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Duration of Norwegian Cartels

What influenced the duration of the legal Norwegian cartels in the period 1957-1991?

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Abstract

In this thesis I study the duration of cartels using data on 191 legal manufacturing cartels that was registered in the Norwegian Cartel Registry between 1957 and 1991. I find that the Norwegian manufacturing cartels typically were quite small and that they more often cooperated through price-based mechanisms rather than market allocation-based ones. Cartels that use quotas or exclusive territories lasted longer than cartels that fixed prices. Economic fluctuations are found to influence the duration of a cartel with negative deviations from trend GDP increasing the probability of a cartel breaking up while positive deviations from trend reduces it. The use of common sales offices are found to be positively related to the durability of cartels.

Thesis structure

This thesis starts with an introduction where I state the motivation for my thesis and summarize my results. In the second section I look at what a cartel is and how cartels operate. Section 3 provides a brief summary of the development of the legal framework concerning cartels in Norway, from the trust-law of 1926 to the modern competition law of 1993. I then look at the previous research that has been made on the subject and summarize the results most relevant to this thesis in section 4. In section 5 I explain how the data was collected and show some examples of what kind of entries the cartel registry contains. I present some descriptive statistics for the selected sample in section 6. The methodology behind and the specifications of the different regression models used in my analysis is presented in section 7, before the results are discussed in section 8. I conclude and look at possible improvements and future research in section 9.

Contents

1. Introduction

Throughout history many firms have been tempted to raise their profits by abandoning competition with their rivals in favor of cooperation through cartels. Some cartels have been quite successful in raising prices, and thus profits, for the producers and have lasted for a long time, while others quickly dissolved as they failed to benefit their members. Economist have tried to analyze what determines the success of a cartel for a long time, but limited data on the subject have made it difficult to answer fundamental questions such as: What is the most common way for cartels to cooperate? Is price fixing more common than market allocation, or the combination of both? How does the different modes of cooperation influence the duration of the cartels?

In order to answer these questions one would need detailed information on a large number of cartels that preferably existed during the same timeframe and who faced a common legal regime. By coding the Norwegian cartel registry, which contains information on all legal cartels that existed in Norway between 1957 and 1991, I have been able to generate a data set where this holds true. The advantage of studying legal cartels is that they share many of the same incentives regarding how to cooperate and organizational structure as illegal cartel and thus their contracts thus serve as good examples of what kind of contracts that illegal cartels would like to write down if it didn't increase their chance of being caught.

Of the previous research on the subject only Hyytinen, Steen and Toivanen (2016) have analyzed similar data. Other earlier studies have faced drawbacks either through limited data on the method the cartels use to cooperate, or because the cartels included in the same study existed at different times or in different countries where the law regimes where different. My thesis follows the structure in Hyytinen, Steen and Toivanen (2016), using the Norwegian cartel data.

I have collected data on 790 cartels in total, and in this thesis I take a closer look at the 191 horizontal cartels that operated on a national level in the manufacturing sector. I find that the Norwegian manufacturing cartels mainly used price-based modes of cooperation. Something which sets the Norwegian manufacturing cartels apart from the Finnish manufacturing cartels studied in Hyytinen, Steen and Toivanen (2016). I find, in line with evidence from the legal Finnish manufacturing cartels (Hyytinen, Steen and Toivanen 2016) and international manufacturing cartels that operated in the inter-war period (Suslow, 2005), that the typical

manufacturing cartel is quite small with a median of only five members. Furthermore, price-based cartels have more members than the market allocation based ones which is consistent the Finnish results (Hyytinen, Steen and Toivanen 2016).

I use a discrete time hazard rate model to study how the initial characteristics of a cartel, and external factors such as the development of the Norwegian economy and law regime, influence the cartels durability. My results indicate that that the use of market allocation-based cooperation significantly increases the duration of cartels while the same is not true for price based cooperation. Furthermore, in line with the legal US Webb-Pomerene cartels (Dick, 1996), I find indications that cartels which cooperate by area-based means or by setting quotas seem to last significantly longer than those who fix prices. Complex market allocation-based cartels are also found to last longer than complex price-based ones. My results also suggest that cartels which use common sales offices last longer than those who don't.

As for the external factors, previous studies have found evidence both supporting (Suslow, 2005), and dismissing (Levenstein & Suslow, 2011) the theory that the developments of the general economy influences the duration of cartels. My results suggests that there indeed exists such a link as I find that cartels have a higher chance of breaking up when the economy is performing badly, and that the opposite is true when the economy is booming. On the other hand, I find no indications that the development of the Norwegian law regime from 1957-1991 increased the likelihood of a cartel breaking up.

2. Why do cartels exist and how do they cooperate?

In this section I will explain what lies behind the term "cartel", look the main ways cartels use to raise profits and explore why cartels break up.

2.1 What is a cartel?

The word cartel, from German *Kartell*, was originally used to refer to a coalition of political parties in late 19th century Germany, but from the early 20th century the term has been used to refer to businesses who cooperate with the purpose of exerting some form of restrictive or monopolistic influence on the production or sale of a commodity. While the term might be relatively new cartel-like organizations have existed since the Middle Ages (Encyclopædia Britannica, 2015). Some of the most famous historical cartels include the Phoebus cartel that together with General Electric controlled three fourths of the light bulb market between the 1920s and the Second World War, the lysine cartel of the mid-1990 that aimed to raise the price of the animal feed additive lysine, and the still existing oil cartel OPEC.

Basic economic theory tells us that in a free market with many small producers a single price will exist that only covers the costs of the producers and thus yields no profits to the producers. On the opposite end of the scale is a monopolistic market where there exists only one producer who is free to set the price of the product such that its profit is maximized. In practice the market of most goods lies somewhere between a free market and a monopolistic market and the goal of a cartel in general is to increase the profits of its members by changing the characteristic of the market it operates in from a free market to a monopoly. There are many different ways the members of a cartel can cooperate in order to achieve this goal.

2.2 How do cartels cooperate?

In this thesis I differentiate between price-based and market allocation-based modes of cooperation. The most obvious mode of price-based cooperation involves the cartel members agreeing to sell the product at a common fixed price that would be higher than the price they could obtain if they were to compete. If the cartel members controls all of the production of a good they could in theory set the price equal to the price a monopolist would set and they would share the maximum theoretical profit. Other modes of price-based cooperation include coordinating what kind of discounts to apply and payment conditions.

Market allocation-based modes of cooperation include quotas, area-based cooperation and a number of non-area-based modes such as product specialization or non-compete clauses.

Quotas can be used to limit how much each member is allowed to produce or sell in a certain market and thus increase the price of the product as the total supply is lower. OPEC is an example of a cartel that has successfully used production quotas to influence the price of a good. In the period of 1973-1974 the oil price quadrupled following production cuts agreed upon by OPEC members.

Area-based cooperation entails that the cartel members agree on territories where only one member is allowed to sell the product. This results in each cartel member effectively becoming a monopolist in a local market given that there is no non-cartel supply. This can be seen as an extreme variant of Quotas where each member is given the entire quota for a region. Typically each member is given exclusive rights over what is considered their home-market. This principle was used by the choline chloride cartel that existed in the 1990s. The cartel consisted of both European and North American members and it was agreed that the North American members would stop exporting to Europe and vice versa (Harrington, 2006).

Of the Non-area-base modes I will focus on the two most relevant to this paper, product specialization and non-compete clause. Product specialization is when the members of a cartel agree that they each will have exclusive right to produce a certain product. An example could be a cartel that consists of two members who both produce shovels and buckets. If they were to come to an agreement that stated that one member should start exclusively producing buckets while the other member exclusively produces shovels, they would each end up as a monopolist in their respective market given no non-cartel supply. Non-compete clauses on the other hand are typically quite vague and only states that the members of the cartel should not actively compete with each other.

2.3 Why do cartels break up?

Now that I've looked at different ways cartels operate and how the members benefit from the different modes of cooperation it's is time to explore why the cartels break up. Generally cartels either naturally break up by themselves, or they are forcefully dissolved by the government. Economic theory tells us that while the cartelization of a market might benefit the members of a cartel, society as a whole stands to lose due to the deadweight loss inherent in monopolistic markets. The increased profits of the producers come directly out of the pocket of the consumers who have to pay more due to an increased price, and a deadweight loss will appear as a result of the lower quantity sold. As a result of this cartels are illegal in

most countries today. I will take a loser at the development of cartel legislation in Norway, and the difference between legal and illegal cartels in the next section.

As for why cartel break up on their own Levenstein & Suslow (2011) introduces the following constraint to analyze how cartel members sustain collusion in a market with identical price-setting firms with perfect information:

$$\sum_{t=0}^{\infty} \delta^t \pi^i\left(p_{i,t}^M, p_{-i,t}^M\right) > \pi^i\left(p_{i,0}^D, p_{-i,0}^D\right) + \sum_{t=0}^{\infty} \delta^t \pi^i\left(p_{i,t}^C, p_{-i,t}^C\right)$$

$p_{i,t}^M$ is the cartel price charged by firm i in period t

$p_{i,t}^D$ is the price charged by firm i if it were to defect from the cartel

$p_{i,t}^C$ is the price charged by firm i in period t in the equilibrium following the defection

π^i is the profit of firm i in a single period

$-i$ indicates firm other than firm i

$\delta^t = e^{-r\tau}$ is the discount factor in period t

r is the instantaneous rate of interest

τ is the real time between periods

The left hand side of the constraint shows the value for firm i of being a loyal member of the cartel, while the right hand side shows the value of cheating by charging a lower price than the cartel has agreed upon. As long as the members are sufficiently patient, high δ^t, and the difference between the value of being a loyal member and cheating is large, the cartel will last. To put is simply cartels will last as long as it is profitable for the firms to stay loyal to the cartel.

The first thing the model tells us is that the stability of the cartel is dependent on the discount rate. The cartel might be stable at a discount rate above some critical level, but unstable if it were to fall below this level. This tells us that unexpected increases in the interest rate could destabilize the cartel (Levenstein & Suslow, 2011).

The second is that the value to break out of the cartel is dependent on what happens to the price once a member has cheated. In this model the remaining members of the cartel would

know immediately when a member cheats and they can punish the cheater by engaging in a price war and thus lowering the cheaters profit in the equilibrium following the defection.

By applying the same framework to a world with imperfect information one could imagine that a low realization of demand due to an unexpected general decline in the economy might lead to the cartel breaking up as the members of the cartel might believe that the fall in demand stems from a cheating member.

3. A brief history of Norwegian cartel legislation 1920-1994

In this section I will summarize the history of Norwegian cartel legislation with a focus on the period the cartel registry existed

3.1 The trust law of 1926

As the first country in Europe, Norway introduced legislation targeting cartels abuse of market power with the temporary price law of 1920. The law introduced, among other things, a compulsory registration of restrictive business arrangements and dominant enterprises as well as of subsidiaries of cartels or dominant companies in other countries (Espeli, 2002). In 1926 the legislation was made permanent when the parliament passed the so-called trust law. While cartels were accepted, a new state agency by the name of "Trustkontrollen" was created and all private agreements regulating competition where to be reported to it. The agency would determine whether the agreements were for the good of the general society, while another state agency by the name of "Truskontrollrådet" was given judicial authority to intervene if deemed necessary (Sandvik & Storli, 2011).

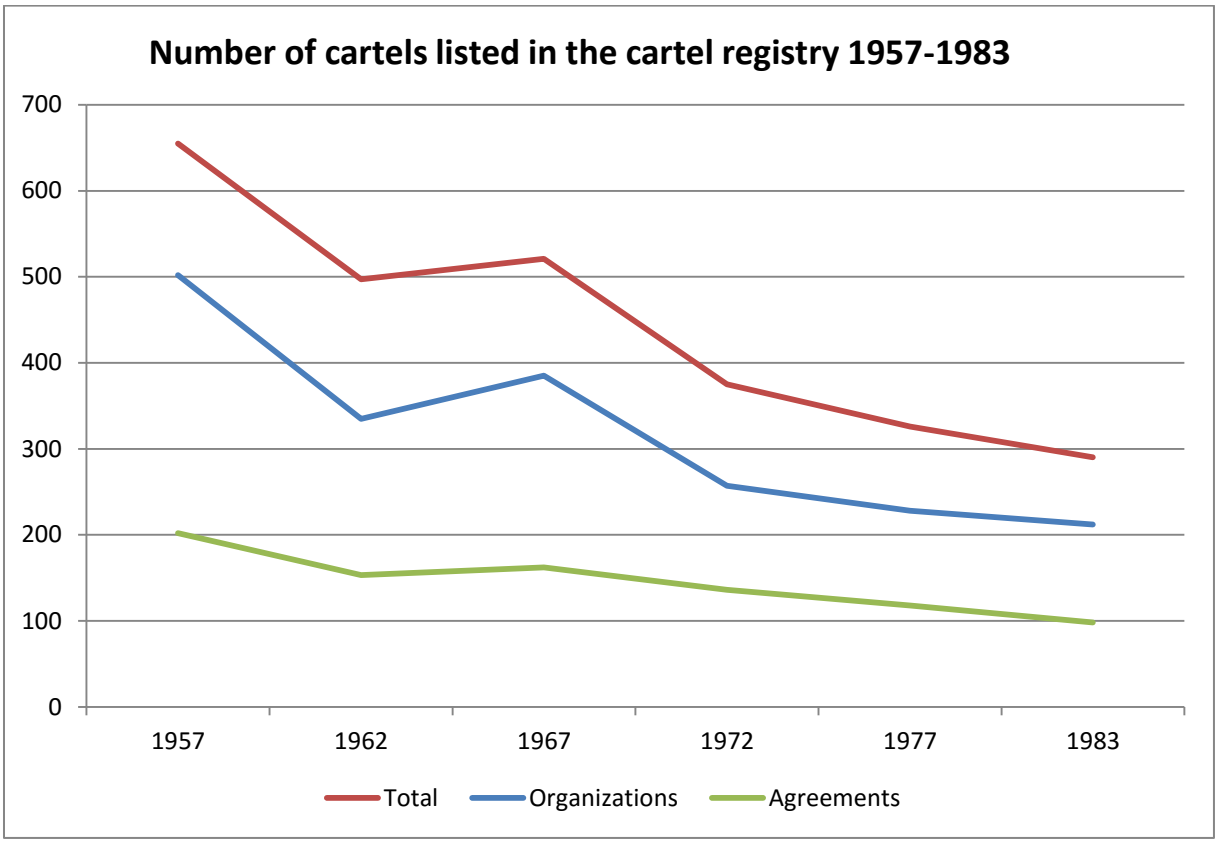
Together with Germany who introduced legislation in 1923, Norway was alone in regulating competition in Europe until the depression of 1930/31. The depression led only to a few minor revisions in the trust law with one notable exception. In 1932 the law was appended to allow for mandatory minimum prices, which in the seven cases it was applied during the 1930s in practice amounted to forces cartelization. At the time Norwegian authorities where quite positive towards domestic cartels and the law was mainly utilized to minimize foreign cartels or trusts' influence on the domestic market.

3.2 The price law of 1954

The trust law of 1926 was finally replaced by the so-called price law in 1954. The law introduced the so called cartel registry which was to contain information about all cartels operating in Norway. Registration was mandatory and cartels that did not comply where considered illegal. The registry was first published in 1955 by "Prisdirektoratet", a state agency which replaced "Truskontrollrådet" during the 2. World War. Seven years before similar legislation was introduced in the U.K and the Netherlands, a disposable ban on vertical price agreements was added to the price law in 1957. At that time Sweden and Denmark had similar legislation in place, but the Norwegian ban was unique in that it was enforced to a much higher extent than in the neighboring countries. A similar ban on

horizontal price agreements was introduced in 1960; however it was quickly undermined through political pressure and the governments liberal exemption practice (Espeli, 2004).

Figure 1



This would mark the start of a 28 year period where the Norwegian legislation would gradually fall behind other nations. During this period the autonomy of "Prisdirektoratet" was greatly challenged by the elected government. The government even introduced an exemption to the price law in 1966 where certain forms of cartels no longer needed to report to "Prisdirektoratet". Not until 1988, when a new provision to the price law imposed controls on mergers, did the Norwegian government start to get tougher on cartels again. Based on the recommendations of a government appointed committee ("The Ryssdal commite") Norway finally got a modern competition law in June 1993. The new law finally banned all forms of cartels and as a result the cartel registry was abolished. "Prisdirektoratet" was renamed "Konkurransetilsynet" and tasked with enforcing the new law.

4. Previous research

In this section I will briefly discuss the main results of previous research that are relevant to my thesis and look at what separates legal from illegal cartels. I will first look at Levenstein & Suslow (2006) as it sums up the results of a wide variety of early studies on cartels. Secondly I will look at Dick (1996), Suslow 2005, Levenstein & Suslow (2011) as they are modern studies which utilize similar methodology and yield results comparable to my own. Thirdly, I take an in depth look at the results of Hyytinen, Steen and Toivanen (2016) as my methodology is based on that paper, and their data on Finnish cartels is collected in the same way as my data on Norwegian cartels. I finally look at the difference between leg and illegal cartels.

4.1 Levenstein and Suslow (2006)

In a 2006 article Levenstein and Suslow review a wide variety of previous empirical studies of cartels to see, among other thing, how long they can last and what makes them break up. They find that while some cartels last less than a year, the median duration of cartels in the 21 reviewed studies is 5-6 years. When it comes to stability they find that cartels in industries that are concentrated tend to be more stable, but that cartels that operate in less concentrated industries can maintain stability by forming industry associations. Furthermore they find that fluctuations in the economic environment such as demand instability undermines cartel stability.

4.2 Dick (1996)

As far as I am aware Andrew R. Dick, in an article published in 1996, was the first to link cartel contracts to durability by using a regression model based on survival methodology. He analyzed 111 legal cartel contracts that were formed following the Webb-Pomerene Export Trade Act which granted antitrust immunity to exporters to form industry cartels for overseas trade. He finds that Webb-Pomerene cartels were relatively short-lived on average with a median duration of 5.3 years and that the cartels did not tend to grow more stable with experience or age. The results from his regression model suggests that cartels that have a common sales agency tended to live longer while cartels that mainly focus on fixing prices where shorter-lived.

4.3 Suslow (2005)

A 2005 article by Valeria Suslow looks at the cartel contract duration of 71 international manufacturing and commodity cartels that existed between 1920 and 1939. Using a

combination of available industrial production indices and GNP data for each country she explores how economic activity affects cartel duration. She uses a Cox model to show that economic activity below trend before the breakup of a cartel is associated with greater chance of cartel failure. Her results also indicate that cartels with lifespans that coincide with growth periods last longer than those that do not coincide with growth periods. Furthermore she finds that the level of economic uncertainty is significantly and inversely correlated with cartel duration and that organizational variables explain much less of the variation in cartel stability than economic uncertainty.

4.4 Levenstein & Suslow (2011)

Levenstein and Suslow looks at the impact of organizational features, macroeconomic fluctuations and industry structure on cartel duration in a 2011 article. Their sample consists of 81 international cartels that were found by either the United States or the EC to have engaged in collusion since 1990. Using two proportional hazard models, one looking at natural deaths and the other looking at deaths by antitrust, they find that cartels that use market allocation mechanisms were significantly less likely to be broken up by authorities, but that it has no significant impact on the probability of natural death. The also find that while active use of a trade organization significantly decreases the probability of natural death, the opposite is true for death by antitrust. When looking at possible macroeconomic effects they find that deviations from trend GDP might increase the likelihood of breakup by a very small amount, but none of the results are statistically significant.

4.5 Hyytinen, Steen and Toivanen (2016)

In a 2016 study Hyytinen, Steen and Toivanen looks at how cartels try to raise profits, how they maintain compliance and which cartels that remain stable. By looking through the Finnish Competition Authorities archive on cartels they gathered information on 359 manufacturing and 539 non-manufacturing cartels that existed between 1958 and 1993. As in Norway cartels were legal in this period as long as they reported the details of their agreements to the Finnish authorities.

The study first looks at how cartels raise profits, and whether the method depends on the sector in which the cartels operate. They find that manufacturing and non-manufacturing cartels in general tend to be quite different. Firstly, market allocation-based cartels are more popular in manufacturing, used by 73% of all cartels, while price-based cartels are more popular in non-manufacturing where it is used by 78% of all cartels. Secondly, manufacturing

cartels mainly operate on a nationwide scale, while non-manufacturing cartels more often are regional or local. Thirdly the market allocation based manufacturing cartels have fever main clauses than price-based ones, while it is the opposite when it comes to non-manufacturing cartels. They also find that market allocation-based cartels in general tend to have a lower amount of member than price based-cartels.

The authors also look at combinations of the main contract clauses and how they are correlated. They show that for manufacturing cartels the price-based clauses are positively correlated with each other, while market allocation-based clauses are negatively correlated. However when it comes to non-manufacturing cartels the correlation patterns are weaker and in the case of price-based clauses even reversed.

The second part of the study the authors explore which contracting features are used to pursue compliance and stability and whether their use depends on the adopted main clauses. By looking at a subset of 109 manufacturing cartels for which the authors have obtained information on additional contract clauses they find that *Quota* cartels typically use a richer set of contract clauses than other types of cartels and in this respect more closely resemble the price-based cartels rather than the remaining market allocation-based cartels.

In the final part of the study the authors try to measure if certain initial contracting features require more adjustment and whether some of them are associated with longer-lived cartels. They use two different regression models; the first is a Poisson-regression which uses the number of contract changes during the lifetime of a cartel as its dependent variable; the second is a discrete time hazard rate model that uses cartel duration as its dependent variable. Both models utilizes roughly the same independent variables including main contract clauses, positive and negative GDP shocks one year prior to registering, law regime and 10-year cohorts. The models are run separately for samples manufacturing and non-manufacturing cartels as well as for a sample including all cartels.

The Poisson-regression yields three main findings; price-based contract clauses positively affect the number of contract changes; *Quota* cartels and cartels with more than one market allocation-based clause have more contract changes than others; larger and nationwide cartels also tend to have more contract changes. The predicted number of contract changes actually increases by as much as 90% for Quota cartels.

The hazard model provides two main results: contract clauses are only weakly associated with the durability of manufacturing cartels, and cartels that make more adjustments to their initial agreements are less likely to break down. However the second result is only statistically significant for the non-manufacturing and the combined sample. The estimated effect is still positive, but not statistically significant for the sample that only includes manufacturing cartels. They also find that the hazard rate increases with time, which means that is the longer a cartel has lived the higher the odds it will break down.

4.6 Legal vs. illegal cartels

As my summary above shows research has been done on both legal and illegal cartels. While it would be wrong to simply assume that legal and illegal cartels are identical, one can argue that they should be quite similar seeing as they share the same motivation to raise profit and face similar organizational issues. For example, the cartels analyzed in this thesis might have been legal, but they could not rely on the government to enforce their contracts. Thus they face the same challenges as illegal cartels do with regards to enforcing the collusion.

The advantage of studying legal cartels is that they, in contrast to illegal cartels, do not need to conceal their behavior. Illegal cartels are incentivized do their utmost to conceal the details of their contracts from the authorities, which in turn make it hard to gather detailed data on how they collude. Legal cartels on the other hand are free to write down the details of their collusion as they do not need to fear legal action from the authorities. Thus the cartel contracts of the legal cartels studied in this thesis can be thought of as the kind of contracts illegal cartels would have liked to have written, given that they didn't face a higher risk of getting caught if they did.

5. Data

In this section I will first explain how the data was collected from the cartel registry before I give some concrete examples of some of the different types of cartels recorded in the registry.

5.1 How the data was collected

The dataset used in this thesis consists mainly of data collected by myself from the Norwegian Cartel Registry, which was published eleven times between 1955 and 1991 by "Prisdirektoratet". The data collection was part of a larger international cartel project financed by the German Research Foundation SEEK with partners from Finland, Germany, Austria and Sweden. The dataset is coded in accordance with the rules set in the project, but accommodated to the Norwegian Cartel Registry.[1]

Each cartel registry contains information on all legal Norwegian cartels that existed at the time of its publication. The first publication of the cartel registry in 1955 differs a bit from the later publication in that it doesn't provide as much information about each cartel and that the information is presented in a different way. Because of this inconsistency the dataset only contains data collected from the registries published after the 1955 registry.

The second cartel registry was published in 1957, only two years after the first one. However between 1957 and 1988 the cartel registry was published every five years, with the exception of the 1983 registry which was published six years after the 1977 registry. In the period between each publication "Prisdirektoratet" would regularly publish addendums to the cartel registry which contained information about changes to the existing cartel agreements and information about new cartel agreements. The addendums are also the only places where it was specified if a cartel had seized to exist. While only two addendum was published between the 1957 and 1962 registry, the general rule would become that three addendums where published in the period between two registries.

Following the 1988 publication the registry was published yearly until the 1991 registry which would become the last registry to be published. The information contained in the 1988-1991 registries were largely consistent with the previous publications with the exceptions that they don't provide summary statistics about the total number of cartels in the registry, or information about how the cartels punish members who don't abide by the rules.

[1] SEEK: Strengthening Efficiency and Competitiveness in the European Knowledge Economies, is a research programme run by the German research centre ZEW. See http://seek.zew.eu/seek/home.html

The cartel registry categorizes all its entries as either agreements or organizations. The information contained in both types of entries is fairly similar so this thesis will not distinguish between the two and refer to both as cartels. Each cartel is further categorized based on the type of industry its members do business in. Information on cartels from all categories except, *agriculture*, *fishing*, *publishing*, *banking* and *other services* have been included in the dataset. *Agriculture*, *fishing* and *publishing* has been excluded due to the high level of government intervention in these industries in Norway, while *banking* and *other services* was excluded because this thesis only looks at firms in the manufacturing sector.

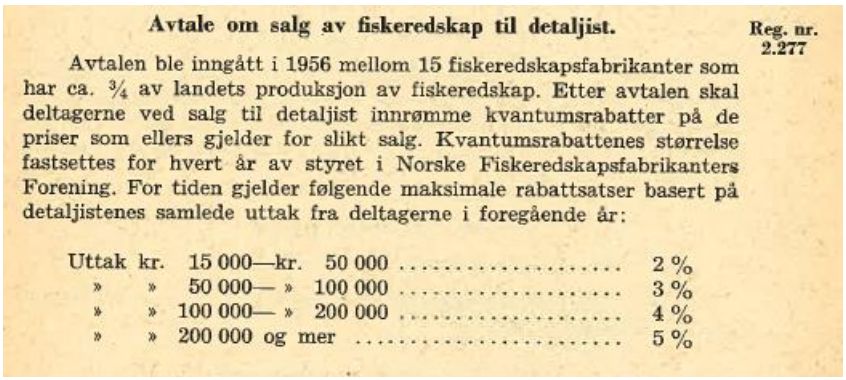
In general each entry in the cartel registry states when the cartel agreement was established, the number of members at the time of the publication, which product(s) it concerns and in what way the members cooperate. However, the entries vary a great deal with regard to the amount of detail it provides for each agreement. Some entries span several pages and include detailed descriptions of the different aspects of the agreements, while others are only a couple of lines long and only cover the bare minimum. This is probably due to the fact that some forms of cartels simply requires less details to be specified, or that some cartels simply chose to have a simpler cartel structure.

When collecting data from the cartel registry each entry with a unique registration number has been assigned a contract identification number. This is so that it is possible to distinguish between multiple agreements within the same cartel. However, there were very few cases where a cartel was found to have multiple agreements. For all contracts the number of members it applies to, the year of publication of the cartel registry the information is based on, the year the contract was formed and other general information is recorded. Furthermore each contract is given certain characteristics using binary variables based on the information in the cartel registry. These characteristics vary from the method they used to collude, to how the members solve disputes. Further information on all variables collected from the cartel registry and how they were recorded see Appendix 2.

5.2 Example cartels

5.2.1 Payment rules

Figure 2



Avtale om salg av fiskeredskap til detaljist. Reg. nr. 2.277

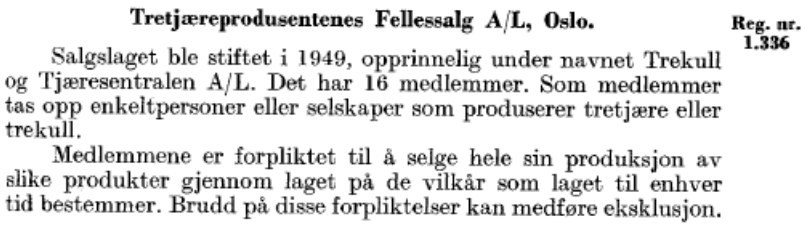
Avtalen ble inngått i 1956 mellom 15 fiskeredskapsfabrikanter som har ca. ¾ av landets produksjon av fiskeredskap. Etter avtalen skal deltagerne ved salg til detaljist innrømme kvantumsrabatter på de priser som ellers gjelder for slikt salg. Kvantumsrabattenes størrelse fastsettes for hvert år av styret i Norske Fiskeredskapsfabrikanters Forening. For tiden gjelder følgende maksimale rabattsatser basert på detaljistenes samlede uttak fra deltagerne i foregående år:

Uttak kr.	15 000—kr.	50 000	2 %
» »	50 000— »	100 000	3 %
» »	100 000— »	200 000	4 %
» »	200 000 og mer	.....	5 %

Figure 2 shows an entry in the 1958 addendum to the 1957 cartel registry. The entry states the details of a cartel agreement between 15 producers of fishing tools that was established in 1956 and first recorded in the 1958 addendum to the 1957 cartel registry. There is no mention of the cartel in the 1962 cartel registry and thus it is assumed to have broken up in 1961. The agreement entails that the members will admit no more than a specified discount when selling to retailers. As the discount varies with the amount sold, and is valid for a certain sales channel the cartel has been given the following characteristics: quantity discounts = 1, sales channels discounts = 1. For the purpose of my analysis this cartel is treated as under risk of breaking up from 1958 to 1961, that is from the year it was first observed until it is assumed or observed to have broken up.

5.2.2 Pricing and payment rules

Figure 3



Tretjæreprodusentenes Fellessalg A/L, Oslo. Reg. nr. 1.336

Salgslaget ble stiftet i 1949, opprinnelig under navnet Trekull og Tjæresentralen A/L. Det har 16 medlemmer. Som medlemmer tas opp enkeltpersoner eller selskaper som produserer tretjære eller trekull.

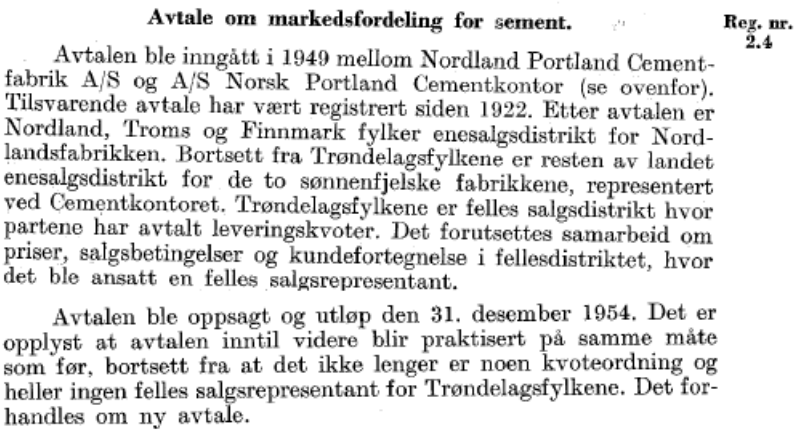
Medlemmene er forpliktet til å selge hele sin produksjon av slike produkter gjennom laget på de vilkår som laget til enhver tid bestemmer. Brudd på disse forpliktelser kan medføre eksklusjon.

Figure 3 shows the entry of “Tretjæreprodudusentenes Fellessalg” in the 1957 cartel registry. The cartel was established in 1949, but was first registered in 1957. As there are no further records of the cartel in the registry it is assumed to have broken up in 1961. In 1957 the cartel consisted of 16 companies or persons who produced wood tar or charcoal. The entry states

that cartel was organized as a sales office that the members where obligated to sell all of their produced wood tar and charcoal through according to terms set by the sales office. It is also stated in the entry that any member who breaks the agreement can be excluded from the cartel. While the entry doesn't specify what terms the sales office set it seems reasonable to assume that it amounts to price fixing and payment conditions. Thus the cartel has been given the following characteristics: fixed price = 1, payment conditions = 1, exclusive joint sales company = 1 and exclusion = 1 and is treated as under risk of breaking up from 1957 to 1961.

5.2.3 Area-based

Figure 4



Avtale om markedsfordeling for sement. **Reg. nr. 2.4**

Avtalen ble inngått i 1949 mellom Nordland Portland Cementfabrik A/S og A/S Norsk Portland Cementkontor (se ovenfor). Tilsvarende avtale har vært registrert siden 1922. Etter avtalen er Nordland, Troms og Finnmark fylker enesalgsdistrikt for Nordlandsfabrikken. Bortsett fra Trøndelagsfylkene er resten av landet enesalgsdistrikt for de to sønnenfjelske fabrikkene, representert ved Cementkontoret. Trøndelagsfylkene er felles salgsdistrikt hvor partene har avtalt leveringskvoter. Det forutsettes samarbeid om priser, salgsbetingelser og kundefortegnelse i fellesdistriktet, hvor det ble ansatt en felles salgsrepresentant.

Avtalen ble oppsagt og utløp den 31. desember 1954. Det er opplyst at avtalen inntil videre blir praktisert på samme måte som før, bortsett fra at det ikke lenger er noen kvoteordning og heller ingen felles salgsrepresentant for Trøndelagsfylkene. Det forhandles om ny avtale.

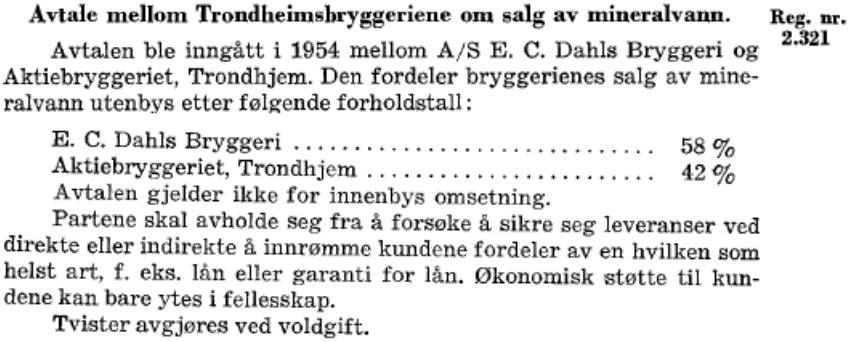
Figure 4 shows an entry in the 1957 cartel registry. The entry states the details of a cartel agreement between 3 cement producers that they entered in 1949. The agreement was first registered in the 1957 cartel registry and dissolved in 1959 according to the 1959 addendum to the 1957 registry. It is stated in the entry that the firm located in Nordland county has exclusive rights to the three northernmost counties in Norway while the firms located in southern Norway has exclusive rights the Norwegian market south of Trøndelag. The cartel has been given the following characteristics: exclusive territories = 1 and is treated as under risk of breaking up from 1957 to 1959.

5.2.4 Quota

Figure 5 shows an entry in the 1962 cartel registry. The entry contains the details of a cartel agreement between 2 breweries located in Trondheim that first started cooperating in 1954. The agreement was first listed in the 1962 registry and is assumed to have been dissolved in 1966 seeing as it does not feature in the 1967 registry. The entry states that the two breweries will split their total sales of mineral water to the rest of the country according to a 58/42 split.

Any disputes are to be solved through arbitration. Based on this information the cartel has been given the following characteristics: sales/purchasing quota = 1 and external dispute resolution = 1, and is treated as under risk of breaking up from 1962 to 1966.

Figure 5



Avtale mellom Trondheimsbryggeriene om salg av mineralvann. Reg. nr. 2.321

Avtalen ble inngått i 1954 mellom A/S E. C. Dahls Bryggeri og Aktiebryggeriet, Trondhjem. Den fordeler bryggerienes salg av mineralvann utenbys etter følgende forholdstall:

E. C. Dahls Bryggeri ..... 58 %
Aktiebryggeriet, Trondhjem ..... 42 %

Avtalen gjelder ikke for innenbys omsetning.

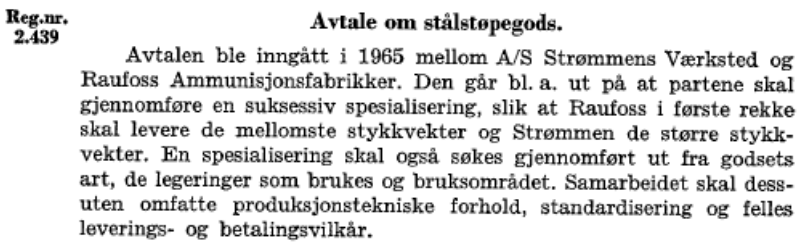
Partene skal avholde seg fra å forsøke å sikre seg leveranser ved direkte eller indirekte å innrømme kundene fordeler av en hvilken som helst art, f. eks. lån eller garanti for lån. Økonomisk støtte til kundene kan bare ytes i fellesskap.

Tvister avgjøres ved voldgift.

5.2.3 Non-area based and payment rules

Figure 6 shows an entry in the 1967 cartel registry. The entry contains the details of a cartel agreement between "A/S Strømmens Værksted" and "Raufoss Ammunisjonsfabrikker", two firms that both casts steel. They entered the agreement in 1965 and it was first listed in the 1967 registry. There are no further mentions of the cartel in the addendums or the 1972 registry so it is assumed to have been dissolved in 1971. The entry states that the firms are to specialize in casting different sizes of steel pieces, with "Strømmen" mainly casting the biggest ones, while "Raufoss" deals with the medium sized pieces of steel. Furthemore they are to coordinate on matters regarding product engineering, standardization and payment conditions. This cartel has been given the following characteristics: product specialization = 1, payment conditions = 1, standardization of product quality = 1 and technology = 1. It is treated as being under risk of breaking up between 1967 and 1972.

Figure 6



Reg.nr. 2.439

Avtale om stålstøpegods.

Avtalen ble inngått i 1965 mellom A/S Strømmens Værksted og Raufoss Ammunisjonsfabrikker. Den går bl. a. ut på at partene skal gjennomføre en suksessiv spesialisering, slik at Raufoss i første rekke skal levere de mellomste stykkvekter og Strømmen de større stykkvekter. En spesialisering skal også søkes gjennomført ut fra godsets art, de legeringer som brukes og bruksområdet. Samarbeidet skal dessuten omfatte produksjonstekniske forhold, standardisering og felles leverings- og betalingsvilkår.

6. Sample selection and descriptive statistics

In this section I will explain what cartels I chose to include in my analysis and what characteristics I focus on, before I look at some descriptive statistics and compare them with previous studies. As my data has been collected in a way similar to that of Hyytinen, Steen and Toivanen (2016) I will mainly look at how my data compares to theirs.

6.1 Main characteristics and sample selection

In this thesis my focus will be on the characteristics of the cartels that relate to how they collude in order to maximize profits. While I have also collected what information the cartel registry contains on characteristics that relate to how the cartels inner workings, i.e. how they are organized and how they solve disputes etc., I will not focus on these features in the following analysis. This comes with the exception of the characteristic which states whether or not the cartel uses a common sales office, as this feature is quite prevalent among the Norwegian cartels and earlier research has shown that it influences the duration of a cartel.

In total I have collected data on 790 different cartels agreements that existed between 1957 and 1991. As previous studies have shown that cartels that operate in different sectors have different characteristics I will limit my analysis to the 191 horizontal manufacturing cartels that operate on a national level. To make sure that my results are comparable to the ones in Hyytinen, Steen and Toivanen (2016) I only look at the characteristics of the cartels the year they were first registered.

Table 1: Specification of main contract clauses used to raise profits

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 payments
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
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 not to compete in a given market

Notes: These specifications are the same as the ones used in Hyytinen, Steen and Toivanen (2016). The specifications listed here are only valid for this section and does not apply to the regression models.

As mentioned in section 2 there are two different approaches the cartels use in order to maximize profits, price-based and market allocation-based collusion. When collecting data I registered eight different kinds of price-based contract clauses. Five of the clauses specify different ways of coordinating *pricing*, including price floors, ceilings or simply agreeing upon a fixed price. The three remaining clauses are different kinds of *payment rules* which specify either what kind of discounts a member can offer or how to deal with payments.

I have also recorded five different clauses that relate to market allocation-based modes of collusion. They are divided into three categories, *quotas*, *area-based*, and *non-area based*. *Quotas* are what the coding manual refers to as sales/purchasing quotas *while area-based* is what the coding manual refers to as exclusive territory. Non-area-based is used for clauses that either, refer to ways the members allocate costumers between them (customer/supplier specialization), stipulates that the members are to specialize in one way or another (product specialization), or agree not to compete in a given market (non-competition clause).

There a few cartels who do not fit in to any of the main categories who will be referred to as having no main clause. These cartels typically cooperated either through sharing of technology or by standardizing the product quality.

6.2 Descriptive statistics

Figure 7

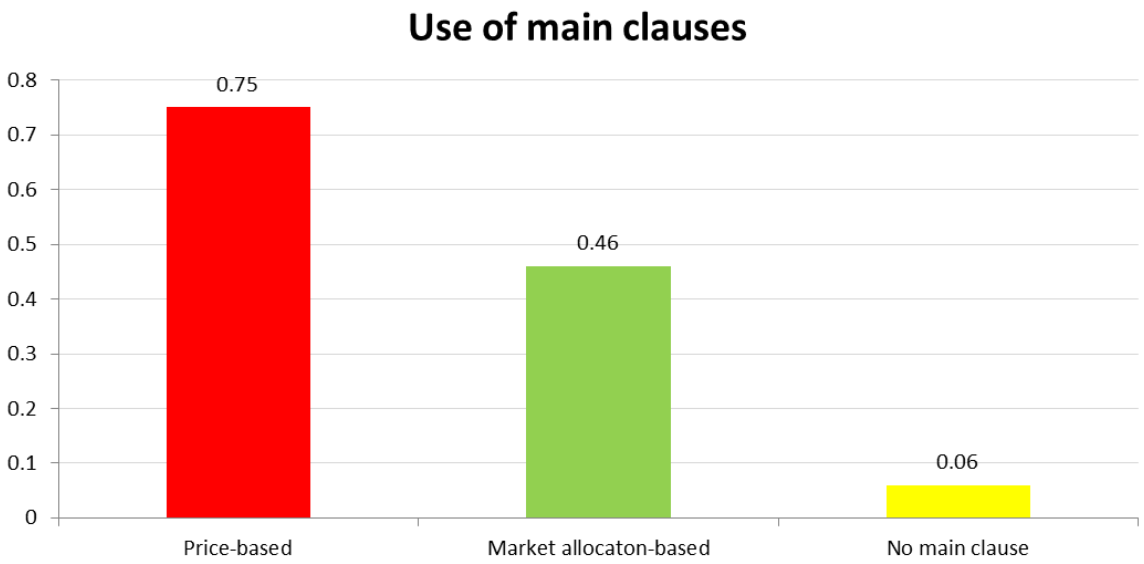


Figure 7 reports the frequency of the use of the main clauses among the Norwegian manufacturing cartels. The first feature of note is that price-based clauses are used more

frequently than market allocation-based clauses. In fact three out of four of the Norwegian manufacturing cartels utilize at least one price-based clause which is a substantially larger share than for the Finnish manufacturing cartels in Hyytinen, Steen and Toivanen (2016) where only 37% utilize such clauses. The opposite is true for market allocation-based clauses which are only used by 46% of the Norwegian cartels while they are used by 73% of the Finnish cartels. If we look at figure 8 we can see that large part of this difference seems to be due to payment rule clauses being far more popular among the Norwegian cartels (60%) than among the Finnish (22%) ones. Similarly Non-area-based clauses were more often used in Finland (52%) than in Norway (21%).

Figure 8

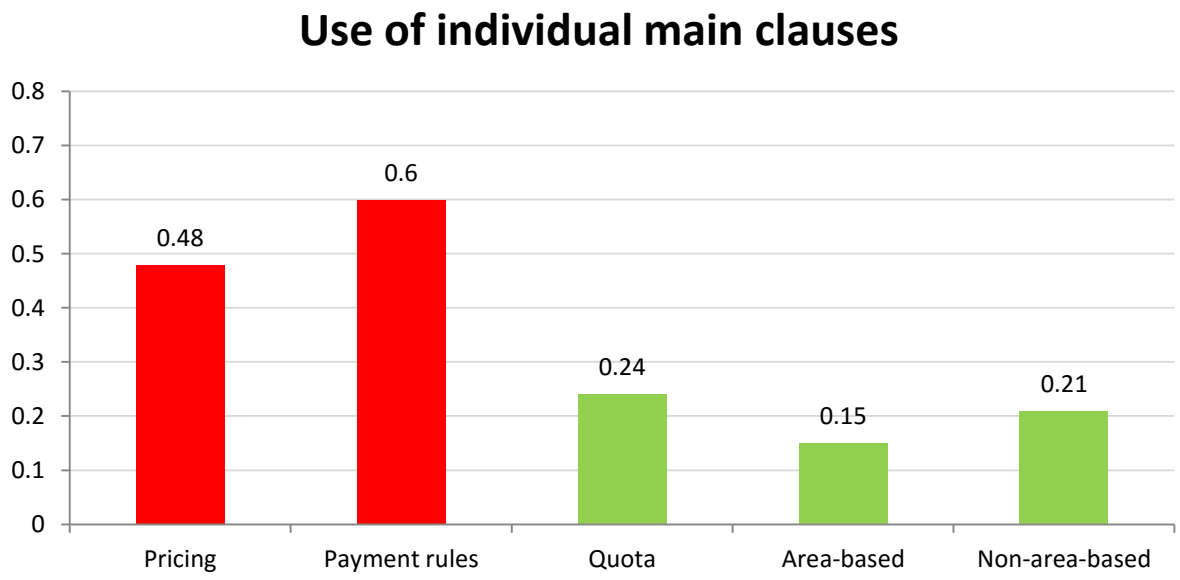


Table 2, which contains descriptive statistics of the different kinds of main clauses, might provide some clues as to why price-based clauses where preferred to market allocation-based ones in Norway. From the table we can see that the Norwegian cartels were registered on average 12 years earlier than the Finnish cartels. A common theme in the Norwegian and Finnish data is that price-based clauses were more common among cartels that were registered early. For the Norwegian data cartels with price-based clauses are registered on average 6 years earlier than Market allocation-based ones while the difference is 8 years for the Finnish data. Thus this difference between the Norwegian and Finnish cartels is not necessarily entirely due to an inherent difference in how Norwegian and Finnish cartels cooperate, but some of it might be because the Norwegian cartels were registered at an earlier time when price-based clauses where more commonly utilized.

As for the size of the cartels we see from table 2 that the median cartel is quite small with only 5 members and that cartels with market allocation-based clauses tend to be smaller than cartels with price-based clauses. This is consistent with the findings of Hyytinen, Steen and Toivanen (2016) which also found a median of 5 members per cartel, and that cartels with market allocation-based were smaller than cartels with price-based clauses, and Suslow (2005) which finds a median of 4 members.

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

	Count	# of members	Year of reg.	# of clauses	Duration
Pricing	92	5.00	1960	2.34	10.7
Payment rules	115	5.00	1961	2.03	10.7
All price-based	143	5.00	1961	1.94	11.04
Quota	45	3.00	1961	2.64	13.07
Area-based	29	3.00	1962	2.1	13.31
Non-area-based	41	2.50	1966	2.61	11.83
All market allocaton-based	88	3.00	1963	2.23	13.42
All with main clause	180	5.00	1961	1.79	11.56
No main clause	11	22.50	1959	0	10.73
All cartels	191	5.00	1961	1.69	11.51

Notes: The reported numbers of members are medians while # of clauses and duration are means. The clauses on the rows are not mutually exclusive. # of clauses is the average of the count of the five main clauses. Year of reg. is the year of entry into the cartel registry. # of members is the number of members as recorded in the registry (information not available for all cartels).

We can also see from table 2 that the average cartel contract is fairly simple with either one or two main clauses being used. Cartels that use price-based clauses on average use 1.94 clauses while cartels utilizing market allocation-based clauses are a bit more complex with 2.23 clauses used. This is opposite of what Hyytinen, Steen and Toivanen (2016) findings where cartels with price-based clauses were significantly more complex than cartels with market allocation-based clauses (1.87 to 1.38). To explore the roots of this difference we can look at table 3 which shows the most popular combinations of the main contract clauses.

Table 3 confirms the results from table 2 that price-based clauses were the most popular clauses to use for Norwegian manufacturing cartels. Cartels using only payment rules, pricing or a combination of the two make up almost half of all manufacturing cartels in Norway. That cartels using only payment rules were the most common type of manufacturing cartels is quite illustrative of how popular the payment rules clause was among the Norwegian cartels. This stands in stark contrast to the Finnish cartels where only using non-area-based clauses was by far the most popular with a share of 42% while only using payment rules doesn't even make

the top five and thus is used by less than 5% of the cartels. Only using non-area-based clauses was quite rare among the Norwegian cartels actually only being the 7th most popular combination with a share of 5%.

The combination of pricing and payment rules was the 2nd most popular combination in both countries but the share was higher in Norway with 18% compared to 11% in Finland. Furthermore exclusively using pricing or area-based clauses follows on the 3rd and 4th rank in both countries and the shares are also identical at 9% and 7% respectively. Finally the combination of pricing and quota is the 5th most popular in Finland while in Norway the 5th most popular combination also includes payment rules.

Table 3: Most popular combinations of main contract clauses

Rank	Type of cartel	# main clauses	Count	Share
1st	Payment rules	1	42	0.220
2nd	Pricing, Payment rules	2	34	0.178
3rd	Pricing	1	16	0.084
4th	Area-based	1	13	0.068
5th	Pricing, Payment rules, Quota	3	12	0.063
6th	No main clauses	0	11	0.058
7th	Non-area based	1	9	0.047

Notes: Count is the number of cartels using a particular combination of the five main contract clauses. Share is the fraction of cartels of cartels doing so.

To further study the combinations of main clauses we can look at table 4 which shows their pairwise correlations. The first thing of note it that pricing and payment rules are positively correlated which is the same result as Hyytinen, Steen and Toivanen (2016) finds for the Finnish data. However the correlation is substantially lower for the Norwegian cartels at 0.184 compared to 0.527 for the Finnish cartels. That the correlation is lower for the Norwegian data is probably due to the prevalence of cartels choosing to only use payment rules as their main contract clause in Norway. As for the correlation between the market allocation-based clauses it is only significant between area-based and non-area based clauses and the correlation is positive. This marks another difference between the Norwegian and the Finnish data as Hyytinen, Steen and Toivanen (2016) results show a significant negative correlation between all of the market allocation-based clauses.

When it comes to the correlation between price-based and market allocation based clauses the results are similar to the Finnish ones with quota being significantly positively correlated with

pricing while area-based is significantly negatively correlated with both pricing and payment rules. However the correlations of non-area-based clauses differs on this point as well as there is no statistically significant correlation between non-area based clauses and the two price-based clauses for the Norwegian data, while the Finnish data shows significant negative correlation with both. Thus it is not only the prevalence of the payment rule clauses and non-area-based clauses that differ between Norwegian and Finnish cartels, the way the clauses are combined with the other main clauses also differs significantly.

Table 4: Pairwise correlations of main contract clauses

		Price-based		Market allocation-based		
Clause	Count	Pricing	Payment Rules	Quota	Area-Based	Non-area-based
Pricing	92	1	-	-	-	-
Payment rules	115	0.184*	1	-	-	-
Quota	45	0.230**	-0.053	1	-	-
Area-based	29	-0.174*	-0.312**	-0.029	1	-
Non-area-based	41	0.006	-0.044	0.070	0.170*	1

Notes: The clauses are not mutually exclusive, as a cartel may use many of them simultaneously. The first column reports the number of cartels using the main clause on the row. The matrices present pairwise correlation for the contract clauses. * = significant at 95% level and ** significant at 99% level of confidence.

7. Methodology

In this section I will first briefly explain the theory behind the regression model used in this thesis before I present the specifications of the models used to analyze the data.

7.1 The survival function

The focus of this thesis is to explore which factors might affect a cartel's duration. To do this I will utilize methodology from survival analysis. A key component of survival analysis is the survival function $S(t)$ which is defined by

$$S(t) = P(T > t) \qquad (1)$$

and tells us the probability $P(T > t)$of an individual, in our case a cartel, surviving beyond time t. The survival function will decrease with time with a value of 1 at the origin and 0 as time moves to infinity.

Figure 9

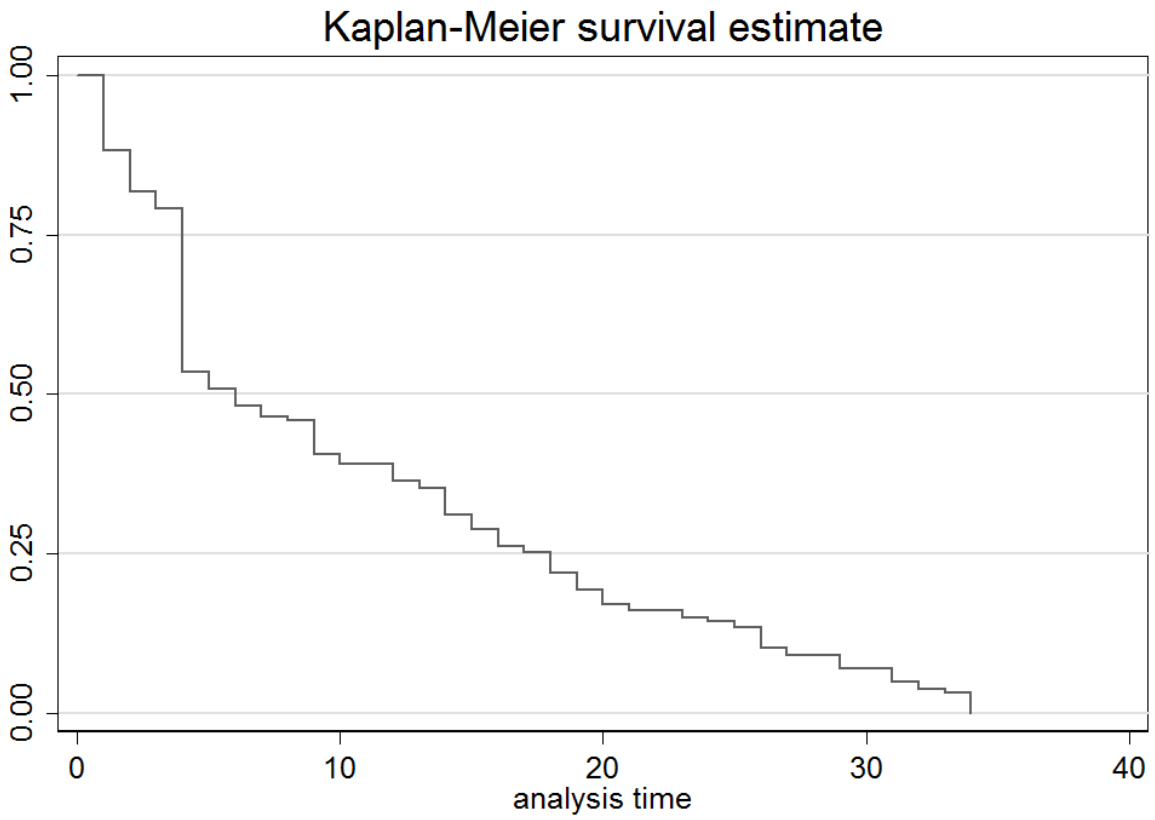


Figure 9 shows the Product-Limit estimated survival function of the Norwegian manufacturing cartels. We can see that the probability of a cartel surviving decreases quite

quickly the first couple of years before it decreases at a somewhat slower pace. The probability of a cartel lasting longer than five years is only 50% which corresponds well with the median duration being 6 years. The big jump between the probability of surviving for 3 and 4 years is probably due to 4 years being the lifetime of a cartel that is only registered in one cartel registry with no detailed information being provided about the time of break up.

7.2 The hazard rate

In order to analyze which factors might influence the duration of a cartel we need to look at the hazard rate $h(t)$. The hazard rate is defined by the following function

$$h(t) = \lim_{\Delta t \to \infty} \frac{Pr[t \leq T < t + \Delta t | T \geq t]}{\Delta t} \qquad (2)$$

and can be thought of as the probability that an event occurs, in this case the breakup of the cartel, at time *t*, given that the event has not yet occurred. In truth it is not actually a probability as it can take values greater than 1 and we can alternatively think of it as the expected number of events in a time interval that is 1 unit long (Allison, 1982).

If T is a continuous random variable the hazard rate can be written as follows

$$h(t) = \frac{f(t)}{S(t)} = \frac{f(t)}{[1 - F(t)]} \qquad (3)$$

where $f(t)$is the probability density for T and $F(t)$ is the cumulative distribution function for T. In order to analyze how other factors than time influences the durability of a cartel we need to express the hazard rate as a function of both time and the explanatory variables. The most common way to do this is the so-called proportional hazard model,

$$\log h(t, \boldsymbol{x}) = \alpha(t) + \boldsymbol{\beta}' \boldsymbol{x} \qquad (4)$$

where $\alpha(t)$ is an unspecified function of time, $\boldsymbol{\beta}$ is a vector of constants of the following dimensions $K \times 1$ and $\boldsymbol{x}$ represent the different explanatory variables. In this model the ratio of the hazard rates for any two individuals at any point in time is constant over time. $\boldsymbol{\beta}$ is a representation of the effect on the probability of an event of the explanatory variables $\boldsymbol{x}$. This means that if the variable x_1 has a positive coefficient β_1, an increase in that variable will lead to an increase in the likelihood that an event will occur. In our case if the coefficient of the variable that measures the negative deviation from trend GDP is positive it means that a negative deviation in GDP increases the odds of a cartel breaking up. The model assumes that

these effects are constant over time, i.e. the effect of a negative deviation in GDP trend is the same in 1957 as it is in 1987.

7.3 Discrete time models

While continuous-time models can usually be used as plausible representations of the processes generating events, in practice time is always observed in discrete units, however small they might be. While it might be acceptable to ignore the discreteness and treat time as continuous when the time units are small, it is problematic to do so in our case where time is measured in years. The discrete time equivalent of equation (2) is defined as follows

$$P_{it} = Pr[T_i = t | T_i \geq t, \boldsymbol{x_{it}}] \qquad (5)$$

Just like equation (2) it is a measure of the conditional probability that an event occurs at time *t*, given that the event has not yet occurred.

The discrete time equivalent of equation (4) is given by

$$P_{it} = 1 - exp[-exp(a_t + \boldsymbol{\beta' x_{it}})] \qquad (6)$$

where the vector $\boldsymbol{\beta}$ is equivalent to $\boldsymbol{\beta}$ in the proportional hazard model (4). This can in turn be rearranged to yield what is called the complementary log-log function:

$$\log[-\log(1 - P_{it})] = a_t + \boldsymbol{\beta' x_{it}} \qquad (7)$$

It is this function that will be used to estimate my results in the next section[2]. It is important to note that the estimated values of the different β reported in the next section does not equal the hazard rate. In order to obtain the hazard rate we need to exponentiate the estimated β, that is calculate e^{β}. Exponentiated results of a selection of the models are reported separately in Appendix 1.

[2] cloglog command in Stata

7.4 Regression models

My regression model is based on the regression model used in Hyytinen, Steen and Toivanen (2016), but I have made some changes due to differences in the data available, and some refinements. All of my models use cartel duration as its dependent variable and as mentioned earlier they only include data for horizontal manufacturing cartels that operate on a national level. They all include three spell year variables of differing configurations to allow for non-linearity and both positive and negative duration dependence. This is important as previous research shows that cartels could become more or less stable with age.

Table 5: Specification of main contract clauses used to raise profits (Regression)

Price-based	
Pricing	=1 if the contract refers to prices and/or pricing rules, **but does not refer to payment rule clauses**
Payment rules	=1 if the contract refers to discount rules and/or rules of delivery and payments, **but does not refer to pricing clauses**
Pricing & Payment rules	=1 if the contract refers to both pricing and payment rule clauses
Market allocation-based	
Quotas	=1 if the contract refers to sales quotas or market shares, **but does not use Area or Non-area-based clauses**
Area-based	=1 if the contract refers to exclusive territories, **but does not use Quotas or Non-area-based clauses**
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 not to compete in a given market, **but does not use Quotas or Area-based clauses**
Many mkt-alloc. based clauses (>1)	=1 if the contract refers to more than one market allocation based clause (i.e. both quotas and area-based clauses)

Notes: These specifications are the same as the ones used in the regression model of Hyytinen, Steen and Toivanen (2016). The specifications apply to all of the regression models.

In addition to the spell year variables the first model includes dummies for the five main contract clauses in addition to two dummies for more complex cartels that include more than one main clause in their contracts. The dummy variables representing the five main clauses are configured in a slightly different way than in the previous section. These differences are listed in table 5. As the model includes dummy variables that cover all the different main clauses the results reported in the next section report the estimated difference in hazard rate between the use of the different main clauses and cartels that use no main clauses. For example is the estimated β of pricing is negative it means that cartels that use *pricing*, but not *payment rules* have a lower hazard rate than cartels that use no main clauses.

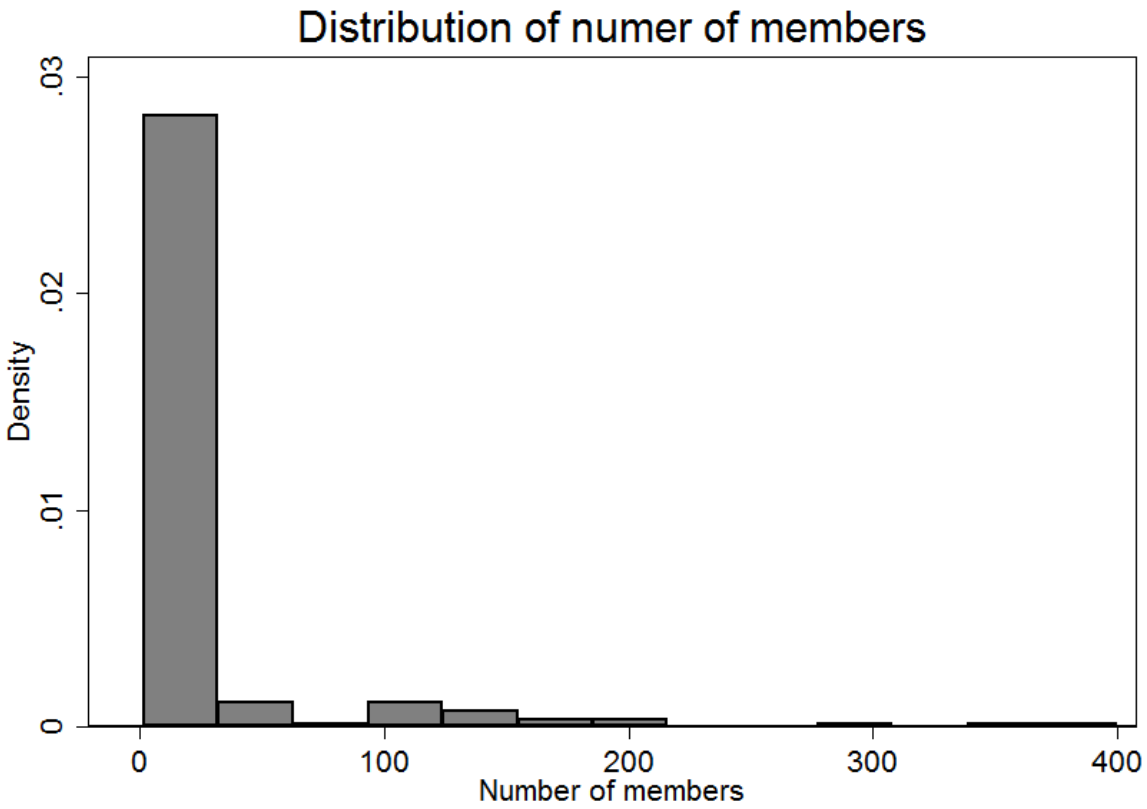
The second model includes two variables that measure the absolute value of either a positive or negative deviation from GDP trend, measured for each year the cartel is alive. This is one of the key differences between my model and the model used in Hyytinen, Steen and Toivanen (2016). While their GDP shock variables measure GDP shocks the year before a cartel was registered and thus aim to see how macroeconomic shocks at the birth of a cartel might contribute to its durability, my variable covers the years the cartel exists and aims to explore how macroeconomic shocks during a cartels lifetime might affect its durability in the vein of Suslow (2005). I also run a model (model 4) where I lag the GDP variable one year with the idea that the effect of a deviation might take some time to be realized.

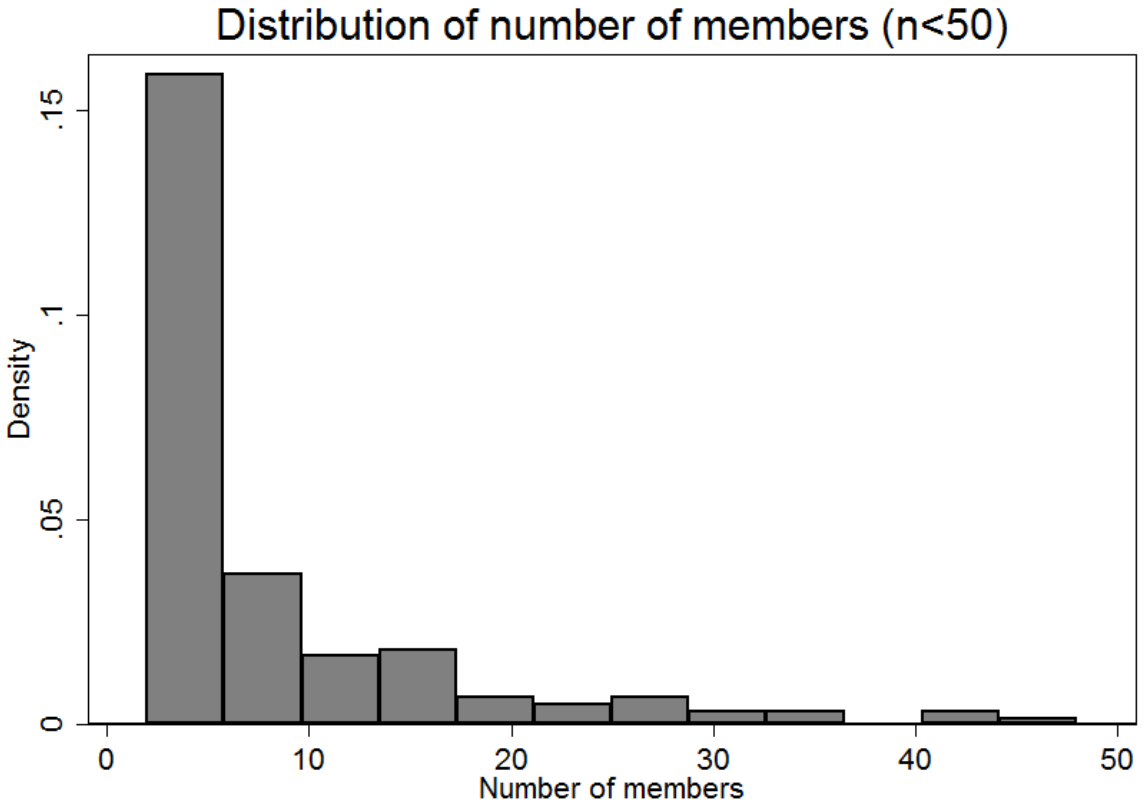
Other control variables included are cohort dummies for cartels that are registered in the periods 1960-69, 1970-79 and 1980-91 with the omitted category being the period before 1960, and law regime dummies that cover periods with different law regimes. The cohorts are chosen identical to the ones used in Hyytinen, Steen and Toivanen (2016) while the law regime variables are quite different due to the fact that the Norwegian laws regimes didn't become progressively tougher like the Finnish ones. The notable law changes include 1960 when horizontal price agreements where banned, 1966 when certain forms of cartels no longer needed to report to "Prisdirektoratet", and 1988 when a new provision to the price law imposed controls on mergers and the competition authorities became more active. Thus we end up with four different law regimes where the omitted regime is the one spanning from 1957 to 1960.

The law regime dummies might sound similar to the cohort dummies as they cover periods in time, but they differ substantially in that the law dummies are set to 1 only in the period the different law regimes exists, while the cohort dummies are set to 1 for the entire duration of a cartel as long as it is registered in the corresponding timeframe. Thus a cartel can only have one cohort dummy set to 1 during its lifetime, but several law dummies depending on the timeframe the cartel exists within. For example a cartel who registered in 1961 and that proceeds to break up in 1975 will have the cohort dummy 1960-69 set to one for all periods, while it will have the dummy representing the second law regime set to 1 only for the year 1961-65 while the dummy representing the third law regime will be set to 1 for the periods 1966-1975.

The third model also controls for the size of the cartels by including a variable that measures the logarithm of the number of members. While most cartels in my sample are relatively small,

Figure 10


Distribution of numer of members
Density
0
.01
.02
.03
0
100
200
300
400
Number of members


Distribution of number of members (n<50)
Density
0
.05
.1
.15
0
10
20
30
40
50
Number of members

there are some quite big ones that stand out as one can see from figure 10 which shows the distribution of the membership numbers. To allow for possible differences the small and very large cartels a dummy for cartels with more than 50 members are also included. I have also included a dummy for the 16 cartels where the number of members was not given in the Norwegian cartel registry. If the number of members were not known they were assigned a membership number equal to the median of number of members (5) of the other cartels. This model is the closest I can get to the model used by Hyytinen, Steen and Toivanen (2016) as I did not have time to compile the data available on contract changes.

Previous research by Dick (1996) has found that cartels that use common sales offices last longer than those that do not. To explore if this is the case for the Norwegian cartels model 5 includes a dummy variable that is equal to 1 if the cartel uses a sales office. In the Norwegian cartel registry it is specified whether the use of the sales office is mandatory or not so to see if there is a difference between these two types of sales offices model 6 distinguishes between the two.

Finally I run several models where I include dummies for cartels that where born before the cartel registry was established. Results from Hyytinen, Steen and Toivanen (2016) suggests that cartels become less stable with time so I run these models to see whether there is a systematic difference in the durability of the cartels that already existed when the cartel registry was first published. Model 7-13 include dummies for cartels born before 1957, 1950, 1940, 1930, 1920, 1910 and 1900 respectively.

8. Results

In this section I will present the results of the different models listed in the previous section. My main focus will be on model 3 as it most closely resembles the model used in Hyytinen, Steen and Toivanen (2016). I also look at how sales offices influences the stability of cartels in model 5 and 6 before I see if cartels that came into existence before the authorities started registering cartels are different from those who only existed during the years of the cartel registry by looking at model 7-13.

8.1 Main contract clauses

Most notable are the results from my preferred model 3 which include most of the control variables. From table 6 we can see that the estimated β for all the market allocation-based main clauses are negative. A negative value translates into a reduction in the hazard rate which in turn tells us that cartels which use any of the market allocation-based main clauses tend to be significantly more stable than cartels which use no main clauses. Of the three different categories of market allocation based clauses, area-based clauses seem to yield the most stable cartels with an estimated β of -1.275 compared to -0.867 for quota and -0.639 for non-area-based, but the difference between them is not statistically significant. The corresponding exponentiated values, the estimated hazard rates, are 0.279 for area-based, 0.420 for quota and 0.528 for non-area-based[3]. As a hazard value of 1 is the null hypothesis, this tells us that cartels which exclusively use area-based clauses are more than 3.5 times ($\frac{1}{0.279} = 3.58$) less likely to break up per unit of time, than cartels which use no main clauses.

While the price based clauses also have a negative estimated β, they are not statistically significant, and when looking at contracts which feature both pricing and payment rule clauses the value is positive, but insignificant. Thus it seems that using at least one market allocation-based clause significantly increases the stability of a cartel, compared to cartels that use no main clauses, while including price-based clauses does not significantly change the stability. Chi-tests show that the difference between the estimated beta β of pricing and both quota and Area-based are significant at the 5% level. In a way this is similar to the results in Dick (1996), where it is shown that legal cartels that mainly focus on fixing prices where shorter lived, in that my finding implicate that cartels which only use pricing are less stable than both quota and area-based ones. Hyytinen, Steen and Toivanen (2016) on the other hand

[3] See table A.1 in the appendix for all exponentiated results

Table 6: Model 1-4

	(1)	(2)	(3)	(4)
Pricing	-0.199	-0.244	-0.092	-0.101
	(0.246)	(0.241)	(0.258)	(0.254)
Payment rules	-0.267	-0.302	-0.397	-0.389
	(0.194)	(0.202)	(0.255)	(0.250)
Pricing & Payment rules	0.048	0.043	0.101	0.092
	(0.182)	(0.184)	(0.206)	(0.202)
Quota	-0.404	-0.396	-0.867**	-0.839**
	(0.216)	(0.216)	(0.225)	(0.224)
Area-based	-0.763**	-0.826**	-1.275**	-1.241**
	(0.264)	(0.281)	(0.382)	(0.369)
Non-area-based	-0.477**	-0.255	-0.639**	-0.641**
	(0.181)	(0.205)	(0.219)	(0.217)
Many mkt-alloc. based clauses (>1)	-0.285	-0.175	-0.599**	-0.589**
	(0.217)	(0.227)	(0.220)	(0.219)
GDP negative deviation (100 million NOK)		0.035**	0.033*	0.021
		(0.013)	(0.013)	(0.012)
GDP positive deviation (100 million NOK)		-0.041*	-0.045**	-0.028
		(0.016)	(0.016)	(0.016)
Law regime 1960-1965		0.007	-0.047	-0.125
		(0.325)	(0.322)	(0.347)
Law regime 1966-1987		-0.575	-0.697	-0.762
		(0.425)	(0.427)	(0.437)
Law regime 1988-1991		-0.682	-1.013	-0.524
		(0.609)	(0.597)	(0.565)
Cohort: 1960-1969		-0.304	-0.451*	-0.454*
		(0.205)	(0.180)	(0.178)
Cohort: 1970-1979		0.263	-0.005	-0.069
		(0.291)	(0.320)	(0.303)
Cohort: 1980-1991		0.784	0.808	0.593
		(0.428)	(0.422)	(0.405)
Ln(number of members)			-0.498**	-0.485**
			(0.110)	(0.109)
Number of members not known			-0.238	-0.239
			(0.248)	(0.245)
Number of members > 50			0.877	0.844
			(0.456)	(0.457)
Lagged GDP	-	No	No	Yes
Number of cartels	191	191	191	191
Cartel-year observations	2,398	2,398	2,398	2,398

Notes: Lagged GDP indicates that GDP from the previous year is used. The model is a discrete time hazard rate model, with proportional hazard (cloglog) and is estimated by maximum likelihood. Standard errors are clustered at contract level with * = significant at 95% level and ** significant at 99% level of confidence.

finds no statistically significant connection between the main clauses and durability when looking at the manufacturing cartels.

8.2 External factors

As for the effect of deviation from trend GDP on cartel duration I find that BNP below trend increases the hazard rate, while GDP above trend reduces it. Thus it seems that when the general economy is preforming poorly and the firms might face falling demand the chance of the cartels breaking up increases, while the opposite is true when the general economy performs well and firms experience increasing demand. This is consistent with the results in Suslow (2005) that showed that economic activity below trend increased the chance of cartel failure and that cartels that coincide with growth periods last longer than those who do not.

Levenstein & Suslow (2011) on the other hand did not find a statistically significant effect of fluctuations in BNP on the duration of cartels. This might be due to the fact that Levenstein & Suslow (2011) studied cartels that existed during the 1990s, a time where global GNP fluctuated relatively little compared to the GNP weighted average of the US, UK and France in the period 1920-1939 used in Suslow (2005) and the Norwegian GDP between 1957 and 1992.

The law regime dummies suggest that the ban on horizontal price agreements introduced in 1960 had no effect on the duration of cartels at that time. This is not a surprising result seeing as the law was quickly undermined by the sitting government as I pointed out in section 3. The law regime following the exemption to price law introduced in 1966 seems to have made it easier for cartels to operate seeing as the law regime dummy associated with it is negative, though it is not statistically significant. That the government softened up on its fight against cartels during the sixties is reflected by the significantly negative value of the dummy representing cartels registered in the 1960s, suggesting that cartels that were registered in the 1960s lasted longer than cartels registered before 1960.

8.3 Size

Finally we can see that an increase in the size of the cartel is associated with a decrease in the hazard rate. A doubling in the number of members appears to reduce the probability of a cartel breaking down in a given year by half, given that it has survived so far. However, this result must be seen in context of the dummy for cartels with more than 50 members that, while not statistically significant, indicate that the effect holds true only up to a certain point. My findings correspond well with Dick (1996) which also finds statistically significant

Table 7: Model 5-6

	(3)	(5)	(6)
Pricing	-0.092	-0.029	-0.022
	(0.258)	(0.253)	(0.255)
Payment rules	-0.397	-0.298	-0.286
	(0.255)	(0.255)	(0.255)
Pricing & Payment rules	0.101	0.339	0.349
	(0.206)	(0.240)	(0.240)
Quota	-0.867**	-0.702**	-0.683**
	(0.225)	(0.238)	(0.239)
Area-based	-1.275**	-1.220**	-1.214**
	(0.382)	(0.378)	(0.379)
Non-area-based	-0.639**	-0.578**	-0.573**
	(0.219)	(0.221)	(0.221)
Many mkt-alloc. based clauses (>1)	-0.599**	-0.489*	-0.474*
	(0.220)	(0.216)	(0.216)
GDP negative deviation (100 million NOK)	0.033*	0.034**	0.034**
	(0.013)	(0.013)	(0.013)
GDP positive deviation (100 million NOK)	-0.045**	-0.044**	-0.044**
	(0.016)	(0.016)	(0.016)
Law regime 1960-1965	-0.047	-0.044	-0.016
	(0.322)	(0.324)	(0.328)
Law regime 1966-1987	-0.697	-0.691	-0.670
	(0.427)	(0.431)	(0.435)
Law regime 1988-1991	-1.013	-0.964	-0.950
	(0.597)	(0.605)	(0.608)
Cohort: 1960-1969	-0.451*	-0.446*	-0.444*
	(0.180)	(0.186)	(0.187)
Cohort: 1970-1979	-0.005	0.092	0.105
	(0.320)	(0.301)	(0.301)
Cohort: 1980-1991	0.808	0.847	0.856*
	(0.422)	(0.433)	(0.436)
Ln(number of members)	-0.498**	-0.508**	-0.515**
	(0.110)	(0.109)	(0.110)
Number of members not known	-0.238	-0.282	-0.286
	(0.248)	(0.252)	(0.254)
Number of members > 50	0.877	0.873	0.897
	(0.456)	(0.473)	(0.476)
Sales office		-0.545*	
		(0.225)	
Exclusive sales office			-0.598**
			(0.219)
Non-exclusive sales office			2.302**
			(0.276)
Number of cartels	191	191	191
Cartel-year observations	2,398	2,398	2,398

Notes: The model is a discrete time hazard rate model, with proportional hazard (cloglog) and is estimated by maximum likelihood. Standard errors are clustered at contract level with * = significant at 95% level and ** significant at 99% level of confidence.

positive relationship between the number of members and the duration of a cartel. While Hyytinen, Steen and Toivanen (2016) estimated β for the number of members in a cartel also is negative, their estimates are not significant at the 5% level.

8.4 Sales office

The results of model 5 listed in table 7 shows that the use of common sales offices is associated with a reduction in the hazard rate. The estimated β of sales offices corresponds to a hazard rate of 0.58 which tells us the cartels which established common sales offices where 1.7 times less likely to break up per unit of time than those who did not. That the use of a common sales office increases the duration of a cartel is in line with the findings in Dick (1996). The reason why a sales office is beneficial for a cartel might be because it provides the members with an effective mechanism to monitor that each member stays true to the main clauses they have agreed upon. Of course the members might still cheat by selling through other channels, but the cheating could be easier to spot as the other member would notice that their supply to the sales office has dropped.

Model 6 indicates that while common sales offices increase the duration of cartels when members must use them, the opposite might be true if the members can choose not to. However, there is only one cartel in the sample which allowed its members not to sell its products through other channels than its common sales office, so the estimated β might not be representative even though it is statistically significant. Nevertheless I choose to include the result as it indicates that further research on the subject, for example on the full sample of Norwegian cartels which includes non-manufacturing firms, could be of interest.

8.5 Pre-existing cartels

The results from model 7-13 are presented in table 8. We can see that none of the dummy variables representing all cartels that were born before 1957, 1950, 1940, 1930, 1920, 1910 or 1900 respectively, are statistically significant at the 5% level. Furthermore the inclusion of each variable does not significantly change any of the main results from model 3. This indicates that the results in model 3 aren't biased due to the sample including cartels that have already existed for some time before being registered.

Table 8: Model 7-13

	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Birth <	1957	1950	1940	1930	1920	1910	1900
Pricing	-0.098	-0.119	-0.094	-0.064	-0.047	-0.091	-0.137
	(0.256)	(0.259)	(0.262)	(0.260)	(0.256)	(0.261)	(0.261)
Payment rules	-0.404	-0.427	-0.407	-0.359	-0.382	-0.403	-0.401
	(0.252)	(0.250)	(0.260)	(0.256)	(0.258)	(0.258)	(0.253)
Pricing & Payment rules	0.095	0.097	0.115	0.115	0.118	0.123	0.099
	(0.204)	(0.202)	(0.202)	(0.209)	(0.208)	(0.205)	(0.205)
Quota	-0.845**	-0.851**	-0.852**	-0.875**	-0.924**	-0.899**	-0.831**
	(0.229)	(0.231)	(0.228)	(0.231)	(0.232)	(0.232)	(0.228)
Area-based	-1.289**	-1.281**	-1.268**	-1.259**	-1.251**	-1.302**	-1.258**
	(0.381)	(0.380)	(0.383)	(0.392)	(0.393)	(0.388)	(0.380)
Non-area-based	-0.648**	-0.643**	-0.628**	-0.652**	-0.662**	-0.650**	-0.620**
	(0.217)	(0.218)	(0.220)	(0.218)	(0.219)	(0.220)	(0.220)
Many mkt-alloc. based clauses (>1)	-0.597**	-0.613**	-0.607**	-0.599**	-0.627**	-0.618**	-0.574**
	(0.220)	(0.220)	(0.223)	(0.224)	(0.223)	(0.221)	(0.222)
GDP negative deviation	0.033*	0.033*	0.033*	0.033*	0.033*	0.033*	0.033*
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)
GDP positive deviation	-0.045**	-0.045**	-0.045**	-0.045**	-0.045**	-0.045**	-0.045**
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Law regime 1960-1965	-0.076	-0.060	-0.059	-0.039	-0.032	-0.042	-0.027
	(0.329)	(0.323)	(0.324)	(0.321)	(0.321)	(0.321)	(0.322)
Law regime 1966-1987	-0.756	-0.728	-0.719	-0.687	-0.672	-0.688	-0.672
	(0.445)	(0.430)	(0.430)	(0.427)	(0.427)	(0.426)	(0.428)
Law regime 1988-1991	-1.092	-1.058	-1.048	-1.026	-1.021	-1.021	-0.986
	(0.632)	(0.602)	(0.604)	(0.598)	(0.598)	(0.599)	(0.599)
Cohort: 1960-1969	-0.512*	-0.495*	-0.478*	-0.518**	-0.510**	-0.484**	-0.444*
	(0.207)	(0.201)	(0.187)	(0.190)	(0.187)	(0.181)	(0.180)
Cohort: 1970-1979	-0.054	-0.036	-0.017	-0.064	-0.054	-0.034	0.005
	(0.324)	(0.324)	(0.318)	(0.325)	(0.324)	(0.318)	(0.317)
Cohort: 1980-1991	0.760	0.777	0.789	0.755	0.765	0.780	0.819
	(0.416)	(0.426)	(0.420)	(0.422)	(0.418)	(0.418)	(0.424)
Ln(number of members)	-0.485**	-0.481**	-0.482**	-0.502**	-0.509**	-0.513**	-0.484**
	(0.107)	(0.113)	(0.108)	(0.112)	(0.113)	(0.113)	(0.110)
Number of members not known	-0.223	-0.219	-0.210	-0.222	-0.188	-0.177	-0.224
	(0.250)	(0.246)	(0.249)	(0.243)	(0.243)	(0.248)	(0.249)
Number of members > 50	0.854	0.859	0.865	0.994*	1.059*	0.981*	0.864
	(0.450)	(0.453)	(0.449)	(0.447)	(0.450)	(0.462)	(0.457)
Birth < X	-0.120	-0.111	-0.110	-0.299	-0.381	-0.381	0.812
	(0.213)	(0.212)	(0.201)	(0.237)	(0.287)	(0.476)	(0.461)
Number of cartels	191	191	191	191	191	191	191
Cartel-year observations	2,398	2,398	2,398	2,398	2,398	2,398	2,398

Notes: The model is a discrete time hazard rate model, with proportional hazard (cloglog) and is estimated by maximum likelihood. Standard errors are clustered at contract level with * = significant at 95% level and ** significant at 99% level of confidence.

9. Conclusion and further research

9.1 Conclusion

In this thesis I have looked at the main characteristics of the legal Norwegian manufacturing cartels that were registered in the Norwegian cartel registry in the period 1957 to 1991 and explored how they influence the duration of the cartels.

I have found that the Norwegian manufacturing cartels were typically quite small with a median of 5 members which is consistent with the Finnish cartels studied in Hyytinen, Steen and Toivanen (2016) and the inter-war international cartels studied in Suslow (2005). The size of the Norwegian manufacturing cartels differed between the cartels that used Price-based and Market allocation-based modes of cooperation, with Price-based ones typically being larger.

The Norwegian manufacturing cartels are found to have favored price-based clauses over market-allocation-based ones which set them apart from the Finnish cartels for whom the opposite is true. This difference can partly be explained by the fact that the Norwegian cartels typically were registered earlier than the Finnish, seeing as both the Finnish and the Norwegian data find that price-based clauses were more popular among cartels that were registered early. The three most common ways to raise profits among the Norwegian manufacturing cartel, which accounts for 50% of all the cartels, all involve price-based clauses.

As for how the characteristics of the cartels influence their duration I find several interesting results. Firstly, cartels which cooperate through areas-based or quota clauses appear to live longer than cartels that simply agree to fix prices. This is similar to Dick (1996) findings that cartels which fix prices are significantly shorter lived than those who don't. Secondly, cartels which use more than one market allocation-based clause to cooperate seem to live longer than those who use both pricing and payment rule clauses. The results from Hyytinen, Steen and Toivanen (2016) on the other hand does not find a significant difference between these types of cartels, and if anything their results indicate that cartels with both pricing and payment rules clauses should live longer than those who use more than one market allocation-based clause. Thirdly, larger cartels appear to be longer lived than smaller ones, at least when it comes to cartels with less than 50 members. Fourthly, in line with Dick (1996) results, I find that cartels which make use of common sales offices tend to live longer.

I also find interesting result when looking at how external factors such as the development of the Norwegian economy as a whole and the evolution of the laws regulating the cartels. As Suslow (2005), I find that the likelihood of a cartel breaking up appears to increase in years when the economy is performing badly while the likelihood is reduced when the economy is booming. It seems cartels, like most individual firms, thrives when supply is plentiful and suffers when supply is limited. The law regimes following the ban on horizontal price fixing in 1960, on the other hand, does not appear to have had an effect on the duration of the Norwegian manufacturing cartels. Not a surprising result considering that the ban was quickly undermined by the authorities and that the laws regulating the cartels were softened in 1966.

Ultimately it must be noted that the results presented in my thesis cannot be interpreted as causal relationships. However, the results do offer a unique look at how the different characteristic of cartels might influence the stability of cartel. It is difficult to say whether my results generalize to cartels operating today under a much harsher legal environment, the underlying attractiveness of raising profits by fixing prices or colluding in other ways still exists, even if it is more difficult when you risk being caught by the authorities. Thus the prevalence of cartels is probably much lower in Norway today, but it is not certain that the cartels which do exists operate in a different way than they did in the period of 1957-1991 seeing as they face many of the same organizational challenges with regards to self-policing. The illegal cartels that operate today would probably want to be organized in the same way as the legal cartels were; they just have to be stealthier.

9.2 Further research and possible improvements

Considering that I have only looked at the characteristics of 191 of the 791 cartels I gathered information on, there is plenty of further research that can be made into the durability of the Norwegian cartels from 1957-1991. Hyytinen, Steen and Toivanen (2016) result indicate that it would be interesting to study whether the cartels that operated in the non-manufacturing sector cooperated in a different way than those in the manufacturing sector. One could also analyze how the results change if we include vertical cartels and local ones. Looking at the whole sample one should also be able to confirm or dismiss the results from model 5 which shows that exclusive sales offices increase the duration of cartels which use it, while the opposite is true for cartels where the sales office is non-exclusive.

It would also be interesting to look at what kind of changes in the cartel agreements are most common and how these changes coincide with changes in the laws regulating the cartels. One

could also look into whether the cumulative number of contract changes affected the duration of the Norwegian cartels in the same way they affected the Finnish ones.

A flaw in the cartel registry is that it contains less information on how each cartel pursues compliance. By looking through each individual cartel contract it should be possible to obtain more detailed information on this and in turn test whether this influences the durability of cartels.

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A. Appendix

A.1 Exponentiated results of selected models

Table A.1: Exponentiated results of model 3, 5 and 6

	(3)	(5)	(6)
Pricing	0.912	0.972	0.978
	(0.235)	(0.246)	(0.249)
Payment rules	0.672	0.743	0.751
	(0.171)	(0.189)	(0.191)
Pricing & Payment rules	1.106	1.403	1.417
	(0.228)	(0.337)	(0.341)
Quota	0.420**	0.496**	0.505**
	(0.095)	(0.118)	(0.121)
Area-based	0.279**	0.295**	0.297**
	(0.107)	(0.111)	(0.113)
Non-area-based	0.528**	0.561**	0.564**
	(0.115)	(0.124)	(0.125)
Many mkt-alloc. based clauses (>1)	0.549**	0.613*	0.623*
	(0.121)	(0.133)	(0.135)
GDP negative deviation (100 million NOK)	1.034*	1.034**	1.034**
	(0.013)	(0.013)	(0.013)
GDP positive deviation (100 million NOK)	0.956**	0.957**	0.957**
	(0.015)	(0.015)	(0.015)
Law regime 1960-1965	0.954	0.957	0.984
	(0.307)	(0.310)	(0.322)
Law regime 1966-1987	0.498	0.501	0.512
	(0.213)	(0.216)	(0.222)
Law regime 1988-1991	0.363	0.381	0.387
	(0.217)	(0.231)	(0.235)
Cohort: 1960-1969	0.637*	0.640*	0.642*
	(0.115)	(0.119)	(0.120)
Cohort: 1970-1979	0.995	1.096	1.111
	(0.318)	(0.330)	(0.334)
Cohort: 1980-1991	2.243	2.333	2.354*
	(0.947)	(1.011)	(1.025)
Ln(number of members)	0.608**	0.602**	0.598**
	(0.067)	(0.066)	(0.066)
Number of members not known	0.788	0.754	0.751
	(0.196)	(0.190)	(0.191)
Number of members > 50	2.403	2.395	2.453
	(1.096)	(1.132)	(1.166)
Sales office			0.550**
			(0.120)
Exclusive sales office			9.999**
			(2.761)
Non-exclusive sales office		0.580*	
		(0.130)	

Notes: The values reported in this table are the exponentiated results of model 3,5 and 6 generated by using the eform command in Stata. * = significant at 95% level and ** significant at 99% level of confidence.

A.2 Coding manual

A.1.1 Cartel identification

In order to identify separate agreements that are part of the same cartel, each agreement has been assigned its own identification number and each cartel has been assigned a cartel number. Cartel number 706 serves as a good example of this as it has one agreement (agreement 7060) that concerns paper and cardboard, and a separate agreement (agreement 7061) that concerns newsprint. In order to be able to look up the details of the agreement in the cartel registry the official registry number of each agreement and the name and number of the category it belongs to has also been included.

Name	Variable type	Source
Cartel number	integer	assigned
Identification number	integer	assigned
Cartel registry number	integer	cartel registry
Category number	integer	cartel registry
Category name	text	cartel registry

A.1.2 Products and area

The product which each agreement applies to have been included as well as the Nace code and description of the industry that the upstream members of the agreement belong to. The binary variables “local” and “international” have the value 1 if the agreement only applies to a part of Norway, or if it applies to more countries including Norway, respectively. An agreement with members from other countries than Norway, where the market is limited to Norway is not considered international. The variable “market description” goes further in to detail about the area that the agreement applies to.

Name	Variable type	Source
Products	Text	cartel registry
Nace code	integer	assigned
Industry description	Text	assigned
Local	binary	cartel registry
International	binary	cartel registry
Market description	Text	cartel registry

A.1.3 Participants

The firms involved in the cartel agreements have been divided into "upstream" and "downstream" firms. If the binary variable "horizontal cartel" has the value of 1 the number of firms in the cartel is recorded only in "Number of firms (upstream)".

Name	Variable type	Source
Number of firms (upstream)	integer	cartel registry
Number of firms (downstream)	integer	cartel registry
Horizontal cartel	binary	cartel registry

A.1.4 Start and end dates

The value "birth" records the year the cartel agreement started according to the cartel registry. However the year the agreement ended is not available in the cartel registry for all cartel agreements. For the cartels where the end date is available, it is recorded by the variable "actual death". For some cartels, the end date is recorded be the variable "possible death", and set to the year previous the first cartel registry where the cartel agreement is no longer mentioned. Cartel number 322 is assigned a "possible death" value of 1961 as it is mentioned in the cartel registry of 1955 and 1957, but not in 1962. For all cartels that exist in the last cartel registry of 1991, the value of "possible death" is set to 1991.

Name	Variable type	Source
Birth	integer	cartel registry
Actual death	integer	cartel registry
Possible death	integer	assigned

A.1.5 Changes in the agreements

For each entry in the dataset, the value of "Cartel registry year" tells us from which cartel registry the information is gathered. The binary variable "Change in the agreement" is equal to 1 if the properties of the agreement (excluding a change in the number of members) has changed from the last cartel registry. The variable "Description of the change" describes the nature of the changes in the agreement. "Last entry" is a binary variable that is equal to 1 if the cartel agreement is not present in the next cartel registry. If the reason for why the cartel is not present in the next cartel registry is explained in a cartel registry appendix, that information is recorded by the variable "Last entry details".

Name	Variable type	Source
Cartel registry year	integer	cartel registry
Change in the agreement	binary	cartel registry
Description of the change	text	cartel registry appendix
Last entry	binary	cartel registry
Last entry details	text	cartel registry appendix

A.1.6 Cartel orientation

The binary variables “Buyer cartel”, “Seller cartel”, “Import cartel” and “Export cartel” identifies the orientation of the cartel agreement. As an agreement could include both a buyer and a seller cartel, multiple answers are allowed.

Name	Variable type	Source
Buyer cartel	binary	cartel registry
Seller cartel	binary	cartel registry
Import cartel	binary	cartel registry
Export cartel	binary	cartel registry

A.1.7 Market segmentation

There are multiple ways that cartels can segment a market. The variable “Sales/purchasing quota” identifies cartel agreements where the members are assigned quotas of how much they can either sell or buy a product. Agreements where the members are restricted to operate only in a certain area are identified by the variable “Exclusive territories”. If each member has restrictions on which kind of product variations it is allowed to produce the value of the variable “Product Specialization” is set to one. Finally, if the agreement put restrictions on suppliers or customers the value of the variable “Customer/supplier specialization” is set to one.

Name	Variable type	Source	Thesis category
Sales/purchasing quota	binary	cartel registry	Quotas
Exclusive territories	binary	cartel registry	Area-based
Product specialization	binary	cartel registry	Non-area-based
Customer/supplier specialization	binary	cartel registry	Non-area-based

A.1.8 Price and discounts

There are pricing rules that cartels can agree upon, where a fixed price is the most common one. Price ceilings, where a maximum price is set, and a price floor, where a minimum price is set, or a combination of both are also possible. For Norwegian cartels, it is also quite common to use suggested price as a tool. The suggested price differs from the fixed price in that the individual firms are not obligated to stick to the suggested price, but it still allows the firms in a cartel to coordinate their pricing.

There are two kinds of discounts that are commonly used, quantity discounts and sales channels discounts. Quantity discounts are given to customers who buy more than a given amount of the product, while sales channels discounts are given to certain types of customers. For instance, a chocolate cartel (cartel number 306) give a 15% discount to detailers on all chocolate, and an additional 2% discount on all purchases over 125kr. Finally, if the firms have agreed upon common payment conditions this is recorded by the variable "payment conditions".

Name	Variable type	Source	Thesis category
Fixed price	binary	cartel registry	Pricing
Suggested price	binary	cartel registry	Pricing
Price floor	binary	cartel registry	Pricing
Price ceiling	binary	cartel registry	Pricing
Price floor and ceiling	binary	cartel registry	Pricing
Quantity discounts	binary	cartel registry	Payment rules
Sales channels discounts	binary	cartel registry	Payment rules
Payment conditions	binary	cartel registry	Payment rules

A.1.9 Vertical exclusivity

If the downstream firms in a cartel is limited to only buying the product from the upstream firms in the cartel the value of the variable "exclusivity in distribution" is set to one. Similarly, if the upstream firms is limited to selling the product to the downstream members of the cartel, the value of the variable "exclusivity in purchase" is set to one.

Name	Variable type	Source	Thesis category
Exclusivity in distribution	binary	cartel registry	Non-area based
Exclusivity in purchase	binary	cartel registry	Non-area based

A.1.10 Norms and cooperation

If the cartel agreement puts a limit on the competition between the members, the variable "non-competition clause" is set to one. Some examples of that are a tin smith cartel (cartel number 1303) where the members have agreed not to finish a project started by one of the other members, and a transportation cartel (cartel number 1736) which bans all disloyal completion, where disloyal competition includes contacting costumers of the other cartel members. The variable "standardisation of product quality" is set to one if the cartel has agreed to how a common product should look and/or perform. If the members of the cartels cooperate on research and development and advertising the variables "technology" and "joint advertising" is set to one. The nature of the cooperation on research and development is described by the variable "technology description".

Name	Variable type	Source	Thesis category
Non-competition clause	binary	cartel registry	Non-area-based
Standardisation of product quality	binary	cartel registry	No main clause
Technology	binary	cartel registry	No main clause
Technology description	text	cartel registry	
Joint advertising	binary	cartel registry	No main clause

A.1.11 Non-member policy

The variable "new member criteria" is set to one if the cartel agreement mentions that new members may join the cartel. If there requirements to join the cartel are minimal then "minimal entry requirements" is set to one, and if the requirements are significant then "approval of entry explicitly regulated" is set to one. The variable "entry" is set to one if the cartel tries to limit entry in the market. An example of this is the scrap metal cartel (cartel number 809) whose office lists all approved scrap metal dealers and wholesalers. If the cartel agreement specifies how to deal with non-member supply, the variable "non-cartel supply" is set to one. For example, the members of a margarine cartel (cartel number 370) are allowed to disregard the price rules of the agreement if competition from non-members warrants it.

Name	Variable type	Source
New member criteria	binary	cartel registry
Minimal entry requirements	binary	cartel registry
Approval of entry explicitly regulated	binary	cartel registry
Entry	binary	cartel registry
Non-cartel supply	binary	cartel registry

A.1.12 Join sales company

If the members of a cartel have to sell all their supply of a given product through the cartels joint sales company, the variable "exclusive joint sales company" is set to one. If a joint sales company exists, but the members are not required to sell all of their supply through it, then the variable "non-exclusive joint sales company" is set to one.

Name	Variable type	Source
Exclusive joint sales company	binary	cartel registry
Non-exclusive joint sales company	binary	cartel registry

A.1.13 Monitoring, fines and dispute resolution

The variable "monitoring" is set to one if the cartel has implemented some sort of monitoring of the members. How the monitoring is handled is described by the variable "monitoring description". Sanctions, due to a breach of contract, come either in the form of some sort of fine or exclusion from the cartel. If the fine is proportionate to the severity of the breach, the variable "fine proportionate" is set to one. The variable "fine percentage" is set to one if the fine is set as a percentage of the perceived value gained by the breach of contract. If there is a limit to how small the fine can be, the value of "fine minimum" is set to one. "Exclusion" is set to one if a breach of contract can result in a member being excluded from the cartel. The variable "internal dispute resolution" is set to one if disputes are resolved by the cartel itself, and "external dispute resolution" is set to one if the disputes are handled externally. It is quite common that disputes are settled internally, but with the possibility of an appeal to an external arbitral tribunal. In those cases, both values are set to one.

Name	Variable type	Source
Monitoring	binary	cartel registry
Monitoring description	text	cartel registry
Fine proportionate	binary	cartel registry
Fine percentage	binary	cartel registry
Fine minimum	binary	cartel registry
Exclusion	binary	cartel registry
Internal dispute resolution	binary	cartel registry
External dispute resolution	binary	cartel registry