of main clauses (listed in Table 1), yet the existing literature doesn't provide such an analysis. Taylor (2007, Table I) comes

close by providing some information on joint use but does not analyze it. Suslow (2005, Table 3) provides correlations between production quotas, export quotas and exclusive territories.

3.3 Empirical findings

Modes of cartelization: Figure 1 displays the prevalence of *Price-based* and *Market allocation-based* cartels by sector. *Market allocation-based* cartels are clearly more popular in manufacturing (73%), whereas *Price-based* cartels are more popular in non-manufacturing (78%). The differences are statistically significant within and across the industry sectors (p-values < 0.01).[9]

Figure 1: Price-based and market allocation-based cartels by sector

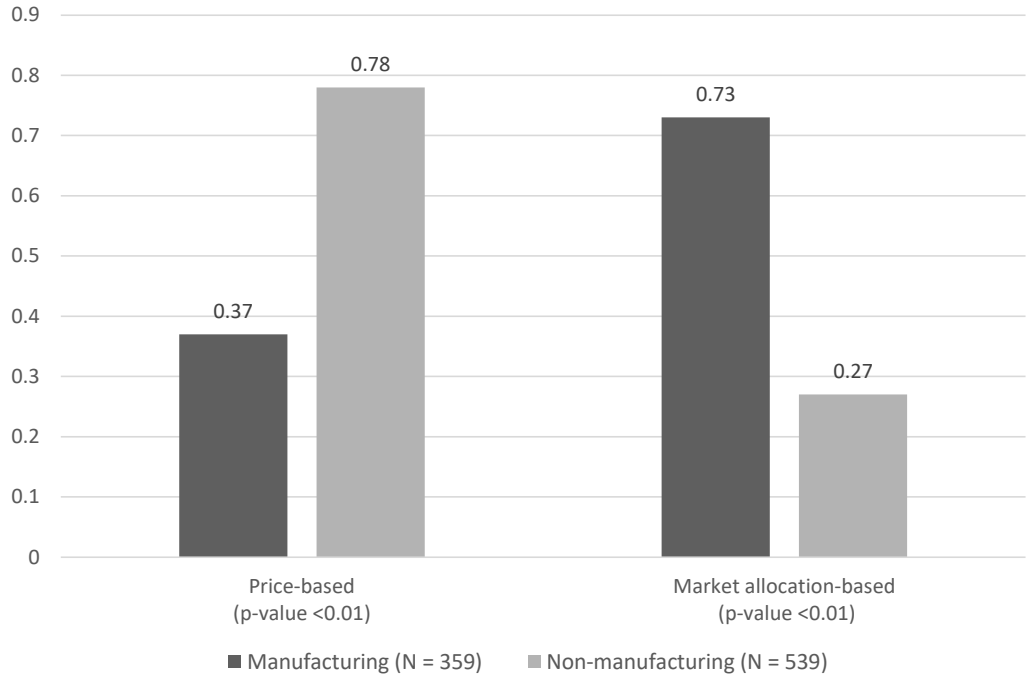


Table 2 reports descriptive statistics by mode of cartelization. Two features are worth noting: First, *Market allocation-based* cartels have a smaller median number of members

[9] A closer look at the data (not shown in the figure) reveals that in manufacturing, 59% of the cartels allocate *only* markets in some way, and have no *Price-based* clauses. In non-manufacturing, 62% of the cartels agree *only* on prices and have no *Market allocation-based* clauses.

than *Price-based* cartels, both in manufacturing and in non-manufacturing. Second, a substantial majority of manufacturing cartels (> 80%) are nationwide, whereas in non-manufacturing, cartels are more often regional or local.[10] In addition, only a small share of the cartels cannot be considered either *Price-based* or *Market allocation-based*, as they have none of the five main clauses.[11]

[TABLE 2 HERE -- landscape]

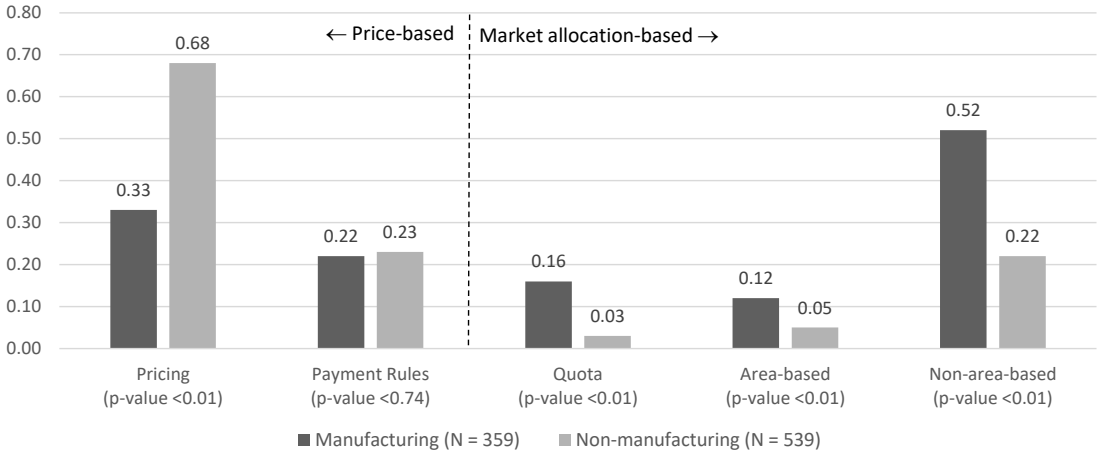
The last column of Table 2 shows that typical contracts are simple: In manufacturing cartels, the more popular *Market allocation-based* cartels have on average 1.4 main clauses, which is fewer than what *Price-based* manufacturing cartels have. In non-manufacturing, where *Price-based cartels* are more popular, this ordering is reversed: *Price-based* cartels have fewer main clauses than *Market allocation-based* cartels.

Popularity of individual main clauses: Figure 2 takes a closer look at the popularity of individual main clauses. It shows that manufacturing cartels use more often each of the *Market allocation-based* clauses than non-manufacturing cartels. These differences are statistically significant. The single most popular main clause in manufacturing is the *Non-area-based* clause (52%). This clause is the reason why *Market allocation-based* cartels are more popular in manufacturing. In non-manufacturing, *Pricing* (68%) is the single most popular main clause. In non-manufacturing, both the *Quota* and the *Area-based* clauses are rare.

[10] Compared to the previous studies (see Appendix A), the cartels in our data are larger and more often nationwide. For example, the median number of firms varies between 4 in Suslow (2005) and 10 in Haucap et al. (2010) and Posner (1970).

[11] There are good explanations for some: an example is the pharmaceutical cartel that was under price regulation and in an industry where entry is regulated. Moreover, some of these cartels were recorded as horizontal agreements, due to some firms co-ordinating their purchases of one or more factors of production.

Figure 2: Use of individual main clauses cartels by sector



Joint use of main clauses: An important but previously overlooked dimension is how the individual main clauses are *combined* into cartel contracts. Table 3 does that. It displays the most popular cartel contracts in terms of the five main contract clauses.

Table 3: Most popular combinations of main contract clauses

Panel A: Large sample, manufacturing (N=359)				
Rank	Type of cartel	# main clauses	Count	Share
1st	Non-area-based	1	151	0.42
2nd	Pricing, Payment rules	2	38	0.11
3rd	Pricing	1	32	0.09
4th	Area-based	1	26	0.07
5th	Pricing, Quota	2	18	0.05
Panel B: Large sample, non-manufacturing (N=539)				
Rank	Type of cartel	# main clauses	Count	Share
1st	Pricing	1	215	0.40
2nd	Pricing, Payment rules	2	67	0.12
3rd	Pricing, Non-area-based	2	65	0.12
4th	Payment rules	1	50	0.09
5th	Non-area-based	1	44	0.08

NOTES: Panel A refers to manufacturing cartels and Panel B to non-manufacturing cartels. Count is the number of cartels using a particular combination of the five main contract clauses. Share is the fraction of cartels doing so. In Panel B, we exclude from the ranking the combination of using none of the five main clauses.

Out of the 32 theoretically possible combinations, the most popular contract accounts for 40% of all contracts in both sectors and consists of only one main contract clause.[12] This

[12] The contracts may have other clauses besides the main clauses (see Section 4).

contract is however different for the two sectors: In manufacturing, the most popular contract includes *only* the *Non-area-based* contract clause, whereas in non-manufacturing, it includes the *Pricing* clause. The 2nd – 5th most popular clauses all use at most two of the five main clauses. The five most popular contracts account for 74% of all cartels in manufacturing and for 82% in non-manufacturing.

To look more closely at the joint use of the main clauses we present their pairwise correlations in Table 4.[13] All but one of the correlations are statistically significant in manufacturing: First, the *Market allocation-based* clauses are negatively correlated with each other; second, the *Price-based* clauses are positively correlated with each other; and third, with the notable exception of *Quota*, the *Market allocation-based* and *Price-based* clauses are negatively associated with each other. We find much weaker correlations (only four are significant) and a couple of very different patterns in non-manufacturing: For instance, *Pricing* and *Payment rules* are negatively correlated with each other, whereas *Quota* is positively correlated with the *Area-based* clause.

[TABLE 4 HERE -- landscape]

3.4 Discussion

Mode of cartelization: Our numbers for manufacturing, where a third agree on prices, confirm those of Bouwens and Dankers (2010) and Haucap et al. (2010, our 37% vs. 34% and 31% where the last number for Haucap et al. refers to price-fixing excl. bidding agreements). Our figures for non-manufacturing match those of Hay and Kelley (our 78% vs. 65%).[14] [15] We also found that cartels use relatively simple contracts: In manufacturing,

[13] In Hyytinen, Steen and Toivanen (2012), we compare the unconditional correlations between main clauses to conditional correlations without finding any major differences.

[14] Their number is based on our calculation using information in their Appendix, suggesting that at least two thirds of the cartels in non-manufacturing agree on prices.

[15] The reported use of the Area-based clause varies from Posner's (1970; see also Gallo et al.) 15% and Bouwens' and Dankers' (2010) 13% to Suslow's (2005) and Harrington's (2006) 30-40%. The lower figures are close to what we obtain for manufacturing.

the more popular *Market allocation-based* cartels are less complex than *Price-based* cartels. The opposite holds in non-manufacturing.

There are a number of explanations for the sectoral division: Non-manufacturing cartels sell more often to final consumers, are established more often in local markets, and use posted and hence more easily monitored prices. This may explain why there is more direct price-fixing in non-manufacturing. A related reason, emphasized already by Stigler (1964), is that inspection of output is costly or ineffective in services. This is especially relevant for quota cartels. Moreover, non-manufacturing cartels in our data have many members and more likely sell differentiated products. Both features complicate market allocation. In contrast, manufacturing cartels have fewer members, are national and often sell their products to downstream firms rather than to final consumers. These characteristics explain the popularity of *Market allocation-based* cartels in manufacturing.

Joint use of main clauses: Even though Stigler (1968) already raised the issue that a cartel agreement may not cover all the terms of sale, the prior literature offers few insights on the joint use of individual main clauses. We found stronger correlations in manufacturing, where *Market allocation-based* clauses are negatively correlated with each other, suggesting substitutability. Consistent with semi-collusion being a problem (e.g., cartels redirecting competition from prices to rebates or terms of delivery), *Price-based* clauses are positively correlated with each other. Moreover, *Market allocation-based* and *Price-based* clauses are negatively associated with each other (with the notable exception of *Quota* which we discuss below).

While some of the correlation patterns are in line with theory, it is less clear why the correlations are weaker in non-manufacturing or why for example *Pricing* and *Payment rules* are positively correlated in manufacturing, but negatively correlated in non-

manufacturing. A possible explanation for this particular sectoral difference is transparency of pricing: Manufacturers sell less often to end-users, meaning that e.g. secret rebates can be more of an issue. As argued above, the complementary use of *Payment rules* in manufacturing may be explained by the need to curb such behavior (as suggested by Stigler 1964). The case of Finnish match producers' pricing cartel (formed as early as 1927) illustrates this: The cartel agreed on prices, on discounts to both wholesale customers and on cash purchases. It also agreed on prices of different labels on the boxes and the size of match boxes. Thus, even within this very homogenous industry, the cartel made an effort to avoid competition in other dimensions than price. In contrast, both prices and payment rules are often more transparent in non-manufacturing, potentially explaining why these clauses appear to be substitutes (negative correlation between *Pricing* and *Payment rules*).

New insights on Quota and Non-area-based cartels: Our findings suggest some new insights and questions related to the prevalence of *Quota* cartels and the economic nature of *Non-area-based* cartels. We discuss each of these in turn.

Quota cartels: Stigler (1964, pp. 46) asserts that quotas are the most efficient way of organizing cartels, if efficient monitoring of output and side-payments can be organized. The previous evidence on the use of *Quota* is mixed: Suslow (2005) and Harrington (2006), both studying international cartels where one could presume that there are natural ways of delineating the market, report very high use of *Quota* (Suslow: 40%, Harrington: 100%). Posner (1970) who looks at illegal U.S. cartels and Taylor (2007) who studies legal US cartels report low use of *Quota* (3% and 11%, respectively), as do Bouwens and Dankers (2010) for Dutch cartels (2-3%).[16] We find more *Quota* cartels in manufacturing

[16] While Posner's low figure may be explained by Stigler's comment (1964, pp. 46) that quota cartels are easy to detect, this does not explain Taylor's low figure as the cartels he studies were legal. Hay and Kelley (1974) and Frass and Greer (1977) who use subsets of Posner's data report that 34-35% and 26% of cartels in their samples use *Quota*.

than in non-manufacturing, which is in line with Stigler who explicitly suggests that monitoring may be difficult in services. However, even in manufacturing, *Quota* is used by only 16% of cartels.

Why do we observe so few quota cartels? If Stigler was right about *Quota* being an efficient form of colluding, then the problems with organizing either monitoring and/or side-payments must be sizeable also in manufacturing, even when there are no restrictions on explicit communication. As a consequence, and in line with the theoretical model of Harrington and Skrzypacz (2011) and with Harrington (2006), *Quota* cartels often adopt complementary practices. For example, the famous lysine cartel augmented its sales quota scheme by coordinating the price setting of its members.[17] The positive correlation between *Quota* and *Pricing* among our manufacturing cartels is consistent with the Lysine cartel. A case in point in our data is the pulp cartel that used both *Quota* and *Pricing*. Uniform pricing was ensured by channeling all sales through the common sales organization. The quota rule of this process-industry cartel was effectively based on relative production capacity of the members. As we show in the next section, quota cartels are special also because they use more clauses for self-policing and compliance.

Non-area-based cartels: The popularity of *Non-area-based* cartels in manufacturing bears on the debate on the blurred line between competition restrictions and mergers, because these contracts stipulate that the members are to specialize in one way or another or the contracting parties simply agree to "not compete" in a given market. These collusive arrangements form a broad category, but they include, for instance, inter-cartel sales of production line(s) and some members ceasing production of certain goods. They are thus similar to the arrangements of German specialization cartels (Audretsch 1989 and

[17] Suslow (2005) finds a negative correlation between production quotas and both export quotas and exclusive territories for the international cartels. These correlations are in line with our data, as *Quota* clauses are negatively correlated with the (spatially determined) *Area-based* clauses.

Haucap et al. 2010) and Dutch collusive specialization arrangements (Bouwens and Dankers 2010, Table 1, Totals) that constitute 15-19% of cartels in their data. More generally, it is not uncommon that production and sales capacity is transferred, relocated and/or sold when cartels are formed and when they dissolve (Röller and Steen 2006, Kumar et al. 2015, Marx and Zhou 2015; see also Motta 2004). Heterogeneity in the economic nature of *Non-area-based* cartels makes direct comparisons difficult, but the 33% Harrington (2006) reports for the *Non-area-based* cartels (in his data, customer allocation) matches closely with the sector weighted average in our data. Posner (1970) and Gallo et al. (2000), who study illegal U.S cartels, report a relatively low share of *Non-area-based* cartels (10-13%).

We illustrate the nature of the *Non-area-based* cartels by two examples. In the steel furniture cartel two producers agreed to specialize. The firms also agreed to organize sales through a joint sales office (owned by one of the firms; the other firm got a seat on the board of the sales office), which in Stigler's (1964) view is a close substitute for a formal merger. Echoing this, the firms agreed that the joint sales office would not sell products of third parties. The firms also agreed that they would share blueprints and even patents (the receiving party is not allowed to disseminate the information further) and committed to a quota structure. Our second example is the plywood box cartel. In this cartel two manufacturers made an agreement whereby one of them ceased the production of these products altogether. It also committed not to re-enter the business for 15 years, and to neither sell nor allow the use of its machinery. Further, it committed to not reveal its production know-how to any domestic competitor. As compensation the firm continuing production promised to pay a royalty on its plywood box revenues to the firm ceasing production. This arrangement had a flavour of monopoly, as in their correspondence with the Registry, the firms explicitly stated that this agreement did not result in a monopoly in plywood box production.

We can think of *Non-area-based* schemes as substituting for firms merging with each other, when there are no restrictions on collusion. The modern enforcement of merger control may be closely tied to firms' collusive practices (Bittlingmayer 1985; Stigler 1950; Kumar et al. 2015) and the overlap between collusive activities and mergers may be greater than has been understood so far.

4 How do cartels pursue compliance?

In this section, we explore which contracting features are used to pursue compliance and stability and go beyond the existing literature by studying how their use depends on the adopted main clauses. To this end, we use information on a set of *additional contract clauses* that we collected for the subsample of 109 nationwide manufacturing cartels.[18]

4.1 Measurement of additional contract clauses

The received cartel literature (e.g., Stigler 1964, Harrington 2006, Levenstein and Suslow 2006, Levenstein and Suslow 2011, Marshall and Marx 2012, chs. 6 and 7) allows us to identify 14 additional contract clauses. These clauses can be classified into four groups: First, into clauses that are related to *Internal stability* issues, aimed at providing incentives not to cheat or deviate from the cartel contract; second, into clauses describing *Organization* of cartels; third, into clauses related to *External threats* that the cartels face; and finally, into *Production-related* clauses. We use this grouping to organize our discussion, but acknowledge that each clause may bear on cartel stability: Cartels use those contract clauses which address problems they anticipate to emerge and whose benefits exceed the costs of including them into the contract (see also Kaplow 2011a, pp. 758-765). Table 5 summarizes the four groups and the definitions of the 14 clauses.

[18] These 109 cartels form a subsample of the larger manufacturing sample used so far and they largely share the features of the larger sample (see Appendix C for details), except for being by definition always nationwide and born earlier.

Table 5: Additional contract clauses

Clause descriptions	
Internal stability	
Monitoring	= 1 if the contract has a clause on how the members monitor each other.
Enforcement	= 1 if the contract stipulates how to handle situations where a member has deviated or mentions price wars, retaliation, etc.
Expel	= 1 if the contract includes rules on how to expel (exclude) a member if rules are broken.
Fine	= 1 if the contract includes clauses on monetary fines for a company that violates the contract.
Organization	
Meeting	= 1 if the contract stipulates whether, and if so, how often, the members are to meet.
Dispute-resolution	= 1 if the contract specifies a way in which disputes among members are to be resolved.
Structure	= 1 if the cartel has a formal structure, such as an association, a limited liability company or other form to organize itself.
Vote	= 1 if the contract specifies a voting procedure.
Sales office	= 1 if the cartel has formed either a trade or a sales association.
External threats	
New members	= 1 if the contract specifies a policy on how to accept new members.
Non-cartel supply	= 1 if the contract specifies how to deal with supply from non-member rivals.
Entry	= 1 if the contract stipulates how to react to entrants into the industry.
Production-related	
Efficiency	= 1 if the contract stipulates, e.g., that sales and/or production should be allocated according to efficiency.
Technology	= 1 if the contract refers to sharing of technological knowledge such as patents or blueprints.

NOTES: The definitions of the clauses are meant to be descriptive of the broad content of each clause. The data contain also other wordings but those have a meaning that is economically similar to what is described in this table. We use term "contract clause" in the meaning of "intended or agreed practice in an agreement", not in its strict formal legal meaning.

The first group consists of four clauses that have to do with *Internal stability* of a cartel: *Monitoring* indicates whether the members monitor each other. As an example, the plywood cartel had a clause whereby "*all information on sales, deliveries and production must be given to the Association twice a month; twice a year a certified auditor's statement of the correctness of previous notifications is required*". *Enforcement* refers to those contracts that stipulate how to handle situations where a member has deviated. Such instances include the mention of price wars, retaliation, and compensations. An example is the clause used by the glass cartel: "*The delegation has the right to order production reductions or temporary closing of a plant. Compensation must then be paid*". If the cartel has rules on how to expel a member if rules are broken, this is captured by *Expel*. Similarly, for contracts including clauses on monetary fines for a company that violates the contract, *Fine* takes the value one. Fines were usually either a percentage of some measurable activity like sales; sometimes a minimum monetary fine was defined.

The second group refers to five clauses that summarize cartels' *Organization*. The first of them, *Meeting*, identifies the contracts that stipulate whether, and if so, how often,

the members are to meet. *Dispute-resolution* in turn denotes whether the contract specifies a way in which disputes among members are to be resolved. There were two primary ways in which disputes resolution was specified in the contracts: Either an internal mechanism, or an external mechanism (arbitration, court).[19] *Structure* indicates whether the cartel has a formal structure, such as an association or a limited liability company to organize itself. *Vote* is an indicator for contracts that include a clause for a voting procedure. Finally, *Sales office* measures if the cartel has formed either a trade or a sales association.

The third group consists of three clauses which deal with *External threats*: *New members* clause indicates whether the contract specifies a policy on how to accept new members. *Non-cartel supply* quantifies whether or not the cartel members have a clause on how to deal with supply from non-member rivals. Finally, *Entry* refers to a clause that stipulates how to react to entrants into the industry.

The fourth group consists of two *Production-related* clauses: *Technology* covers e.g. sharing of technological knowledge, such as patents or blueprints. As an example, the cartel for concrete-reinforcement steel bars had a contract stipulating the "*sharing of information on raw materials, production techniques etc.*" *Efficiency* refers to contract clauses that aimed at achieving production or delivery efficiencies. As an example of an *Efficiency* clause, the plastic pipe cartel's agreement stipulated that the member whose facility is closest to a given customer should deliver the goods (*"when dividing orders the length of transport must be considered if possible"*).

[19] One solution used by cartels was to use the arbitration provided by the Finnish Chamber of Commerce, used e.g. by the match makers cartel after their reorganization. The Chamber unfortunately keeps the (as such confidential) arbitration documents for only ten years, and thus their archive would not shed light on whether cartel members really resorted to arbitration.

4.2 Prior literature: What do we know?

The existing literature provides limited evidence on the use of contract clauses on internal stability, organization of cartels, external threats and production-related issues (for a detailed account, see Appendix A). For example, there is almost no information on whether the use of these additional contract clauses varies by the mode of cartelization.

The only cartel feature that is reported widely is *Sales office*: Almost all previous studies report information related to that, like on the use of a trade association. The fraction of cartels having a joint sales office is slightly above 30% in most studies. There is also some coverage of the *Monitoring* clause, but besides Harrington (2006), the evidence on the other clauses is rather patchy. Suslow (2005, see her Table 3) is the only study exploring the relationship between main clauses and additional clauses. She finds that the use of a production quota is positively correlated with penalties and negatively with cross-licensing of technology; and that the use of exclusive territories is positively correlated with both of these. Taylor (2007, see his Table 1) reports for each cartel the use of the provisions (= clauses) on which he has data, but doesn't analyze the patterns in the use of the provisions.

In their related work, Fink et al. (2016) analyze a larger number of contract clauses on cartel governance, allowing them to characterize our corresponding, but more aggregated clauses in more detail.

4.3 Empirical findings

We report the use of the 14 additional contract clauses separately for *Price-based, Quota* and *Market allocation-based* (excl. *Quota*) cartels. A preliminary investigation showed that *Pricing-* and *Payment- rule* cartels on the one hand and *Area-based* and *Non-area based* cartels on the other hand are very similar with each other. Within both pairs, there are no statistically significant differences (at the 5% level) in the use of the 14 additional

contract clauses. However, *Quota* cartels stand out clearly, so we report them as a separate group.

Figure 3 reports the average use of the 14 additional contract clauses (and the modal value). It shows that *Quota* cartels use a richer set of contract clauses than other types of cartels, as they have on average 6.16 additional clauses (mode = 6). The difference to the other *Market allocation-based* cartels (*Area-based* and *Non-area-based* cartels) is especially visible (average = 3.48, mode = 3).

Figure 3: Use of the 14 additional contract clauses (average and mode)

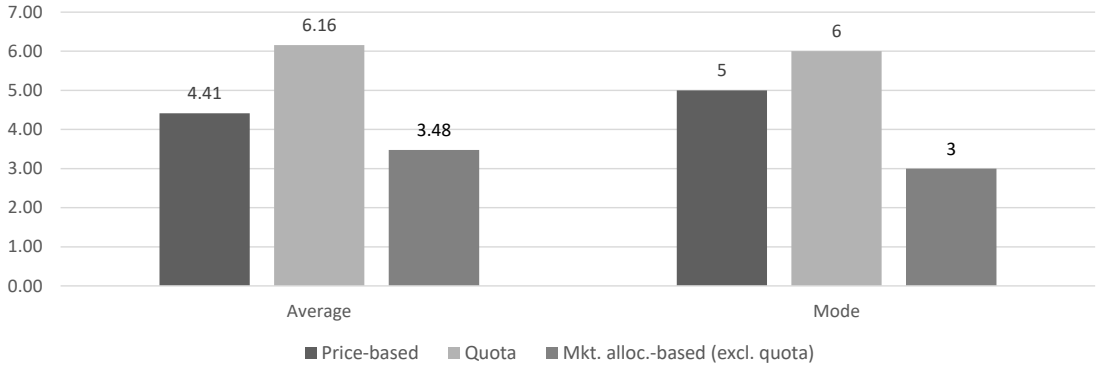


Figure 4 shows why *Quota* cartels stand out by displaying separately how often *Internal stability*, *Organization*, *External threats* and *Production-related* clauses are used. *Quota* cartels use *Internal Stability* clauses often. These clauses are directly related to strengthening incentive compatibility. Second, *Quota* cartels resort to *Organization* clauses frequently. In this regard, they are similar to *Price-based* cartels.

Figure 4: Use of additional contract clauses by economic purpose

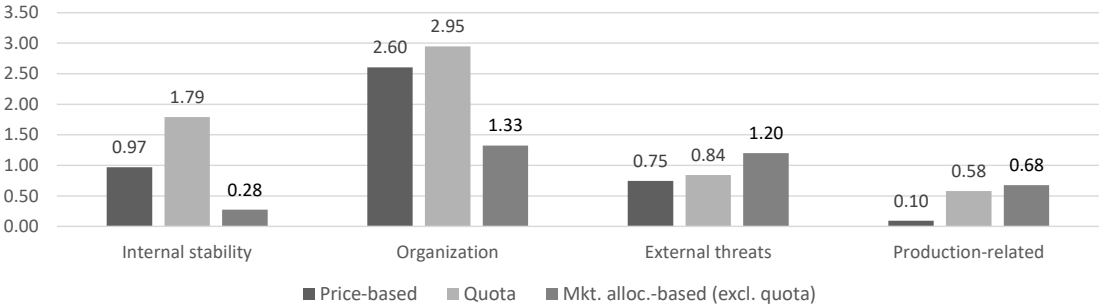


Table 6 zooms even closer into the use of each of the 14 additional contract clauses. It provides us with three main findings: First, the reason why *Quota* uses *Internal Stability*

clauses (except *Expel*) often is that out of 19 quota cartels, 63% use *Monitoring*, 53% use *Enforcement* and 47% use *Fine*. Second, *Quota* cartels resemble *Price-based* cartels in having several *Organization* clauses (*Structure, Vote* and *Sales Office*). Third, while the *Area-* and *Non-area-based* cartels use relatively few additional contract clauses, they nevertheless have clauses related to *Dispute resolution*, *Non-cartel supply*, and *Entry*. In contrast, *Price-based* cartels pay attention to the procedures that are needed to deal with new members.[20]

[TABLE 6 HERE -- landscape]

4.4 Discussion

Manufacturing cartels can be divided into three groups in terms of their use of the additional clauses: *Price-based* cartels use the *Organization* clauses a lot. *Market-allocation* based cartels (excl. *Quota*), which also use fewer main clauses, only use *Dispute resolution*, *Non-cartel supply*, and *Entry* more often than the other types of cartels. *Quota* cartels resort often to the *Organization* and *Internal Stability* clauses. These findings raise the question of why the additional clauses are used so differently across the three groups of cartels.

Price-based cartels: The use of *Organization* clauses by *Price-based* cartels is consistent with their need to make more often active decisions to change prices in face of external shocks and demand fluctuations (e.g., Rotemberg and Saloner 1986) or to update conditions for discounts and payments. For example, a joint sales office may be a good way to organize such recurrent activities (Stigler 1964). The reason why *Price-based* cartels in our data often have a procedure for accepting new members may be related to their need to make the cartel sufficiently ("optimally") encompassing. As Bos and Harrington

[20] While not reported in the table, cartels using the *Vote* clause often also specify the voting rules to be used: Voting power is distributed according to (sales) quotas or sales (billing), using the 1-share-1-vote-rule, as relative to wages paid, or as a function of the size of the members. As an example, the cardboard cartel used the following voting rule: "*Voting power is based on production (volume)*".

(2010) show, pricing cartels typically have an incentive to be more inclusive (i.e., new members are welcome), but they are not necessarily all-inclusive. The capacity under the control of a pricing cartel and its stability both depend on the incentives of the (smallest) cartel members to exit and of the largest non-members to join the cartel.

Area and non-area-based cartels: Closing down production in one unit and/or agreeing on specialization, or agreeing explicitly on a spatial market division, appears to be enough to lessen competition without heavy use of other clauses. Exceptions to this rule are *Dispute resolution*, *Non-cartel supply* and *Entry*. Especially the use of the latter two speaks for the view that these types of cartels worry about external supply from existing non-member rivals (intensive margin) or from new entry (extensive margin) into the industry. An example of a *Non-area-based* cartel that used *Non-cartel supply*, *Entry* and *Dispute resolution* is the industrial metal pipes cartel. One of the members ceased the production of some very specific welded stainless steel pipe products; the two firms co-operated in the manufacturing of other products. To support the arrangement, the cartel had an external dispute resolution mechanism (private arbitration). The contract also stipulated restrictions on the cartel members regarding the sale of third parties' products.

The cement cartel is an example of a spatial market allocation cartel in a homogenous goods market with two members (registered in 1959). The cartel has the simplest contract observed by us, as the two cement producers only agreed on geography-based market allocation: The firms announced that they had agreed to divide Finland geographically, with the smaller firm (whose market share was 35%) concentrating on an area that in the South was round the capital Helsinki, and extended to the north. Both to West and East of this area, as well as North of it was the designated area of the larger member. The reason for this split of the market was the location of production facilities, which allowed each of the two firms to serve easily their own dedicated areas (due to the associated

opportunities for lake and sea transportation) but *not* those of its rival.[21] In line with this, Aiginger and Pfaffermayer (1997) argue that in the cement industry, geographic competition is limited. Further correspondence between the Registry and the cartel indicated that the spatially determined market shares remained stable over time. The larger cartel member stated in one of its letters that "*the marketing areas of cement are determined by customer choices, driven largely by transport costs*".[22] Internationally, geographic market sharing is common in the cement industry. A notable exception was the Norwegian cement cartel where *all* cement producers had access to cheap sea transport to most local markets (due to the country's geographical shape and its long coast). Cross-transportation was therefore less costly and was one of the reasons why the Norwegian cement producers established a joint sales office (Röller and Steen, 2006, pp. 324).[23]

Quota cartels: *Quota* cartels, which in our data mostly operate in intermediate goods markets with hard-to-observe prices and quantities, use *Internal Stability* clauses often. Consistent with Stigler's conjecture that *Quota* cartels need monitoring and side payments to function (see also Harrington and Skrzypacz 2011), we find that *Quota* cartels use *Monitoring* often. The wide use of *Enforcement* and *Fine*, as well as *Dispute Resolution*, may be interpreted as a way to implement side payments. *Quota* cartels also use *Pricing* clauses relatively often (see Table 4). 90% of all *Quota* cartels use at least

[21] The production facility of the smaller member was, at the time of registration, located West of Helsinki (in the town of Lohja). The larger competitor had (in 1959) a production facility in the south-eastern town of Lappeenranta, which allowed it to service eastern Finland with the lowest possible transportation costs (as lake transport was readily available). The other production facility of the larger member was at the time in the South-west town of Parainen on the coast. This location allowed relatively cheap sea transport to the northern port of Oulu and thereby northern Finland was allocated to this member (as the other was not located on the coast). The firms also produced quicklime with 1959 market shares of 20-50% for the larger firm and 20-40% for the smaller, depending on the type of quicklime.

[22] It turns out that in separate contracts, given different entry numbers by the Registry, the two firms agreed, in addition, on discounts with their downstream retailers. In effect, they ensured a price-cost margin to their retailers through these contracts without agreeing on a final price for their products.

[23] In addition, the Norwegian cartel agreed on capacity quotas, according to which domestic market shares were determined on the basis of the members' share of total capacity. This sharing rule created distorted incentives to export cement overseas (capacity competition), and eventually ruined the efficiency of the Norwegian cartel.

two clauses from the set {*Pricing, Monitoring, Fine, Enforcement, Dispute resolution*}. Moreover, about 80% of *Quota* cartels have at least two *Organization* clauses. The use of *Organization* clauses is less frequent in non-quota cartels. These numbers suggest that the picture provided by Stigler and subsequent work may be somewhat incomplete: *Quota* cartels need more than just a simple monitoring and side payment scheme for self-policing.

5 Which cartel arrangements are stable?

In this section, we revert back to using the large manufacturing and non-manufacturing samples and ask: Do initial contracting features predict subsequent contract adjustments? Due to changes in the external environment, learning, and for internal reasons, cartels need adjust their behavior and contracts over time (e.g., Genesove and Mullin 1998). An improved understanding of the dynamics of contract changes is policy relevant, because cartels that make frequent changes are more likely to be detected by competition authorities. To supplement this analysis and to provide a point of comparison to the earlier literature, we provide an analysis of cartel duration in Appendix E.[24]

5.1 Measurement of adjustments

To measure the stability of cartels' arrangements, we use the number of subsequent adjustments made to the initially registered cartel contract. Our stability measure comes directly from the cartel registry (unfortunately, the exact reason for an adjustment was rarely spelled out).

[24] Hyytinen, Steen and Toivanen (2016a) provide a related empirical analysis using a hidden Markov model. They find a high probability that a cartel continues after being established.

Table 7 displays descriptive statistics for the outcome variable. *Price-based* and *Quota* cartels make more adjustments to their initial contracts, especially in manufacturing. For example, 48% of the quota cartels in manufacturing have made an adjustment. Conditional on doing so at least once, cartels made on average two adjustments.

Table 7: Descriptive statistics for contract adjustments

Panel A: Large sample, manufacturing (N=359)

	Number of contract adjustments		
	All	At least one change	
	Mean	Fraction (> 0)	Mean (> 0)
Price-based	1.04	0.50	2.07
Pricing	1.07	0.51	2.08
Payment Rules	1.19	0.53	2.27
Quota	0.97	0.48	2.00
Market allocation-based (excl. Quota)	0.09	0.06	1.50
Area-based	0.16	0.11	1.40
Non-area-based	0.12	0.06	1.83
All, manufacturing:	0.47	0.25	1.92

Panel B: Large sample, non-manufacturing (N=539)

	Number of contract adjustments		
	All	At least one change	
	Mean	Fraction (> 0)	Mean (> 0)
Price-based	0.59	0.37	1.62
Pricing	0.61	0.37	1.64
Payment Rules	0.66	0.41	1.60
Quota	0.87	0.47	1.86
Market allocation-based (excl. Quota)	0.39	0.24	1.63
Area-based	0.68	0.32	2.11
Non-area-based	0.39	0.24	1.62
All, non-manufacturing:	0.54	0.34	1.58

NOTES: The rows of the table refer to the main contract clauses and are not mutually exclusive. Number of contract adjustments refer to the number of times the initial contract was changed, as recorded by the Registry. Panel A reports descriptive statistics for the manufacturing and Panel B for the non-manufacturing sample.

5.2 Prior literature: What do we know?

Even though the importance of communication and renegotiation for the workings of collusion and cartels have been studied from a number of angles (see, e.g. Athey and Bagwell 2001, Aoyagi 2002, Harrington, Hernan-Gonzalez, and Kujal 2014, Cooper and Kühn

2014), we are not aware of any studies that would explore whether and how the initial cartel contract predicts subsequent contract adjustments.[25]

5.3 Empirical findings

We regress subsequent contract adjustments on initial contracts features, analyzing the two sectors separately.[26] The key explanatory variables are indicators for the five main contract clauses, as well as two indicators capturing the joint use of either *Price-based* or *Market allocation-based* clauses.

We include several explanatory variables (see Appendix D for the descriptive statistics). We control for the geographic coverage of a cartel by an indicator for nationwide cartels. We capture positive and negative macro shocks at the time the cartel was registered by including separate variables for the absolute value of the negative and positive GDP shocks, measured one year before the cartel was registered (e.g., Green and Porter 1984, Rotenberg and Saloner 1986). Other explanatory variables are a variable capturing changes in the law regime (as delineated in Section 2), and cohort indicators for decades. While acknowledging its potential endogeneity, we also include the logarithm of the number of cartel members for those for whom this is observed, a dummy for large cartels (> 50 members), and a dummy for cartels for which we do not observe the number of members.

Table 8 presents five Poisson models, with standard errors clustered by the year of cartel registration. The two first are for manufacturing, with the second model adding the log of the number of members to the specification of the first model. Models three

[25] Echoing this, Levenstein and Suslow (2006, pp. 70) write: "*While most cross-sectional studies acknowledge the importance of cartel organization and learning, the difficulties in observing and quantifying such information for a large number of industries has meant that these critical subjects are usually ignored. Case studies are much more amenable to studying organizational issues, and there have been several recent contributions in this area*."

[26] We also report the results for the merged sample, where we include an indicator for the manufacturing cartels.

Table 8: Contract adjustments (Poisson-regression)

Sample:	Manufacturing (N = 359)		Non-manufacturing (N = 539)		Combined (N = 898)
	(1)	(2)	(3)	(4)	(5)
Pricing	0.799	0.773*	0.540**	0.495**	0.732**
	(0.411)	(0.366)	(0.161)	(0.173)	(0.143)
Payment Rules	0.870	0.906*	0.200	0.205	0.550*
	(0.458)	(0.438)	(0.262)	(0.269)	(0.236)
Many price-based clauses (> 1)	1.144**	1.201**	0.556*	0.561*	0.962**
	(0.404)	(0.373)	(0.216)	(0.225)	(0.188)
Quota	0.412*	0.469*	0.686**	0.745**	0.658**
	(0.181)	(0.210)	(0.249)	(0.241)	(0.169)
Area-based	-0.077	0.043	-0.380	-0.341	-0.111
	(0.701)	(0.712)	(0.380)	(0.364)	(0.339)
Non-area-based	-1.104*	-0.924	0.151	0.235	-0.060
	(0.536)	(0.527)	(0.175)	(0.191)	(0.184)
Many mkt-alloc. based clauses (>1)	0.395	0.449	0.486	0.683**	0.666**
	(0.511)	(0.495)	(0.263)	(0.236)	(0.240)
National (1/0-dummy)	1.101*	0.929	0.810**	0.879**	0.850**
	(0.458)	(0.476)	(0.139)	(0.127)	(0.132)
GDP-neg-shock (one year prior to registering)	-0.658	-0.848	0.557	0.811	-0.126
	(1.464)	(1.645)	(0.671)	(0.599)	(0.670)
GDP-pos-shock (one year prior to registering)	-0.763	-0.843	1.006	1.117	0.057
	(1.436)	(1.395)	(0.802)	(0.674)	(0.711)
Law regime	-0.139	-0.040	-0.423**	-0.421**	-0.309**
	(0.177)	(0.173)	(0.137)	(0.124)	(0.092)
Cohort: 1960-1969	0.144	0.173	-0.084	-0.079	-0.027
	(0.193)	(0.212)	(0.156)	(0.156)	(0.112)
Cohort: 1970-1979	-0.523	-0.422	-0.211	-0.351	-0.414
	(0.557)	(0.564)	(0.264)	(0.236)	(0.254)
Cohort: 1980-1993	-1.005*	-0.974*	-1.384**	-1.433**	-1.304**
	(0.454)	(0.484)	(0.531)	(0.530)	(0.369)
Ln(number of members)		0.283*		0.221*	0.259*
		(0.121)		(0.113)	(0.107)
Manufacturing dummy					-0.218
					(0.132)
Auxiliary control variables	Yes	Yes	Yes	Yes	Yes
Observations	359	359	539	539	898
Joint-test for price-based clauses (p-value)	0.000	0.000	0.000	0.000	0.000
Joint-test for mkt-alloc-based clauses (p-value)	0.000	0.001	0.035	0.003	0.000

NOTES: Dependent variable = # of contract changes. The auxiliary control variables are a dummy for cartels with more than 50 members and a dummy for cartels for which we do not observe the number of members. Method of estimation is the Poisson count regression, estimated by maximum likelihood. Standard errors are clustered at birth-year level, with * = significant at 5% level, ** = significant at 1% level. Combined sample merges the manufacturing and non-manufacturing samples.

and four repeat the analysis for non-manufacturing cartels. Finally, the fifth model combines data from both sectors and includes a dummy for manufacturing cartels.

Three main findings emerge. First, the two *Price–based* contract clauses and the indicator for cartels with more than one price-based clause carry positive coefficients throughout the table (and are jointly significant): Being a *Price-based* cartel predicts subsequent contract changes. Second, *Quota* and the joint use of *Market allocation* clauses

predict more subsequent contract adjustments. Third, larger and nationwide cartels have more adjustments.[27]

To get a sense of the economic magnitudes, let us focus on quota cartels and use the estimates from column (5): When *Quota* = 0, the predicted number of contract adjustments is 0.48, whereas when *Quota* = 1, the predicted number of adjustments is 0.93. The predicted number of contract adjustments nearly doubles for a quota cartel.

5.4 Discussion of results

We find that being a *Price-based* cartel predict more contract adjustments. A cartel agreeing on prices may need to readjust its contract more frequently than a cartel based on exclusive territories. Reasons for this are, for example, the need of pricing cartels to update pricing lists and to allow for new product variants. As a case in point, the match producers' cartel announced some changes to the earlier agreement that had to do with the pricing of different labels. Being a *Quota* cartel also predicts more contract adjustments. A possible explanation is that *Quota* cartels resort heavily to using stability clauses (as shown in Section 4), suggesting that more complex contracts need more adjustments. The complexity of contracts may also explain why the joint use of *Market allocation*-clauses is associated with contract changes.

The above findings complement the existing literature that mostly uses cartel duration as a measure of stability. We provide a duration analysis in Appendix E. A new result from our duration analysis is that making more adjustments to the initial agreement predicts a longer duration. This finding is broadly consistent with theoretical models and empirical analyses that stress the importance of communication and adjustments for stability and efficient working of explicit collusion.[28]

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[27] These results are robust to explicitly controlling for the fact some cartels may have more contract adjustments simply because of their longer duration (i.e., for 'exposure').

[28] See, Athey and Bagwell (2001, 2008), Genesove and Mullin (2001), Harrington (2006), Harrington, and Skrzypacz (2011), Harrington, Hernan-Gonzalez, and Kujal (2014), Cooper and Kühn (2014), and Clark and Houde (2014).

6 Conclusions

This paper has provided an anatomy of cartel contracts. The key elements of this anatomy are the following:

How do cartels raise profits? Manufacturing cartels use *Market allocation–based* clauses more often while non-manufacturing cartels agree on prices much more often. The most common contracts use only one of the five main clauses: *Non-area based* in manufacturing, and *Pricing* in non-manufacturing. Cartels using quotas are quite infrequent, even in manufacturing and even in an environment in which explicit collusion was allowed. Manufacturing cartels frequently use *Non-area based* clauses, e.g., specializing through product positioning. This is consistent with some types of cartels being a substitute for mergers and divestitures (see Kumar et al. 2015).

In manufacturing, use of the two *Price-based* clauses is positively correlated, and use of three *Market-allocation based* clauses negatively correlated with each other. Correlation in usage across these two groups of clauses is also negative. These patterns are weakened or reversed for non-manufacturing cartels.

In contrast to our data, Fink et al. (2016) find that quota cartels were very common in Austria, where the legal environment allowed for binding cartel contracts. Like quota cartels in our data, these cartels resorted often to using pricing clauses.

How do cartels pursue compliance and stability in manufacturing? *Price-based* cartels have more often a formal organizational structure, including a joint sales office and rules on admitting new members. Quota cartels stand out, as they use more complex contracts, especially due to their frequent reliance on organizational clauses and clauses related to self-policing, such as monitoring, enforcement and fines. Cartels that allocate markets spatially or specialize in serving certain customers prefer simpler contracts than the other types of manufacturing cartels.

Some of these results are echoed by Fink et al. (2016): For example, also in their data quota cartels often employ stability and organizational clauses. As in our data, Austrian specialization cartels, which correspond to our area- and non-area-based cartels, rarely rely on governance clauses related to internal stability and cartel organization.

Which contracts and cartels are stable? In addition to using more complex cartel agreements, quota cartels appear to require more adjustments over time. Nationwide cartels make more changes, and the number of cartel members is associated with more contract changes. Making more adjustments to initial agreements is associated with a lower likelihood of subsequently breaking up.

Implications: Our results have implications for empirical and theoretical work. They suggest systematic differences in how collusion is organized in different types of industries, and by cartels agreeing on prices and cartels allocating markets. It seems fair to say that the existing literature has not systematically explored these broader characteristics of how collusion is organized. For example, the literature on harmful market practices has paid relatively little attention to why and when various schemes to specialize (the *Non-area–based* market allocation clause) provide a substitute for price-fixing, market allocation or even a merger to monopoly.

We want to make it clear that the stylized facts that we report do not establish causality. They are nonetheless useful for the development of cartel theory, because a theoretical cartel model is arguably more useful if the equilibrium of the model is consistent with the patterns found in the data. For example, one could follow Harrington and Skrzypacz (2011) and build a model that in equilibrium delivers a cartel contract observed in our data under the assumption that there is no competition authority.[29] In spirit of Bos

[29] Harrington and Skrzypacz (2011; see also their 2007 paper) have analyzed the properties of an equilibrium that qualitatively match the key dimensions of observed cartel agreements in certain markets (quota cartel with monitoring), and show under what conditions such an equilibrium exists.

and Harrington (2010, 2015), the environment can thereafter be changed to study what type of a cartel agreement arises in the new equilibrium and how cartels adapt (e.g., by introducing a competition authority, modelled as a detection probability and an associated fine). The systematic variation in contracts that we document implies e.g. that a model of a pricing cartel should in equilibrium feature the use of rebates and terms of delivery in manufacturing, but not in the non-manufacturing sector.

Regarding competition policy, our findings suggest sector-specific regularities in what types of horizontal agreements to expect and search for. For example, were manufacturing cartels free to write collusive contracts, they would – by revealed preference – use relatively simple market allocation schemes whereby markets are divided spatially, or by agreeing on the firms' positioning in the product space. According to our results, indications of market allocation are more suggestive of collusion in manufacturing than non-manufacturing. Quota cartels on the other hand call for much more complex contractual arrangements, suggesting that competition authorities should expect to find more evidence of communication for detected illegal quota cartels. This kind of knowledge should ultimately increase the likelihood of authorities and courts making proper decisions and rulings in cartel cases. This is important because the boundaries for unlawful and harmful practices remain unclear (e.g. Harrington 2015, Kaplow 2011a,b).

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Tables and Figures (landscape)

Table 2: Characteristics of price-based and market allocation-based cartels by sector

Panel A: Large sample, manufacturing (N=359)	Count	# of members	National	Year of reg.	# of clauses
Price-based	134	5.00	0.87	1968	1.87
Market allocation-based	261	2.00	0.84	1976	1.38
Chi2-test: Price-based vs. mkt alloc. based (p-value):		-	*< 0.61*	*< 0.01*	*< 0.01*
All	344	2.00	0.86	1973	1.40
None of the above	15	3.00	0.80	1973	0.00
All	359	2.00	0.86	1973	1.35

Panel B: Large sample, non-manufacturing (N=539)	Count	# of members	National	Year of reg.	# of clauses
Price-based	421	26.00	0.49	1971	1.41
Market allocation-based	148	7.50	0.46	1975	1.74
Chi2-test: Price-based vs. mkt alloc. based (p-value):		-	*< 0.48*	*< 0.01*	*< 0.01*
All	480	19.00	0.53	1971	1.37
None of the above	59	11.00	0.71	1974	0.00
All	539	18.00	0.55	1972	1.22

Panel C: Chi2-tests manuf. vs. non-manuf.		# of members	National	Year of reg.	# of clauses
Chi2-test, Panel A vs. B: Price-based (p-value)	-	-	*< 0.01*	*< 0.01*	*< 0.01*
Chi2-test, Panel A vs. B: Market allocation-based (p-value)	-	-	*< 0.01*	*< 0.61*	*< 0.01*

NOTES: Panel A refers to manufacturing cartels and Panel B to non-manufacturing cartels: The reported numbers are means, except for the number of members, where we report the median. The clauses on the rows are not mutually exclusive. # of clauses is the average of the count of the five main clauses. National takes the value one if a cartel is nationwide. Year of reg. is the year of entry into the Registry. # of members is the number of members as recorded by the Registry or verified by us (data not available for all cartels). In Panel A and B, the Chi2-tests are in italics and contrast price-based cartels with market allocation -based cartels. In Panel C, the Chi2-tests contrast manufacturing with non-manufacturing cartels. None of the above -row refers to miscellanous cartels, i.e., to a (small) group of competition restrictions which cannot be classified as either price-based or market allocation -based cartels.

Table 4: Pairwise correlations of main contract clauses

Panel A: Large sample, manufacturing (N = 359)

		Price-based		Market allocation-based		
Clause	Count	Pricing	Payment Rules	Quota	Area-based	Non-area-based
Pricing	117	1	-	-	-	-
Payment Rules	78	0.527**	1	-	-	-
Quota	58	0.276**	0.081	1	-	-
Area-based	44	-0.169**	-0.156**	-0.141**	1	-
Non-area-based	186	-0.590**	-0.398**	-0.273**	-0.133*	1

Panel B: Large sample, non-manufacturing (N = 539)

		Price-based		Market allocation-based		
Clause	Count	Pricing	Payment Rules	Quota	Area-based	Non-area-based
Pricing	367	1	-	-	-	-
Payment Rules	126	-0.130**	1	-	-	-
Quota	15	-0.029	-0.067	1	-	-
Area-based	28	-0.019	-0.031	0.367**	1	-
Non-area-based	121	-0.118**	-0.255**	-0.064	0.034	1

NOTES: Panel A refers to manufacturing cartels and Panel B to non-manufacturing cartels. The clauses are not mutually exclusive, as a cartel may use many of them simultaneously. The first column in both panels reports the number of cartels using the main clause mentioned on the row. The matrices present pairwise correlation coefficients for the contract clauses. ** = significant at 1% level; * = significant at 5% level.

Table 6: Use of additional contract clauses

Panel A: Use of additional contract clauses (internal stability and external threats)

		A-1: Internal stability				A-2: External threats		
	Count	Monitoring	Enforcement	Expel	Fine	New members	Non-cart. supply	Entry
Price-based	63	0.29	0.13	**0.38**	0.17	**0.56**	0.17	0.02
Quota	19	**0.63**	**0.53**	0.16	**0.47**	0.37	0.47	0.00
Mkt. alloc.-based (excl. quota)	40	0.13	0.03	0.08	0.05	0.08	**0.75**	**0.38**
Chi2-test (p-value): Price-based vs. Quota		*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.11*	*< 0.01*	*< 0.33*
Chi2-test (p-value): Price-based vs. Mkt. alloc.-based (excl. quota)		*< 0.05*	*< 0.04*	*< 0.01*	*< 0.06*	*< 0.01*	*< 0.01*	*< 0.01*
Chi2-test (p-value): Quota vs. Mkt. alloc.-based (excl. quota)		*< 0.01*	*< 0.01*	*< 0.29*	*< 0.01*	*< 0.03*	*< 0.03*	*< 0.01*
All cartels (N = 109)		0.24	0.12	0.27	0.15	0.38	0.41	0.15

Panel B: Use of additional contract clauses (organization and production-related)

		B-1: Organization					B-2: Production-related	
	Count	Meeting	Disp. Resol.	Structure	Vote	Sales office	Technology	Efficiency
Price-based	63	0.08	0.48	**0.70**	**0.62**	**0.73**	0.06	0.03
Quota	19	0.11	**0.89**	**0.63**	**0.58**	**0.74**	0.26	**0.32**
Mkt. alloc.-based (excl. quota)	40	0.05	**0.78**	0.18	0.18	0.15	**0.60**	0.08
Chi2-test (p-value): Price-based vs. Quota		*< 0.77*	*< 0.01*	*< 0.54*	*< 0.73*	*< 0.94*	*< 0.05*	*< 0.01*
Chi2-test (p-value): Price-based vs. Mkt. alloc.-based (excl. quota)		*< 0.54*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.27*
Chi2-test (p-value): Quota vs. Mkt. alloc.-based (excl. quota)		*< 0.52*	*< 0.24*	*< 0.01*	*< 0.01*	*< 0.01*	*< 0.02*	*< 0.04*
All cartels (N = 109)		0.08	0.62	0.50	0.44	0.52	0.28	0.08

NOTES: The rows in the table for the price-based, quota, market allocation-based (excl. quota) cartels are not mutually exclusive. Panel A reports the use of additional contract clauses for internal stability and external threats and Panel B for organizational and production-related purposes. The reported numbers are means. Chi2-tests contrast different types of cartels, as defined by the main clause on the row, against each other in terms of which additional clauses the cartels use; each cell in italics reports the p-value of the Chi2 test. The cells in bold highlight how quota cartels are different from the rest of the market allocation -based cartels.

Appendices - for online publication

Appendix A: Tables summarizing the prior literature

Appendix B: Description of the data sources

Appendix C: Tables for the smaller manufacturing sample (N = 109)

Appendix D: Tables for descriptive statistics of the control variables

Appendix E: Duration analysis

Table A1, Panel A: Prior literature on cartel codes and contracts (excl. case / single industry studies)

	Posner (1970)	Hay & Kelley (1974)	Frass & Greer (1977)	Audretsch (1989)	Dick (1996)	Gallo et al. (2000)	Suslow (2005)	Taylor (2007)	Harrington (2006)	Bouwens & Dankers (2010)	Haucap et al. (2010)	Levenstein & Suslow (2011)
Period covered	1890-1969	1963-1972	1910-1972	1973-1986	1918-1965	1955-1997	1920-1939	1927-1937	2000-2004	1930-200	1958-2004	1971-2007
Type of cartels	Illegal / detected	Illegal / detected	Illegal / detected	Legal	Legal export	Illegal / detected	Semi-legal	Legal	Detected	Legal	Legal and illegal	Illegal
Sector	Manuf. & non-manuf.	Manuf. & non-manuf.	Manuf. & non-manuf.	Manuf. & non-manuf.	Manuf. & non-manuf.	-	Manuf.	Manuf.	Manuf. & non-manuf.	Mostly manufac.	Manuf. & non-manuf.	Manuf. & non-manuf.
Country/international	US	US	US	Germany	US	US	International	US	EU / Internat.	The Netherlands	Germany	International
Nationwide	38 %	22 %	-	-	-	32 %	-	-	-	-	-	-
Price -based	100% (?)	-	-	-	-	-	-	-	100 %	34 %	-	-
Pricing	Deliv. pricing: 2%, Resale prices: 7%, Pricing rules: 14%	65 %	Basing point system: 2%, RPM: 5%, Price discrim.: 7%	-	Price-setting and market allocation: 83%	-	-	Notification / filing of price changes: 34%	"Common to all" ≈ 100%	-	Illegal: 31% price-fixing, 23% bidding agreements	-
Payment rules	-	14 %	Terms and conditions: 5%	Condition & rebate cartels: 21%	-	-	-	52 %	Some cartels	Rebates and exclusive: 5%	Condition & rebate cartels: 17% (legal), 10% (illegal)	-
Market allocation -based	26 %	34%-35%	26 %	-	(see above)	-	-	-		33 %	-	80 %
Quotas	2 %	-	-	-	-	-	40 %	11 %	> 50%	2 %	(see below)	-
Area-based	15 %	-	-	-	-	14 %	40 %	-	> 30%	13 %	Illegal: 4%	-
Non-area -based	10 %	-	-	(see Panel B)	-	13 %	-	-	> 33%	Specialization: 18%	(see Panel B)	-
Other notes												
Capacity restriction	-	-	-	-	-	-	-	Restriction of capacity: 26%	Quantity fixing: > 33%	-	Quantity fixing: 14% (illegal)	-
Comment	Nearly all fix prices?, 989 cases	Overlaps with Posner data, 62 cases	Overlaps with Posner data, 606 cases	Numbers refer to average for 1983 and 1986; 321 cartels in 1986	Fractions pertain to 23 cartels, 111 cartel episodes	Same source as Posner, 688 cases	Only 18% were terminated due to antitrust indictment; 71 cartel episodes	National Industrial Recovery Act did not allow price-fixing; at most 62 cartels (66 ind. obs.)	Qualitative descriptions of 23 cases, EC decisions. The data refer to "practices"	Data here refers to 1980	863 legal and 95 illegal cartels, legal data overlaps with Audretsch data	81 cartels in US, EC or both
Sector-specific information on usage	NO	Data available, no statistics	NO	NO	NO	NO	only manuf.	only manuf.	NO	YES	NO	NO

Table A1, Panel B: Prior literature on cartel codes and contracts (excl. case / single industry studies)

	Posner	Hay & Kelley	Frass & Greer	Audretsch	Dick	Gallo et al.	Suslow	Taylor	Harrington	Bouwens & Dankers	Haucap et al.	Levenstein & Suslow
Internal stability	-	-	-	-	-	-	-	-	-	-		-
Monitoring	Exchange info: 6%	-	-	-	-	-	-	89 %	> 30%	-	-	79 %
Enforcement	-	-	-	-	-	-	-	-	Compensation: > 33%	-	-	Compensation: 33%, Punishment: 19%
Expel	-	5%-6%	12 %	-	-	-	-	-	-	-	-	-
Fine	Fine+audits: 4%	-	-	-	-	-	Penalties: 30%	-	-	-	-	-
										-		
Organization	-	-	-	-	-	-	-	-	-	-	-	-
Meeting	-	-	-	-	-	-	-	-	> 65%	-	-	-
Dispute-resolution	-	-	-	-	-	-	-	-	-	-	-	-
Structure	-	-	-	-	-	-	-	-	> 39%	-	-	-
Vote	-	-	-	-	-	-	-	-	-	-	-	-
Sales office	Trade association: 36%, Sales agent: 6%	Trade association: 31%	Trade association: 36%, Sales agent: 3%	-	Foreign sales office/agent: 57%	Intra-ind. organization: 23%	Central sales agency: 30%	-	Some cartels	-	-	Trade association: 31%
										-		
External threats	-	-	-	-	-	-	-	-	-	-	-	-
New members	-	-	-	-	-	-	-	-	-	-	-	-
Non-cartel supply	-	-	-	-	-	-	-	-	> 21%	-	-	36 %
Entry	-	-	-	-	-	-	-	-	Some cartels	-	-	-
										-		
Production-related	-	-	-	-	-	-	-	-	-	-	-	-
Efficiency	-	-	-	(see below)	Engineering: 17%	-	-	-	-	-	(see below)	-
Technology	10 %	-	10 %	-	-	-	Patent/cross-licens.: 20%	-	-	-	-	-
Other notes										-		
	-	-	-	SME-cooperation 34%, specialization 16%, rationalization 9%	Distributing and licensing: 17%, Freight, insur.: 35%, Storage facilities: 9%	-	Multi-product - cartel (scope): 40%	-	Price war threat: > 17%	-	Out of legal cartels, SME-cooperation 34%, specialization 19%, rationalization 13%	-

Table A1, Panel C: Prior literature on cartel codes and contracts (excl. case / single industry studies)

	Posner	Hay & Kelley	Frass & Greer	Audretsch	Dick	Gallo et al.	Suslow	Taylor	Harrington	Bouwens & Dankers	Haucap et al.	Levenstein & Suslow
Joint use of clauses												
Data on joint use of clauses / practices?	-	-	Limited data on joint use (Table 3, 4)	Limited data on joint use (Table 2)	-	-	Limited data on joint use (Table 3?)	Raw data, but no analysis (Table 1)	Some information	-	-	-
Contract complexity and changes												
Data contract complexity or contract changes?	-	-	-	-	-	-	-	Contract complexity measured by # of code pages; negatively associated with output growth	-	-	-	-
Duration												
Link contracts (codes, clauses or organization) to duration?	-	-	-	-	Duration positively associated with joint sales agency; negative duration dependence	-	Links 5 contract clauses to duration: Only penalties and cross-licencing significant (negative)	-	-	-	Legal cartels longer-lived	Four out of six clauses associated with duration
Information on national	0.38	Data available, no statistics	NO	NO	-	0.33	-	NO	-		NO	-
# of contract changes	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Duration (years)	7.5	NO	NO	NO	5.3	5.4	3.7	NO	Data available, no statistics	NO	6.2 illegal, 13.4 legal	8.1
# of members: mean (median)	29.1 (6-10)	7.3 (7)	16.7 (8)	NO	18.3	3.9	7.4 (4)	NO	Data available, no statistics	NO	9 (4) illegal, 10 (4) legal	7.4

Appendix B

Archive work: All the data on the cartels and their contracts is based on our archive work in the Registry and on the information available therein. The Registry contains in total 898 cartels, of which 359 are manufacturing and 539 non-manufacturing cartels. For each registered cartel, the Registry established a folder, and gave an identification number. The folder contains a concise, quite standardized written description of the cartel, drafted by the civil servants who worked for the Registry, and all the correspondence between the Registry and the cartel. The standardized descriptions contains a fair bit of information on all the cartels, including information on what they mainly agreed on (i.e., on how they tried to raise profits). The Registry also always asked for the actual cartel contract, which is in the folder if one was submitted by the cartel. The Registry maintained a listing of cartels and their primary activities and basic features, based on the standardized descriptions and the correspondence between the Registry and the cartel. The listing covered all of the registered cartels. Once a cartel was registered, basic information on it was published in the Official Journal of the Finnish government.

Data on contract clauses: The cartel listing allows us to identify whether a given cartel tried to collude by agreeing on prices, by allocating markets in one way or another, or by doing both. These data are available for all the cartels in our data. In order to understand more deeply what cartels contract on, we collected more detailed information on nationwide manufacturing cartels, and chose to include the first cartel(s) in a given 3-digit industry. We concentrate on the first cartel in each industry, because early on, the law was more lenient on what one could contract on, suggesting that the richest contracts were written for these first cartels. This resulted in us going through the folders of 109 cartels in a very detailed manner. For this, we used a semi-structured approach to collect information on 14 further contract clauses. After initial discussions on how to interpret contracts, we first randomly chose eight cartels and had four researchers go through each of them independently. We then checked for any differences

in interpretation, and decided on a common approach. We thereafter followed a written protocol with the 109 cartel contracts. We collected the information on the contract that was in force at the time of registration.[1]

Data on contract changes and cartel duration: The cartel listing allows us to calculate how many times a registered cartel contract was changed subsequently. It also contains the date the cartel was registered and when it was removed from the Registry. We use this information to measure the (approximate) duration of the cartels.

Data on (other) cartel characteristics and industry/macroeconomic variables: Besides assigning each cartel to manufacturing or non-manufacturing, we use information in the cartel listing to classify whether a cartel was nationwide or not, and to obtain a proxy for the number of members. The information on the size of the cartels is not available for all cartels. In econometric analyses, we also control for the changes in competition law, for the cohort when a cartel entered the registry, and for whether the cartel was registered right after a positive or negative GDP shock. To measure the GDP shocks, we use HP-filtered GDP and calculate the absolute values of the positive and negative shocks to GDP. The GDP data are from the Research Institute of the Finnish Economy (ETLA).

[1] It is worth noting that in terms of the form (template) of the contracts, there is no clear pattern. Thus, unlike in Austria (private correspondence with Konrad Stahl and Christine Zulehner), registrations were not done through law firms, nor was a standard template used.

Appendix C

Table C1: Descriptive statistics (N = 109, national manufacturing cartels)

		Count	Share	# of clauses	National	# of changes	Duration	Year of reg.	# of members
Price-based		**63**	**0.58**	**1.79**	**1.00**	**1.52**	**17.54**	**1963**	**7.00**
Pricing		55	0.50	1.95	1.00	1.51	17.55	1963	6.00
Payment Rules		41	0.38	2.12	1.00	1.71	17.93	1962	6.00
Market allocation-based		**58**	**0.53**	**1.66**	**1.00**	**0.69**	**12.47**	**1971**	**2.00**
Quota		19	0.17	2.37	1.00	1.47	16.79	1966	5.00
Area-based		11	0.10	2.09	1.00	0.45	14.36	1969	2.00
Non-area-based		42	0.39	1.52	1.00	0.29	10.07	1973	2.00
	All	104	-	1.62	1.00	1.04	14.69	1967	4.00
None of the above		5	0.05	0.00	1.00	0.20	13.60	1971	5.00
	All	109	-	1.54	1.00	1.00	14.64	1967	4.00

NOTES: The table uses the small sample of manufacturing cartels: The reported numbers are means, except for the number of members, where we report the median. The clauses on the rows are not mutually exclusive. Share refers to the fraction of cartels using a given contract clause. # of clauses is the count of the five main clauses. National takes the value one if a cartel is nationwide. # of changes is the number of contract changes as recorded by the Registry. Duration is the difference in years between the date of entry into and exit from the Registry. Year of reg. is the year of entry into the Registry. # of members is the number of members as recorded by the Registry or verified by us. Information on the number of members is not available for all cartels.

Table C2: Most popular combinations of main contract clauses (N = 109, national manufacturing cartels)

	Count	Share	Cum share	Pricing	Payment Rules	Quota	Area-based	Non-area-based
1st	26	0.24	0.24	0	0	0	0	1
2nd	22	0.20	0.44	1	1	0	0	0
3rd	16	0.15	0.59	1	0	0	0	0
4th	7	0.06	0.65	1	1	1	0	0
5th	6	0.06	0.71	0	0	0	1	1

NOTES: Count is the number of cartels using a particular combination of the five main contract clauses. Share is the fraction of cartels doing so. Cum Share is the cumulative sum of the shares. The remaining columns refer to the binary indicators for the individual contract clauses.

Table C3: Pairwise correlations of main clauses (N = 109, national manufacturing cartels)

	Price-based		Market allocation-based		
	Pricing	Payment Rules	Quota	Area-based	Non-area-based
Pricing	1				
Payment Rules	0.466**	1			
Quota	0.117	0.043	1		
Area-based	-0.216*	-0.197*	-0.074	1	
Non-area-based	-0.611**	-0.459**	-0.115	0.235*	1

NOTES: This table reports the pairwise correlations of the main clauses, for the smaller manufacturing sample.

Appendix D

Table D1: Descriptive statistics, control variables

Panel A: Large sample, manufacturing	Obs	Mean	Std. Dev.	Min	Max
National (1/0-dummy)	359	0.86	0.35	0.00	1.00
GDP-neg-shock (one year prior to registering)	359	0.07	0.11	0.00	0.39
GDP-pos-shock (one year prior to registering)	359	0.06	0.11	0.00	0.42
Law regime (cumulative count)	359	2.36	0.76	1.00	3.00
Cohort: 1960-1969	359	0.37	0.48	0.00	1.00
Cohort: 1970-1979	359	0.32	0.47	0.00	1.00
Cohort: 1980-1993	359	0.29	0.45	0.00	1.00
Ln(number of members)	359	1.21	0.91	0.69	6.15
Large cartel -dummy	359	0.03	0.17	0.00	1.00
Dummy for missing Ln(# of members)	359	0.18	0.38	0.00	1.00
Panel B: Large sample, non-manufacturing					
National (1/0-dummy)	539	0.55	0.50	0.00	1.00
GDP-neg-shock (one year prior to registering)	539	0.08	0.10	0.00	0.39
GDP-pos-shock (one year prior to registering)	539	0.04	0.08	0.00	0.42
Law regime (cumulative count)	539	2.17	0.75	1.00	3.00
Cohort: 1960-1969	539	0.35	0.48	0.00	1.00
Cohort: 1970-1979	539	0.40	0.49	0.00	1.00
Cohort: 1980-1993	539	0.20	0.40	0.00	1.00
Ln(number of members)	539	1.82	1.40	0.00	8.29
Large cartel -dummy	539	0.12	0.32	0.00	1.00
Dummy for missing Ln(# of members)	539	0.58	0.49	0.00	1.00

NOTES: This table reports descriptive statistics for the control variables, for the manufacturing (Panel A) and non-manufacturing (Panel B) sample. National = 1 if the cartel is nationwide; GDP-neg-shock (GDP-pos-shock) = the absolute values of the negative (positive) shocks to GDP, calculated as the difference between the realized GDP and HP-filtered GDP; Law regime = the cumulative sum of the indicators that measure the various law regimes that affected the legal status of cartels and that we explain in the main text; Cohort indicators have been formed on the basis of the year of entry to the Registry; Ln(number of members) = the logarithm of the number of members for those cartels for which the information is available, and Ln(1) for the rest; Large cartel dummy = 1 if the cartel has more than 50 members; Dummy for missing Ln(# of members) = 1 for those cartels for whom the data on the number of members are not available.

Appendix E

In this appendix, we report how cartel duration is related to initial contract characteristics.

Prior literature: There are a number of empirical studies on the durability of cartels (for a review, see Levenstein and Suslow 2006; see also Levenstein and Suslow 2011 and 2016). While various covariates have been at the center of interest (e.g., demand variability, downstream structure, concentration and the number of members), studies linking cartel organization to duration are rare. Dick (1996), Suslow (2005) and Levenstein and Suslow (2011) are the only studies known to us which link cartel contracts to durability. Dick (1996) explores US export cartels (Webb-Pomerene cartels) and finds that they were quite short-lived (median: 5.3 years) and became more likely to dissolve as they aged. He also shows that the export cartels that did not have a common sales agency and that primarily focused on fixing prices were shorter-lived. Using data on 71 inter-war international manufacturing and commodity cartels that had overt formal collusive agreements, Suslow (2005) finds that organizational variables explain a smaller fraction of the variance of cartel durability than the (measurable) economic uncertainty. She provides some evidence that the cartels that had contractual clauses for penalties (for exceeding quotas) or for technological collaboration (patent or cross-licensing provisions), or that were single-product agreements (as opposed to multi-product ones), may have had a lower probability of breaking down. Finally, Levenstein and Suslow (2011) explore durability of (recently prosecuted or dissolved) international cartels, producing mostly intermediate manufactured goods and business-to-business services. Levenstein and Suslow have data on the presence of a trade association, as well as on the use of contractual provisions for punishment, compensation, exclusion, and market allocation. They find that the use of a trade association and compensation clauses is negatively associated with cartel dissolution, whereas the use of punishment/enforcement clauses is positively related to it.

Outcome variable: Our measure of cartel duration refers to the lifespan of a cartel and is calculated as the difference between the years of entry into and exit from the registry, approximating the longevity of each cartel.[1] Table E1 shows that there is a great deal of variation in how long cartels live: The shortest cartel arrangements in our data survived for less than a year, but the most stable ones continued their operations for over thirty years. These raw data suggest that non-manufacturing cartels have had somewhat longer durations (average = 13.6 years; median = 11 years) than manufacturing cartels (average = 11.2 years; median = 9 years). These durations are longer than what is e.g. observed for the international cartels studied by Levenstein and Suslow (2011), who report a mean of 8.1 years.

[1] There is some terminological confusion in the earlier literature about the difference between durability and cartel stability (as noted e.g. by Suslow 2005), because a price war (equilibrium punishment; Green and Porter 1984) can be indicative of stability problems of a cartel but does not mean that the cartel breaks down completely

Table E1: Descriptive statistics for cartel duration

Panel A: Large sample, manufacturing (N=359)

	Duration (in years)			
	Mean	Std.dev	Min	Max
Price-based	14.14	8.86	1	33
Pricing	14.24	9.07	1	33
Payment Rules	14.38	8.76	1	33
Quota	11.60	7.85	1	32
Market allocation-based (excl. Quota)	9.38	5.97	0	34
Area-based	11.93	8.72	0	34
Non-area-based	8.83	4.96	0	33
All, manufacturing:	11.16	7.42	0	34

Panel B: Large sample, non-manufacturing (N=539)

	Duration (in years)			
	Mean	Std.dev	Min	Max
Price-based	14.02	8.49	0	34
Pricing	14.59	8.49	0	34
Payment Rules	11.47	7.89	0	34
Quota	8.87	6.25	4	26
Market allocation-based (excl. Quota)	13.10	7.60	1	34
Area-based	12.86	8.62	2	34
Non-area-based	12.98	7.53	1	34
All, non-manufacturing:	13.59	8.22	0	34

NOTES: The rows of the table refer to the main contract clauses and are not mutually exclusive. Duration is the difference in years between the date of entry into and exit from the Registry. Panel A reports descriptive statistics for the manufacturing and Panel B for the non-manufacturing sample.

Model specification: We link features of the initial contracts to cartel duration, analyzing manufacturing and non-manufacturing cartels separately. The key explanatory variables are dummies for the five main contract clauses, as well as two dummies capturing more complex cartels that used more than one *Price-based* clause and/or that used more than one *Market allocation-based* clause. We also include several explanatory variables (see Appendix D for the descriptive statistics): a measure for the geographic coverage of the cartel (dummy for the nationwide cartels), variables capturing positive and negative macro shocks at the time the cartel was registered (e.g., Green and Porter 1984, Rotenberg and Saloner 1986; we include separate variables for the absolute value of the negative and positive GDP shocks, measured one year

before the cartel was registered), a variable capturing changes in the law regime (as delineated in Section 2), and cohort dummies (1960-1969, 1970-1979, 1980-1993, with the period before 1960 being the omitted category). While acknowledging its potential endogeneity, we also include the logarithm of the number of cartel members (e.g. Stigler 1964) for those for whom this is observed, a dummy for large cartels (with more than 50 members), and a dummy for cartels for which we do not observe the number of members. We also report for both outcome variables estimation results for which the manufacturing and non-manufacturing samples are merged but in which a separate dummy for the manufacturing cartels is included.

We employ discrete time hazard rate models to study the duration of cartels (see Kalbfleisch and Prentice 1980; Allison 1982). The discrete-time hazard rate refers to the probability that a given cartel dissolves during a period, conditional on it having not dissolved by the (end of the) last period. The models we estimate explicitly allow for right-censoring of the spells (i.e., for the possibility that when the operation of the registry was ceased, some cartels were still in the register).[2] Our baseline hazard is a cubic polynomial in time. It hence allows for both positive and negative duration dependence, as well as for non-linearity. This flexibility is important, because prior work on cartel duration has found that cartels may become more or less stable with age.

Empirical findings: We display the results of the hazard model estimations in Table E2: The estimation sample(s) and the explanatory variables are the same as those used in Table 8 of the main text, the only difference being that we also add to the vector of control variables a time-varying variable that captures the cumulative number of past contract adjustments. We include this new variable for two reasons. First, it links explicitly the analyses of contract ad-

[2] We use the complementary log-log hazard function model which corresponds to a continuous time proportional hazard model.

justments and cartel duration. Second, and more importantly, it allows us to explore the previously overlooked question of whether those cartels which adjust their collusive agreements dynamically are longer-lived.

Table E2 provides us with two main results: First, consistent with the observations made by Suslow (2005), contract clauses are only weakly associated with the durability of cartels in manufacturing (columns 1-2). The results are however quite different for the non-manufacturing cartels (columns 3-4), where *Payment rules* -clauses and the dummy for cartels with more than one *Price-based* clause carry positive and significant coefficients. Cartels having such pricing clauses can therefore be predicted to be shorter-lived. Second, we find that making more adjustments to initial agreements is associated with longer duration. Using the estimates of column (5), we can predict that the probability of a cartel breaking down in a given year, conditional on it having survived so far, is nearly 1.5 times higher for those cartels that have made no adjustments, as compared to those who have made two adjustments. As we also mention in the main text, this finding is broadly consistent with theoretical models and empirical analyzes that stress the importance of communication for stability and efficient working of explicit collusion (e.g. Athey and Bagwell 2001, 2008, Genesove and Mullin 2001, Harrington 2006, Harrington, and Skrzypacz 2011, Harrington, Hernan-Gonzalez, and Kujal 2014, Cooper and Kühn 2014, Clark and Houde, 2014).

It is also worth pointing out that consistent with the raw data, manufacturing cartels have a higher hazard of breaking down (see column 5).[3] Moreover, like Dick (1996), we find a monotonically increasing hazard rate (negative duration dependence): Using the estimates from column (5), we find that for the non-manufacturing cartels, the probability of a cartel breaking

[3] Two additional observations are in order: First, Levenstein and Suslow (2011) find that market allocation cartels are less likely to be broken up by antitrust enforcement, but find no effect on "natural death" of cartels. Consistent with this, we find that the *Market allocation–based* clauses carry, in general, insignificant coefficients both in manufacturing and in non-manufacturing. The only exception to this is the *Area-based* clause, for which the coefficient is significant and negative in the combined sample. Second, we find that larger non-manufacturing cartels, as measured by the number of members, are longer lived. As the prior work has stressed, this finding is hard to interpret, as it may mirror many things; indeed, the empirical evidence is quite mixed. For example, Levenstein and Suslow (2011) find no effect of cartel size on duration. For our manufacturing cartels, the same result applies.

down after three years is 3%, conditional on it having survived the first two years. After 15 years, the conditional probability is 7%. The corresponding conditional probabilities for the manufacturing cartels are higher, 4% and 10%, respectively. These findings mean that conditional on having survived so far, the probability of a cartel continuing is decreasing over time.

Table E2: Duration of cartels (discrete time hazard rate model)

Sample:	Manufacturing (N = 359)		Non-manufacturing (N = 539)		Combined (N = 898)
	(1)	(2)	(3)	(4)	(5)
Pricing	-0.065	-0.269	-0.065	0.074	-0.123
	(0.229)	(0.253)	(0.178)	(0.181)	(0.140)
Payment Rules	0.302	0.010	0.860**	0.825**	0.540**
	(0.263)	(0.306)	(0.214)	(0.211)	(0.175)
Many price-based clauses (> 1)	-0.116	-0.389	0.701**	0.701**	0.482**
	(0.235)	(0.260)	(0.207)	(0.207)	(0.181)
Quota	0.173	0.075	0.391	0.241	0.143
	(0.202)	(0.198)	(0.610)	(0.680)	(0.187)
Area-based	-0.058	-0.449	-0.604	-0.711	-0.650*
	(0.376)	(0.426)	(0.528)	(0.533)	(0.304)
Non-area-based	-0.053	-0.294	0.009	-0.133	-0.245
	(0.238)	(0.243)	(0.172)	(0.175)	(0.138)
Many mkt-alloc. based clauses (>1)	0.229	0.020	0.111	-0.295	-0.077
	(0.283)	(0.302)	(0.375)	(0.466)	(0.238)
National (1/0-dummy)	0.405	0.327	0.022	-0.262	-0.022
	(0.250)	(0.248)	(0.126)	(0.135)	(0.112)
GDP-neg-shock (one year prior to registering)	1.031	1.209	1.418	1.071	1.042*
	(0.708)	(0.707)	(0.733)	(0.730)	(0.504)
GDP-pos-shock (one year prior to registering)	0.434	0.557	1.334*	1.283	0.833
	(0.738)	(0.744)	(0.620)	(0.673)	(0.494)
Law regime	-0.206	-0.311	0.266	0.153	-0.033
	(0.154)	(0.168)	(0.141)	(0.143)	(0.106)
Cohort: 1960-1969	0.415	0.282	0.528	0.562	0.438
	(0.303)	(0.357)	(0.341)	(0.350)	(0.259)
Cohort: 1970-1979	1.262**	1.105*	0.033	0.567	0.745*
	(0.394)	(0.433)	(0.413)	(0.418)	(0.306)
Cohort: 1980-1993	1.187*	1.089*	0.640	1.029*	0.940**
	(0.493)	(0.527)	(0.468)	(0.482)	(0.358)
Cumul. number of contract changes	-0.166	-0.131	-0.254**	-0.303**	-0.203**
	(0.098)	(0.091)	(0.076)	(0.079)	(0.062)
Ln(number of members)		-0.165		-0.579**	-0.348**
		(0.095)		(0.114)	(0.072)
Manufacturing dummy					0.366**
					(0.126)
Manufacturing dummy*Many price-based clauses					-0.580**
					(0.223)
Auxiliary control variables	Yes	Yes	Yes	Yes	Yes
Number of cartels	359	359	539	539	898
Cartel-year observations	4,010	4,010	7,329	7,329	11,339
Joint-test of the baseline hazard variables	0.000	0.000	0.000	0.000	0.000
Joint-test for price-based clauses (p-value)	0.000	0.000	0.000	0.000	0.000
Joint-test for mkt-alloc-based clauses (p-value)	0.740	0.470	0.773	0.601	0.089

NOTES: The auxiliary control variables are a dummy for cartels with more than 50 members and a dummy for cartels for which we do not observe the number of members. The model is a discrete time hazard rate model, with proportional hazard (cloglog) and estimated by maximum likelihood. Standard errors are clustered at birth-year level, with * = significant at 5% level, ** = significant at 1% level. Combined sample merges the manufacturing and non-manufacturing samples.