The role of personality traits on price cartel characteristics

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En rapport skriven av
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Förord

I Konkurrensverkets uppdrag ingår att främja forskning på konkurrens- och upphandlingsområdet.

Konkurrensverket har gett dr Magnus Söderberg vid CERNA, Mines ParisTech i uppdrag att, inom ramen för Konkurrensverkets uppdragsforskning, undersöka betydelsen av både ekonomiska incitament och individers personlighetsdrag för bildandet och varaktigheten av priskarteller.

Denna studie är den första som undersöker personlighetsdrag i en konkurrensekonomisk tillämpning och preliminära resultat indikerar att både ekonomiska incitament och individers personlighetsdrag påverkar bildandet och varaktigheten av priskarteller. Studien är intressant då den ger en ökad förståelse till varför personer och företag bildar och deltar i kartellverksamhet.

Till projektet har knutits en referensgrupp bestående av Mats Bergman (Södertörns högskola), Lars Persson (IFN), Patrik Ekheimer (Chalmers), Lars Korsell (BRÅ) samt Marcus Asplund (KTH). Från Konkurrensverket har Omar El Kathib samt Joakim Wallenklint deltagit.

Författaren ansvarar själv för alla slutsatser och bedömningar i rapporten.

Stockholm, oktober 2014

Dan Sjöblom
Generaldirektör

Innehåll

Sammanfattning

Bekämpandet av priskarteller börjar med att ta reda på vilka faktorer som påverkar bildandet och varaktigheten av karteller. Den nationalekonomiska litteraturen har nästan uteslutande antagit att förekomsten av karteller bestäms av ekonomiska incitament. Den psykologiska litteraturen menar å andra sidan att det är individers personlighetsdrag som påverkar förekomsten av karteller. Syftet med denna studie är att integrera den ekonomiska och psykologiska litteraturen och undersöka betydelsen av både ekonomiska incitament och individers personlighetsdrag för bildandet och varaktigheten av priskarteller. Denna studie är den första som undersöker personlighetsdrag i en konkurrensekonomisk tillämpning och den innehåller omfattande ekonometriska analyser för att fastställa betydelsen av varje enskilt personlighetsdrag.

Undersökningen bygger på s.k. ekonomiska experiment. Mer konkret skapas (i) ett förfrågningsunderlag för att mäta ett antal potentiellt relevanta personlighetsdrag och (ii) ett prissättningsspel där individer kan kommunicera och besluta sig för att samordna sina priser. Totalt 33 individer har deltagit i undersökningen (11 prissättningsspel med tre personer i varje).

Preliminära resultat indikerar att både ekonomiska incitament och individers personlighetsdrag påverkar bildandet och varaktigheten av priskarteller. I situationer då individer nyligen har ingått i en priskartell är det mer sannolikt att de också kommer att ingå i en kartell i nuvarande period. Det kan tolkas som att då koordineringskostnaden är låg och det redan finns en tillit bland individerna att inte avslöja varandra ökar frekvensen av karteller. Då individer tidigare signalerat att de kan höja priset över den konkurrensutsatta jämviktsnivån ökar också benägenheten att ingå karteller. Detta kan tolkas som en signal till andra aktörer att man är intresserad av att ingå en kartell. Vad gäller personlighetsdrag tenderar samvetsgranna och hedonistiska individer att vara med benägna att ingå karteller. Dessutom varar prissamarbeten längre då de individer som ingått prissamarbetet har narcissiska personlighetsdrag. Individer med hög självkontroll är varken mer eller mindre benägna att delta i priskarteller. Detta står i kontrast till en stor del av den tidigare litteraturen som menar att just självkontroll är en central faktor för att förstå varför brott begås rent allmänt.

Summary

Fighting price cartels begins by understanding what factors influence the formation and duration of cartels. The economic literature has almost exclusively assumed that the existence of cartels is determined by economic incentives. A review of the psychology literature shows that certain personality traits may have an impact on cartel characteristics. This study develops (i) a survey to measure a number of potentially relevant personality traits and, (ii) a duopolistic Bertrand game where individuals can communicate and decide whether to coordinate prices. A total of 33 individuals participate in the complete experiment (11 experiments with 3 individuals in each). Preliminary results provide support for that some of the investigated personality traits can influence both the formation and the duration of price cartels.

1 Introduction

There are at least two reasons for why the economic literature on cartels is voluminous: (i) cartels can, and often do, raise the market price substantially, and (ii) because the population of cartels is unobserved, their general characteristics are uncertain. In order to fight cartels, there is a need to understand what factors influence the formation and duration of cartels. The more factors that are identified, and the higher the precision with which those can be determined, the better authorities and firms themselves can prevent and detect cartels. Previous studies have found that the presence of cartels is related to industry concentration, product differentiation, excess capacity, entry barriers and different antitrust enforcement policies such as leniency programmes that have been studies in several recent papers (Holt, 1995; Levenstein and Suslow, 2006; Bigoni et al., 2012).

To this date, the economic literature has almost exclusively assumed that cartels are determined by economic incentives. This view is clearly revealed in the following statement by Fejø (2001, p. 159):

"Why has the Commission not yet put so high fines on hard core cartels that they have been met with the reaction from the side of the Court of First Instance and the European Court of Justice that the fine in itself is too heavy. The answer must be that until this happens hard core cartel members are not treated harshly enough, since hard core cartels still exist …"

However, experiences from other types of crimes suggest that this view may be too simplistic. For example, violent crimes are not eliminated even under the harshest possible punishment (capital punishment). The economic explanation to why individuals commit illegal actions even when a cost-benefit analysis suggests that they should not is that individuals are not fully rational. Other scientific disciplines have looked more deeply into these 'irrationalities', although they have often studied white-collar crimes rather than the more narrowly defined antitrust violation that is the focus in this study. For example, sociologists have studied the relationship between white-collar offenders and their social context (e.g. Engdahl, 2011; Kennedy and Ticknor, 2012; Sutherland, 1983), i.e. what economists would refer to as situational irrationality. These studies have found that the organisational culture and other characteristics of the organisation, affect the likelihood of organisational offending (Simpson and Koper, 1997). Psychologists have found that there is a relationship between certain personality traits and the propensity to commit white-collar crimes (e.g. Alalehto, 2003; Blickle et al., 2006), i.e. what economists would label as individual-specific irrationality.

Anecdotally, it is interesting to note that the Swedish Competition Authority and the Swedish National Council for Crime Prevention have found that individuals who participate in cartels are relatively more likely to have a criminal record. A positive relation between white-collar crimes and previous criminal offences (both

white-collar and street crimes) has also been identified in the literature (e.g. Weisburd and Waring, 2001). Hence, this suggests that, keeping economic incentives constant, there may be insights to gain about the working of cartels that economists so far have not paid much attention to. While there are several studies investigating the relationship between white-collar crime and personality, no study have looked at the relationship between only antitrust violations and personality. The purpose of this project is fill that gap, or more specifically to econometrically investigate if personality traits are related to individuals' propensity to engage in price collusion.

The primary challenge when investigating cartels empirically is that of data availability. When revealed data is used analysts are restricted to the sub-sample of detected cartels and those are not necessarily representative for all cartels. Even if they are representative of all cartels, they are not observed at the time they are formed and objective data representing the formation is difficult to extract for a sample large enough for meaningful econometric investigations. These problems are also present in the psychology literature referred to above since it relies entirely on market data. A second empirical problem is that results based on real competition cases have turned out to be sensitive to the particular modelling strategy, e.g. the models' functional form (Paha, 2011; Kühn, 2001). This may suggest that important explanatory factors are unobserved and/or that the relationship between factors are more involved than what standard linear models are able to reveal. A third challenge when using market data is that cartels do not have to be single binary groups (member vs. non-member) but can consist of a complex network of direct and indirect members where some firms are more active than others, e.g. when the cartel is created (Goyal and Joshi, 2003). For all these reasons, empirical strategies other than those that rely on revealed market data should be explored.

This project uses an experimental research design based on a duopolistic Bertrand game with multiple periods where individuals play the role of business leaders. From period 5, and in all subsequent periods, a third firm can decide whether it wants to enter/exit the market. This is an extension of the majority of pricing games performed previously and the purpose is to capture the dynamics of entry/exit that a market is likely to experience when prices fluctuate. Players can engage in free-form communication. This loosely structured communication format allows the investigations to treat cartel initiators and followers separately and specifically, to determine if they have different personality traits. This distinction is important as cartel initiators often act as ringleaders. If players decide to collude on prices, they have the possibility to self-report the cartel. If they do not self-report, the cartel can be detected with an exogenous probability of 10%.

Some cartel characteristics that have previously been found to be economically relevant have been excluded from this project to make it manageable. First, the experiment only considers individual decision-making. In reality, more individuals can be involved in a firm's price setting process and Gillet et al (2011) has found that group decisions, and in particular group decision rules, can result in outcomes

that are distinct from decisions made by individuals. Second, it is also assumed that no governance issues are present, i.e. a firm's shareholders have the same incentives as the single price setter. Third, number of firms in the market has been claimed to have a potentially strong impact on firms' price setting behaviour (e.g. Huck et al., 2004). A robust finding is that as the number of firms involved in the cartel increases, the risk for the cartel collapsing also increases (e.g. Dufwenberg and Gneezy, 2000; Zu et al., 2012). Here number of firms varies by the decision of the third player to enter and exit the market, i.e. number of firms in the market is endogenous.

2 Literature Review

This literature review draws on both economic studies on cartels (Section 2.1) and the psychology literature on white-collar crime (Section 2.2).

2.1 Economists view on cartels

According to the economic theory of crime developed by Becker in the 1970s, criminal offenders are rational agents who weigh the rational expected utility of every criminal opportunity against its expected cost. In other words, individuals will commit crimes if the criminal actions result in net material advantages. One important assumption of Becker's theory is that people are generally driven by their desire for material goods and pleasure. Support for this view is provided by Coleman (1987) who argues that economic crimes are motivated by the culture and social settings the offenders live in. Criminal offenders tend to live in social environments that attach high value to material success and wealth (Coleman 1987, Blickle et al. 2006).

Support for the Becker's economic explanation in the context of cartels has been provided by scholars studying the impact of leniency programmes. Miller (2009) shows both theoretically and empirically that the introduction of a firm leniency programme increases both deterrence and detection rates. Brisset and Thomas (2004) reach a similar conclusion in their theoretical model. Brenner (2009) suggests that the 1996 EU Leniency Program improved agencies' access to information about cartels and the length of their investigations got shorter. The limited evidence that exists on the formation of cartels suggests that cartels form when prices fall, i.e. when the benefit of creating a cartel increases (Levenstein and Suslow, 2012). Moreover, Levenstein and Suslow (2011) find that cartel break-ups depend on active antitrust enforcement, the financial stability of a significant producer, and whether cartels have policies for punishing members that deviate from agreed-upon behaviours. Hence, these studies provide support for that the presence of a cartel and the strength of economic incentives are positively related.

Economists have dismissed that personality affects individuals' propensity to commit economic crimes (Shapiro, 1990; Ruggiero, 2000). The justification of this has been that a separation of the individual and the act is necessary for analytical tractability, i.e. to not confuse the act with the character. Instead, economists claim that it is the situation, the organisational structure and the norm system that are the determinants of a criminal act. The reminder of this section summarises the economic aspects that are relevant in the experiment that we present in Section 3.

The only study that takes personal characteristics into account is Sabaster-Grande and Georgantzis (2002) where individuals' level of risk appetite is investigated. They find that risk aversion is negatively related to collusive behaviour.

2.2 Psychologists view on white-collar crimes

Psychologists seek to describe human behaviour with stable underlying dispositions. For example, when people are caught lying or cheating they are considered dishonest; when they perform poorly they are said to lack ability or motivation; and when they help a person in need they are called altruistic or compassionate (Aizen, 2005). Such personality factors are generally believed to exert influences on behaviour that are relatively consistent over time (Klein et al., 2004).

Psychologists' interest in the link between economic crime and personality started when Edwin Sutherland claimed that personality has no relevance for the likelihood of economic crime (Sutherland, 1983). Since then, Sutherland's conclusion has been fiercely challenged and there are now several studies in the psychology field suggesting that there is a meaningful relationship between personality and the likelihood to commit crimes (e.g. Boes et al., 1997; Moffitt el al., 1995). More specifically, Alalehto (2003) and Blickle et al. (2006), both find that white-collar offenders have a significantly different personality compared to non-offenders. This literature is extensively reviewed by Ragatz et al., (2012).

While Shapoiro (1990) and Ruggiero (2000) highlight the challenge of empirically separating the situational/norm factors and personality traits, it appears defensive to completely disregard personality given these findings by psychologists. In fact, by controlling the economic incentives and keeping all other situational factors constant in a lab experimental, it is possible to investigate the causal relationship between personality and the propensity to commit crimes. That is the methodological approach used in this study, which is explained more fully in Section 3. Four personality traits have been found to have particularly strong influences on white-collar crimes. The following sections review those traits.

2.2.1 Conscientiousness

Conscientiousness refers to the tendency to be dutiful, persistent, responsible, careful, prepared, organized, and detail-oriented (Klein et al., 2004). In their study, Collins and Schmidt (1993) compared prison inmates convicted of white-collar offences with individuals employed in positions of authority. They found that the convicted white-collar criminals showed a greater tendency for irresponsibility, a disregard for rules, high risk-taking, and unreliability than non-convicted individuals. Collins and Schmidt (1993) derived that the identified characteristics can be summarized as 'conscientiousness'. However, Blickle et al. (2006) were not able to replicate this result. Hence, there is at least some evidence that higher level of conscientiousness leads to a lower probability of an individual committing an economic crime.

2.2.2 Self-control

Self-control has been used as a distinct personality trait by many criminologists as an explanation of white-collar as well as common crimes (e.g. Zahra et al. 2007, Marcus 2004, or Klein et al. 2004). The General Theory of Crime states that all criminal offences are associated with low self-control shared by all criminals (Gottfredson and Hirschi, 1990, as cited by Marcus, 2004). Moreover, this stream of the literature argues that individuals with low self-control are risk-takers who, when the opportunity presents itself, easily resort to criminal behaviour in order to achieve their goals. Thus, companies that participate in price competition can be a tempting setting for committing antitrust violations for those managers who have low self-control. While a low level of self-control has been found empirically to increase the likelihood of individuals committing crimes (e.g. Collins and Bagozzi, 1999), studies have also suggested that there is no such relationship (Listwan et al., 2010).

The calculating criminal has also been described as socially competent who, although he is ruthless in his criminal act, knows how to behave in a dignified and social manner in public. He also knows how to work persistently to achieve goals that are admirable by others (Alalehto, 2003, and references therein). This behaviour requires social control. However, Zahra et al. (2007) claim that even individuals that have reached the highest level sometimes show signs of low self-control, and they mention Bill Clinton as an example.

A more nuanced impact of self-control on crime might be that a lack of self-control only manifests itself when the situation is troublesome. Alalehto (2003, p. 341) mentions that a situation-dependent criminal may commit a crime because he is close to bankruptcy or because he is unable to handle his affairs in a business-like manner. An interaction between social control and financial status might therefore be relevant to evaluate.

2.2.3 Hedonism

Schmitt et al. (1993) conducted a longitudinal study of values, where they found that variance of value measures can to a large extent be explained by individual differences in value priorities. Similarly, individuals differ in their valuation of material wealth and enjoyment of life. Individuals who believe that the level of material consumption is central to their lives and those who attach high weight to pleasure are called hedonists (Klein et al., 2004). Simon (1999) claims that the competitive spirit that often characterises business leaders is just a sign of perpetual pursuit of money since money is a sign of success and social status. Hence, all else equal, one can hypothesise that a higher level of hedonism leads to an increased likelihood of crime.

2.2.4 Narcissism

In the 1960s psychiatric case studies were used to study white-collar criminals. One finding, which has later been confirmed by others, was that economic criminals are typically narcissistic, implying that they are omnipotent and tend to identify themselves with both the wealth and power of their company as well as achieving success at any price (Alalehto, 2003; Blickle et al. 2006; Ames et al., 2006). This omnipotence induces a person to break the law if it serves his self-interest (Alalehto, 2003). Closely related to this is the finding by Terpstra el al. (1993) who find that highly competitive individuals are more likely to report intensions to engage in insider trading. It can be hypothesised, therefore, that a narcissistic individual is more likely to take part in cartels.

3 Method

As mentioned, it is difficult to identify cartel characteristics based on revealed market data, and communication, which is a key facilitator of cartels (e.g. Neven, 2001), is particularly challenging to observe. The investigation in this study therefore uses repeated duopoly/triopoly games where economically incentivised individuals are asked to play the role of business executives in discrete Bertrand price games with differentiated products.

Individuals were invited to participate in the experiment and paid a flat show-up reward (€5) plus a performance-based reward at the end of the experiment. The average performance-based reward was €17.14 and the maximum was €56.38. In the experiments, "points" were used as currency where 1 point corresponded to 0.01 euro. Each individual only participated in one experiment and none had previously participated in a pricing game. Individuals were recruited among business and engineering students at Gothenburg University (Sweden) and Mines ParisTech (France). A total of 11 experiments (with 3 individuals in each experiment) were executed. The complete experiment consisted of two parts: (1) the personality assessment and (2) the cartel experiment. Both parts took approximately 2 hours and 15 minutes to complete.

Three players participate in each experiment but only two players participate in periods 1-4. Player 3 can decide to join the game in Period 5, which s/he decides, and reveals to the other players, at the end of Period 4. In all subsequent periods, Player 3 decides whether s/he wants to participate in the game in Period t at the end of Period t-1. If s/he stays outside, s/he earns a low but certain profit (100 points). Player 1 and 2 are participating in the game in every period. If Player 3 joins the game and makes a loss three periods in a row, it is considered bankrupt and is forced to stay outside the market for five consecutive periods. When five periods have passed, Player 3 can again decide whether it wants to participate in the game or stay outside in each period.

3.1 Personality assessment

The personality assessment uses questionnaires with questions that are standard in the assessment of personality within the psychological discipline. Conscientiousness can be determined using the Big-five factor model, a model that has gained acceptance as a general classification of personality traits (e.g. Klein et al., 2004). The model suggests that five traits can be used to describe the most relevant aspects of personality. Each trait is measured by asking respondents to rate how much they agree with each statement on a five-point scale from 1 (very inaccurate) to 5 (very accurate). Ten questions/statements are available for measuring self-control (Goldberg et al., 1996). Again, respondents are asked to indicate for each of the statements to what extent they agree on a scale from 1 to 5. No standardised set of

questions were identified for measuring hedonism. To find a proxy for it, respondents were asked to indicate on a scale from 1 (not important at all) to 5 (very important) how important 'pleasure' and 'enjoying life' were to them. Narcissism is measured with the 16-item Narcissistic Personality Inventory (NPI-16), which was developed by Ames et al. (2006).

Some of the personality traits used here, e.g. conscientiousness and hedonism, may be influenced by what is considered socially desirable responses. Conceivably, individuals want to be judged as dutiful, responsible and materially successful and such desires can lead to biased responses (Klein et al., 2004; Mick, 1996). To reduce this type of bias, individuals' level of social desirability is also measured and included and as a control variable in the analysis. Figures A1-A5 in Appendix A show examples of questions/statements used in the assessment to construct these variables.

In addition to these personality traits, risk preference is included as a separate variable. This is to control for the association between risk and collusion found by Sabaster-Grande and Georgantzis (2002). Additionally, risk preference is often used in the economic literature as a composite measure of 'personality'. The inclusion of risk therefore provides a direct test of whether the four personality traits explain anything unique in relation to more standard economic specifications. Moreover, since conscientiousness and self-control have been claimed to be related to risk preference (see above), the inclusion of individuals' risk preferences provides a cleaner measure of these traits. To measure risk preference, we use the method suggested by Holt and Laury (2002) that is based on the repeated choice of two pairs of lotteries. The choice scenarios used in this study are provided in Figure A6.

3.2 Cartel experiment

Sessions were organised with 2-4 experiments at the time. The experimental administrator matched individuals randomly in groups of three and this matching was fixed throughout the experiment. At the beginning the players were seated so that they could not see or communicate with any other player. Once seated, the instructions were read out load by the administrator. The same instructions were also handed out in writing and the players were given time to read through everything and ask questions (in public) before the game started.

In the first stage of the experiment, players decide whether they want to communicate with each other. If players decide to communicate they do so by writing their messages on paper notes. When players have written their messages the administrator collects the notes and passes them on to the right players. This paper-and-pencil format has the substantial advantage of allowing the administrator to separate communication meant to form/sustain a cartel from any other form of communication in real time. Computer-based experiments often make the assumption that a cartel is formed as soon as any form of communication has taken

place between players. This is a restrictive assumption as it is unrealistic that firms only discuss coordination of prices when they interact. When reviewing messages in this experiment, it is indeed revealed that a majority of messages were not explicit attempts to coordinate prices. To eliminate the risk that this paper-and-pencil format has any impact on the behaviour, experiment fixed effects are included in all econometric estimations.

The communication stage continues for a maximum of 10 minutes where players can send as many notes, and communicate with as many other players, as they wish. This free-form communication is more realistic compared to other forms of communication and it has been found to increase cooperation among players (Fonseca and Normann, 2012; Cooper and Kuhn, 2009). Next, players are asked to simultaneously set the price of their single product, where the price could be {1, 2, 3, 4, 5, 6}. Players can identify the profit they get in Profit Tales provided in the documents handed out at the beginning of the experiment. The profits displayed to players are based on a standard linear Bertrand game, similar to what is used by Bigoni et al (2012). When there are two players in the market, the profit levels are as displayed in Table 1. The more extensive profit outcomes in the case of three players are displayed in Tables B1 and B2 in Appendix B.

Players know the number of competitors before setting their prices. Player 1 and 2, who are always in the market, have the same profit function, which is public knowledge. Player 3 has a different profit function where it earns somewhat lower profit to reflect that an unestablished firm needs to spend more on marketing activities to attract customers.

Table 1. Profits when there are two players in the market

Your price \ Your competitor's price	1	2	3	4	5	6
1	-10	-10	-10	-10	-10	-10
2	-49	84	217	350	483	616
3	-263	-63	137	336	536	735
4	-602	-336	-70	196	462	728
5	-1068	-735	-403	-70	263	595
6	-1659	-1260	-861	-462	-63	336

In addition to being a function of own and competitors' prices, profit levels vary depending on the number of competitors. The unique competitive equilibrium is achieved when all players set their prices equal to 2, regardless of whether there are two or three players in the market. All players can earn higher profit if they coordinate their prices at higher levels. Maximum profits are realised when all firms set their prices at 6. At this price a player can increase its profit from 336 to 735 (when there are two players in the market) by undercutting the joint profit-maximising price to 3. When there are three players in the market, the joint profit

maximising price is also 6, where Players 1 and 2 earn 276 points and Player 3 earns 245 points. Players 1 and 2 can optimally undercut by setting the price to 4, where each would get 328 points. Player 3 maximises its profit by undercutting the price to 5, where it earns 264 points. These numbers also show that profits generally drop when the number of firms increases from two to three and that Firm 3 earns less than Firms 1 and 2.

Once all players have submitted their prices they receive feedback on prices and profits for each player. Conditioned on price coordination above the competitive benchmark, any player that participated in the cartel can self-report the cartel to a fictitious authority. The reporting player is then granted immunity but other participating players have to pay a fine, amounting to 600 points. If two or more players report the cartel in the same period, they pay half the fine (300 points) each, and the third player pays the full fine (if there are three players in the market). If all three players self-report, each player pays a third of the full fine (200 points). If a cartel is formed and no player reports it, the cartel is detected with an exogenous probability of 10%.

The experiment lasts for at least 15 periods, but not more than 30 periods. The probability the experiment ends in each period when the number of periods is between 15 and 30 is 5%. The players are only informed that there will be at least 10 periods, and that in every subsequent period there is a 5% probability the experiment ends. Because all experiments last for at least 15 periods, the empirical analyses are restricted to the first 15 periods.

At the end of each round each player is given a note with all relevant information: prices set by each player, profit earned by each player, if the potential cartel was reported or detected, if the game ends or not and if Player 3 is going to be in the market in the following period.

4 Analysis

This section presents the data, descriptive statistics and econometric results.

4.1 Data

Eleven complete experiments have been conducted, implying that 33 individuals ('players') have participated. Variables displayed in Table 2 are recorded for each experiment, period and player. The key variables in the analyses are the ones that describe the characteristics of cartels: their formation and duration. To investigate the formation of cartels, the analysis focuses both on what determines one player to suggest the formation of a price cartel (to one or both the other players) and when two or three players agree to form a cartel. This is potentially important as those being active and passive founders of cartels may be driven by different personality traits and a cartel may be avoided by targeting those individuals that are active. However, that is an empirical question as those that are active might have made the suggestion only after finding out from pre-stage communication that the other player is positive about the cartel. Cartel duration, which is defined as the number of periods the cartel has been active, is investigated separately.

Table 2. Variable names and descriptions

Variable	Description
Communication	Dummy var = 1 if player communicated with any other player
Cartel_suggested	Dummy var = 1 if player suggested price cartel
Cartel_agreed	Dummy var = 1 if cartel was agreed with any other player
Cartel_duration	Count var indicating the number of periods a cartel has been active
Risk	Players risk preference
Conscientiousness	Level of conscientiousness (based on average of 20 statements, using a Likert scale from 1 to 5)
Self-control	Level of self-control (based on average of 10 statements, using a Likert scale from 1 to 5)
Hedonism	Level of hedonism (based on average of 2 statements, using a Likert scale from 1 to 5)
Narcissism	Level of narcissism (based on average of 16 statements, using binary true/false responses)

To investigate this econometrically, three different variables are used as dependent variables in three different models: Cartel_suggested is a binary variable taking the value 1 when the player has suggested to one or both the other players to form a price cartel; Cartel_agreed is a binary variable taking the value 1 when two or three players have agreed to form a price cartel; Cartel_duration is a count variable indicating for how many periods a cartel has been active.

In contrast to computer-based experiments where communication between two or more players is often treated as the establishment of a cartel, this study identifies cartels by going through the actual communication between players and it defines the suggestion/formation of a cartel only when players have explicitly suggested/agreed to coordinate prices.

4.2 Descriptive analysis

Descriptive statistics for the variables defined in Table 2 are displayed in Table 3. Data used in the analyses is restricted to periods 1-15 to get a balanced sample. From Table 3 one can observe that Communication takes place, on average, in every fourth period and cartels are suggested in about half of the periods where communication takes place (11% of all periods).

Table 4 contains a correlation matrix for the same variables. One can observe that none of the five personality traits are strongly correlated with the suggestion or agreement of cartels. Also, the personality traits are not strongly correlated with each other, indicating that each of them captures unique individual-level features. It is also worth emphasising that communication is strongly correlated with both the suggestion and agreement about a cartel, confirming the important role of communication.

Table 3. Descriptive statistics

Variable	Mean	S.D.	Min	Max
Communication	0.2410	0.4281	0	1
Cartel_suggested	0.1084	0.3112	0	1
Cartel_agreed	0.1044	0.3061	0	1
Cartel_duration	0.2731	1.0198	0	8
Risk	5.6285	1.3784	3	10
Conscientiousness	3.5486	0.5779	2.4	4.65
Self_control	3.2566	0.5274	2.1	4.4
Hedonism	4.5301	0.3673	4	5
Narcissism	0.3513	0.2184	0.125	0.9375

Table 4. Partial correlation matrix

	Communi-cation	*Cartel_ suggested*	*Cartel_ agreed*	*Cartel_ duration*	*Risk*	*Conscien-tiousness*	*Self-control*	*Hedonism*	*Narcissism*
Communication	1								
Cartel_suggested	0.5940	1							
Cartel_agreed	0.5810	0.4934	1						
Cartel_duration	0.4543	0.4517	0.7851	1					
Risk	-0.0822	-0.0654	-0.0748	-0.0494	1				
Conscientiousness	-0.0829	-0.0629	0.0293	0.0688	0.0779	1			
Self-control	-0.0943	-0.1049	-0.0728	-0.0546	0.1209	0.3803	1		
Hedonism	0.0228	0.0858	0.0078	0.0559	0.1990	-0.0709	-0.2025	1	
Narcissism	0.2010	0.1508	0.1030	0.0201	-0.0189	-0.0189	-0.1188	-0.0538	1

4.3 What influences the formation of a cartel?

The first model uses Cartel_suggested as the dependent variable, and in the baseline specification it uses personality traits and risk preference as explanatory variables. Period and experiment fixed-effects are included as controls. The period fixed effects control for general learning/experience (see Altavilla et al., 2006, for further details) and the experiment fixed effects capture what may vary across experiments, such as questions asked by players (and answers given to those questions), participants' state of mind etc.

The estimated parameters for this model using OLS are included in column (1) in Table 5. In an extended specification two additional variables are used as explanatory variables: Cartel_suggested and average market price in the previous period. If a cartel was suggested in the previous period, then the individual had already collected enough information to come to the conclusion that it was meaningful to suggest a cartel in that period. If the response was positive in that period, it seems likely that the individual will suggest a cartel in the present period as well. A negative response in the previous period can reveal more information about the competitor that can help the individual to rephrase a suggestion in the present period. This extended model is displayed in column (2).

Two additional specifications are also evaluated. Column (3) uses model (1) as a starting point and adds the four personality traits and risk preferences of the competitor(s) that are asked to join in the formation of the cartel. The justification for this extended specification is that players may assess the willingness of competitors to start a cartel before they make the formal suggestion. When a suggestion is put forward to two other competitors, these variables are the average of those two. The specification in column (3) is also extended to include the personality traits of the competitors; this is displayed in column (4).

Table 5. Regression output using *Cartel_suggested* as dependent variable.

Variable	(1) Mean (S.E.)		(2) Mean (S.E.)		(3) Mean (S.E.)		(4) Mean (S.E.)	
Lag: Cartel_suggested			0.2799	***			0.2636	**
			(0.0936)				(0.0971)	
Lag: Average price			0.0477	**			0.0489	**
			(0.0205)				(0.0213)	
Conscientiousness	0.0003		0.0083		0.0204		0.0144	
	(0.0377)		(0.0270)		(0.0357)		(0.0213)	
Self-control	-0.0062		-0.0125		0.0175		0.0026	
	(0.0522)		(0.0380)		(0.0511)		(0.0392)	
Hedonism	0.1574	***	0.1063	**	0.1986	***	0.1459	***
	(0.0573)		(0.0405)		(0.0638)		(0.0531)	
Narcissism	0.1561		0.1033		0.2814	**	0.1742	
	(0.0974)		(0.0708)		(0.1242)		(0.1057)	
Risk	-0.0053		-0.0091		-0.0310	*	-0.0436	**
	(0.0093)		(0.0074)		(0.0162)		(0.0218)	
Conscientiousness of competitor(s)					0.0101		-0.0328	
					(0.1367)		(0.1022)	
Self-control of competitor(s)					0.0518		0.0405	
					(0.0796)		(0.0634)	
Hedonism of competitor(s)					-0.0315		-0.0247	
					(0.1460)		(0.1087)	
Narcissism of competitor(s)					0.3316		0.2148	
					(0.2361)		(0.1818)	
Risk of competitor(s)					-0.0517	*	-0.0436	*
					(0.0296)		(0.0218)	
Period Fixed Effects	Yes		Yes		Yes		Yes	
Experiment Fixed Effects	Yes		Yes		Yes		Yes	
R^2	0.212		0.349		0.231		0.357	
No obs	498		465		498		465	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered over players.

As displayed, both lagged effects (i.e. cartel suggested and average price) are highly relevant. They are both relevant at least at the 5% level, increase R2 substantially and they affect the other parameters. The fact that they are both positive imply that if a cartel was suggested in the previous period by a player, then the probably that the same player will suggest a cartel in the present period is about 25 percentage points higher. The fact that higher prices in the previous period lead to a higher likelihood of a cartel being suggested in the present period can be interpreted as higher prices signalling a stronger willingness to participate in price cartels. A model where cumulative profit was an additional variable was also evaluated but it did not give any further insights (detailed results not reported here). Hence, there is no evidence that individuals take higher risks and suggests the formation of a cartel as their financial status deteriorates.

Neither conscientiousness nor self-control appear to have any meaningful impact. Hedonism is the only personality trait that has an influence on the likelihood of a cartel being suggested that is consistently and significantly different from 0 across the four models. Narcissism is positive in all models, but only significant in one of the models. Risk preference is negative in all models and at least weakly significant when competitors' characteristics are included. Remembering that higher values of Risk imply increasing risk aversion, one would conclude that a more risk averse individual tends to be less inclined to suggest a cartel, which is consistent with expectations.

Although none of the competitor's personality traits are significant at any conventional level, they seem to exert relevant influences on the estimated parameters. Interactions between own and competitor's personality traits may be an interesting extension to this specification but more observations are needed to find robust results when both main effects and interactions are considered.

A more direct investigation of the establishment of cartels is to investigate what influences the agreement of a cartel, i.e. when two or three players have agreed to raise their prices. This is investigated by re-running the specifications displayed in Table 5, but using Cartel_agreed as the dependent variable. Interactions between own and competitor's personality traits have not been evaluated but here it seems even more relevant than when Cartel_suggested is used as dependent variable. Interactions in this case are justified by the fact that an agreement can only be reached when all players involved have certain personality traits. Reading the communication between players, it is not unusual to observe that some players consistently refuse to engage in cartels, even when competitors are importunate about raising prices. This specification will be evaluated when more data is available.

The results displayed in Table 6 are structurally similar to those in Table 5. The most striking results are the strong impacts of the two lagged effects. When only own personality traits are included (models (1) and (2)), results are generally weaker but the coefficient signs are in accordance with expectations and similar to those found in Table 5. Results become substantially stronger when competitor's personality traits are also included (model (3) and (4)), but only own traits are consistently significant across models.

A final note about the estimates displayed in Tables 5 and 6 is that they have been estimated using OLS. A dynamic binary model should ultimately be used when the lagged dependent variable is used as explanatory variable to solve the initial condition problem. That will been done in the future.

Table 6. Regression output using *Cartel_agreed* as dependent variable.

Variable	(1) Mean (S.E.)		(2) Mean (S.E.)		(3) Mean (S.E.)		(4) Mean (S.E.)	
Lag: Cartel_agreed			0.3461	***			0.3212	***
			(0.0953)				(0.0945)	
Lag: Average price			0.0781	**			0.0815	**
			(0.0306)				(0.0310)	
Conscientiousness	0.0513		0.0366	*	0.0634	*	0.0468	*
	(0.0308)		(0.0188)		(0.0339)		(0.0234)	
Self-control	-0.0257		-0.0241		0.0459		0.0312	
	(0.0419)		(0.0260)		(0.0625)		(0.0439)	
Hedonism	0.0758		0.0532	**	0.1984	**	0.1526	**
	(0.0470)		(0.0258)		(0.0826)		(0.0593)	
Narcissism	0.0785		0.0273		0.2362	**	0.1546	
	(0.0861)		(0.0542)		(0.1157)		(0.0928)	
Risk	-0.0032		-0.0023		-0.0399	*	-0.0301	*
	(0.0077)		(0.0049)		(0.0229)		(0.0157)	
Conscientiousness of competitor(s)					0.0428		0.0349	
					(0.1499)		(0.1079)	
Self-control of competitor(s)					0.1461	*	0.1129	
					(0.0800)		(0.0668)	
Hedonism of competitor(s)					0.1913		0.1588	
					(0.1574)		(0.1313)	
Narcissism of competitor(s)					0.3064		0.2377	
					(0.2565)		(0.1904)	
Risk of competitor(s)					-0.0529		-0.0388	*
					(0.0328)		(0.0225)	
Period Fixed Effects	Yes		Yes		Yes		Yes	
Experiment Fixied Effects	Yes		Yes		Yes		Yes	
R^2	0.188		0.461		0.217		0.478	
No obs	498		465		498		465	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered over players.

4.4 What influences the duration of a cartel?

To investigate the duration of cartels, Cartel_duration is used as the dependent variable, a zero-inflated negative binomial regression model is estimated. Here only the specification with interactions between own and competitors' personality traits is reported since alternative specifications provide weaker results. As displayed in Table 7, conscientiousness and narcissism are both positively and significantly correlated with the duration of cartels.

A specification where cumulative profit for each player was included as an explanatory variable suggested that that financial status is positively related to cartel duration. The results were rather weak though and are not reported here.

Table 7. Regression output using *Cartel_duration* as dependent variable.

Variable	**Mean (S.E.)**	
Interaction between own and competitors' conscientiousness	0.8081	***
	(0.2575)	
Interaction between own and competitors' self-control	-0.1755	
	(0.1595)	
Interaction between own and competitors' hedonism	0.3490	
	(0.4045)	
Interaction between own and competitors' narcissism	10.103	***
	(3.5979)	
Interaction between own and competitors' risk	0.0330	
	(0.0788)	
Zero-inflate model		
Communicate	-65.164	***
Sweden	27.439	***
Period Fixed Effects	Yes	
Experiment Fixied Effects	Yes	
No of nonzero obs	52	
No obs	498	

Notes: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered over players.

5 Discussions and Conclusions

The literature review conducted as part of this project shows that certain personality traits may have an impact on individuals' propensity to form illegal cartels. Surveys were constructed to measure a number of relevant personality traits and a cartel experiment has been developed and evaluated based on a total of 33 individuals (11 experiments with 3 individuals in each). Preliminary econometric results presented in this report suggest that some of the investigated personality traits influence both the formation (i.e. the birth) and duration of price cartels.

It is important to note that the results are preliminary. More experiments will be conducted and that will provide a better basis for more detailed specifications. What seems particularly relevant from an econometric point of view is to apply dynamic panel data models when Cartel_suggested and Cartel_agreed are used as dependent variables. Both these states are likely to be affected by whether a cartel was suggested/agreed in the previous period. Fonseca and Normann (2012) also observed substantial state-dependence in their pricing game, but they did not conduct a full econometric investigation.

It is also relevant to investigate what makes the third firm decide to participate in the market. It seem likely that this decision depends on its expectations about the future and those expectations will depend on previous market outcomes.

The plan is also to change the market conditions by eliminating entry and exit, i.e. to only have duopoly experiments. This will make the experiments comparable with many previous cartel experiments and it will reduce the requirement for the number of students needed to run a given number of experiments.

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7 Appendix A

Example of questions used to measure personality.

Figure A1. Example of questions used to determine level of Conscientiousness.

Part I

Please, indicate for each statement to what extent you agree or disagree by ticking the corresponding circle.

		Disagree strongly	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree strongly
1	I am always prepared.	○	○	○	○	○
2	I pay attention to details.	○	○	○	○	○
3	I leave a mess in my room.	○	○	○	○	○
4	I get things done right away.	○	○	○	○	○
5	I leave my belongings around.	○	○	○	○	○

Figure A2. Example of questions used to determine level of Self-Control.

Part II

Please, indicate for each statement to what extent you agree or disagree by ticking the corresponding circle.

		Disagree strongly	Disagree somewhat	Neither agree nor disagree	Agree somewhat	Agree strongly
1	I am not easily affected by my emotions.	○	○	○	○	○
2	I never spend more than I can afford.	○	○	○	○	○
3	I use flattery to get ahead.	○	○	○	○	○
4	I demand attention.	○	○	○	○	○

Figure A3. Questions used to determine level of Hedonism.

Part III

Please, indicate how important each of the two values below are for you by ticking the corresponding circle.

		Not important at all	Less important	Indifferent	Somewhat important	Very important
1	Pleasure	○	○	○	○	○
2	Enjoying life	○	○	○	○	○

Figure A4. Example of questions used to determine level of Social Desirability.

Part IV

Please, indicate for each statement whether it is mostly 'true' or 'false' for you by ticking the corresponding circle. [Words in *italics* and parenthesis are synonyms for the words preceding them]

		True	False
1	Before voting I thoroughly investigate the qualifications of all the candidates.	○	○
2	I never hesitate to go out of my way to help someone in trouble.	○	○
3	It is sometimes hard for me to go on with my work if I am not encouraged.	○	○
4	I have never intensely disliked anyone.	○	○
5	On occasion I have had doubts about my ability to succeed in life.	○	○

Figure A5. Example of questions used to determine level of Narcissism.

Part V

Please, indicate which of the two statements describe you best.

1	I know that I am good, because everybody keeps telling me so.	○	○	When people compliment me I sometimes get embarrassed.
2	I like to be the center of attention.	○	○	I prefer to blend in with the crowd.
3	I think I am a special person.	○	○	I am no better or worse than most people.
4	I like having authority over people.	○	○	I don't mind following others.
5	I find it easy to manipulate people.	○	○	I don't like it when I find myself manipulating people.

Figure A6. The 10 choice scenarios used to determine each individual's risk preference. Adopted from Holt and Laury (2002).

Please, indicate which of the two lotteries you would prefer.

Scenario number	Option A			Option B
1	1/10 of 20€, 9/10 of 16€	○	○	1/10 of 38.5€, 9/10 of 1€
2	2/10 of 20€, 8/10 of 16€	○	○	2/10 of 38.5€, 8/10 of 1€
3	3/10 of 20€, 7/10 of 16€	○	○	3/10 of 38.5€, 7/10 of 1€
4	4/10 of 20€, 6/10 of 16€	○	○	4/10 of 38.5€, 6/10 of 1€
5	5/10 of 20€, 5/10 of 16€	○	○	5/10 of 38.5€, 5/10 of 1€
6	6/10 of 20€, 4/10 of 16€	○	○	6/10 of 38.5€, 4/10 of 1€
7	7/10 of 20€, 3/10 of 16€	○	○	7/10 of 38.5€, 3/10 of 1€
8	8/10 of 20€, 2/10 of 16€	○	○	8/10 of 38.5€, 2/10 of 1€
9	9/10 of 20€, 1/10 of 16€	○	○	9/10 of 38.5€, 1/10 of 1€
10	10/10 of 20€, 0/10 of 16€	○	○	10/10 of 38.5€, 0/10 of 1€

8 Appendix B

Table B1. Profits for player 1 and 2 when there are three players in the market

	Price of firm 2					
Price of firm 3 : 1	1	2	3	4	5	6
Your price: 1	-10	-10	-10	-10	-10	-10
2	-4	34	72	110	148	186
3	-60	-3	54	111	168	225
4	-152	-76	0	76	152	228
5	-280	-185	-90	5	100	195
6	-444	-330	-216	-102	12	126

	Price of firm 2					
Price of firm 3 : 2	1	2	3	4	5	6
Your price: 1	-10	-10	-10	-10	-10	-10
2	6	44	82	120	158	196
3	-45	12	69	126	183	240
4	-132	-56	20	96	172	248
5	-255	-160	-65	30	125	220
6	-414	-300	-186	-72	42	156

	Price of firm 2					
Price of firm 3 : 3	1	2	3	4	5	6
Your price: 1	-10	-10	-10	-10	-10	-10
2	16	54	92	130	168	206
3	-30	27	84	141	198	255
4	-112	-36	40	116	192	268
5	-230	-135	-40	55	150	245
6	-384	-270	-156	-42	72	186

	Price of firm 2					
Price of firm 3 : 4	1	2	3	4	5	6
Your price: 1	-10	-10	-10	-10	-10	-10
2	26	64	102	140	178	216
3	-15	42	99	156	213	270
4	-92	-16	60	136	212	288
5	-205	-110	-15	80	175	270
6	-354	-240	-126	-12	102	216

	Price of firm 2					
Price of firm 3 : 5	1	2	3	4	5	6
Your price: 1	-10	-10	-10	-10	-10	-10
2	36	74	112	150	188	226
3	0	57	114	171	228	285
4	-72	4	80	156	232	308
5	-180	-85	10	105	200	295
6	-324	-210	-96	18	132	246

	Price of firm 2					
Price of firm 3 : 6	1	2	3	4	5	6
Your price: 1	-10	-10	-10	-10	-10	-10
2	46	84	122	160	198	236
3	15	72	129	186	243	300
4	-52	24	100	176	252	328
5	-155	-60	35	130	225	320
6	-294	-180	-66	48	162	276

Table B2. Profits for player 3 when there are three players in the market

		Lowest price of your competitors					
		1	2	3	4	5	6
Your price	1	-50	-50	-50	-50	-50	-50
	2	-10	27	65	102	140	178
	3	-52	5	61	118	174	230
	4	-117	-42	34	109	184	259
	5	-206	-112	-18	76	170	264
	6	-319	-206	-94	19	132	245

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