

# Why do cartels end ?

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## Abstract

This study examines the factors influencing the dissolution of cartels, with a particular focus on the role of leniency programs. Leniency programs, which offer reduced penalties to firms that disclose cartel activity, have been widely adopted by competition authorities to destabilize collusion. However, recent trends indicate a decline in leniency applications, raising concerns about their continued effectiveness. Building on literature from strategic alliances and organizational wrongdoing, this research explores the impact of various proximity factors (geographic, cultural, and organizational) on cartel stability and the likelihood of firms resorting to leniency. Using a logistic regression model, we analyze a dataset of 91 detected cartels to assess whether these factors influence cartel dissolution. Our findings suggest that an increase in cultural distance within a cartel raises the probability of leniency applications, while geographic distance has the opposite effect. Contrary to expectations, variations in organizational structure do not significantly impact leniency decisions. Additionally, we observe that a high frequency of meetings among cartel members correlates with a higher likelihood of leniency, indicating that increased interaction may signal internal coordination difficulties rather than cohesion.

# Introduction

It is well known that some cartels can last for long periods, even spanning several decades, such as the organic peroxides cartel with a duration of around 29 years. There are three main reasons why a cartel may come to an end: either the members mutually agree to dissolve it because continuing the arrangement becomes too risky or unprofitable, an antitrust authority detects and sanctions the cartel, thereby putting an end to it, or one of the cartel members reports the agreement under a leniency program. In practice, the first scenario is relatively rare (Levenstein and Suslow, 2011). Leniency programs, on the other hand, have been responsible for approximately half of all cartel convictions since their introduction (Jaspers, 2020).

In recent years, competition authorities have faced a concerning trend: there has been a significant decline in the use of leniency programs. OECD jurisdictions observed a 58% drop in leniency applications over a seven-year period (OECD, 2023). This trend is particularly pronounced in Europe, where, for example, in 2018, only four decisions involved the leniency program. Antitrust practitioners have also reported a decline in their clients' willingness to apply for leniency (Ysewyn and Kahmann, 2018). This is problematic because, since its adoption, leniency has been widely praised almost unanimously by competition authorities and researchers alike as an effective policy tool with numerous advantages in the fight against cartels. However, its effectiveness is now being questioned.

The leniency program grants reductions, or even sometimes full exemptions, from the often substantial fines imposed on companies that disclose the existence of a cartel, provide evidence, and cooperate with competition authorities. The extent of the fine reduction varies depending on the circumstances and the level of assistance provided. This policy offers several

benefits, particularly for competition authorities. One key advantage is that it destabilizes companies involved in anticompetitive agreements; later in this study, we will discuss the mechanisms at play when this program is introduced. Ultimately, the program aims to mitigate the negative economic impact of cartels.

The leniency policy was first introduced in the United States in 1978. Initially, it was largely ineffective because it provided little incentive for companies to report cartels in which they were involved. However, the program was revised in 1993 to adopt a more transparent and attractive system for whistleblowers. Following the U.S. model, many countries and economic regions gradually implemented their own leniency programs, including the European Union in 1996. Today, there is broad consensus that leniency is a valuable tool in the fight against cartels. Nonetheless, it remains an imperfect mechanism, which has led to a rich body of academic literature, mainly in economics and law, exploring its effects and limitations. Our research contributes to this ongoing debate on the impact of leniency, specifically in the EU context.

Studying cartels and understanding their dynamics is a crucial public policy issue, as it allows for the development of more effective strategies to combat them. This includes both detecting existing cartels and implementing policies that can deter cartel formation *ex ante*. More specifically, analyzing the effects of leniency policies on cartel dynamics is essential to evaluating their effectiveness and identifying potential improvements. Enhancing these policies could involve increasing the likelihood of detection or identifying and targeting certain types of cartels that remain unaffected by the current competition framework.

Our study contributes to the literature on leniency policy and its effectiveness by introducing an original perspective. To date, most research on

leniency has examined its overall effectiveness, sometimes considering how the policy's design influences its success. However, very few studies have explored whether leniency has differentiated effects depending on cartel characteristics. Additionally, this work contributes to the literature on organizational wrongdoing, as it helps explain how firms, beyond the reach of legal enforcement mechanisms, are able to coordinate, and more specifically, what factors enable the long-term sustainability of such coordination.

Given that this specific research question has been relatively underexplored in the literature, we draw on existing studies on alliances to guide our analysis. Indeed, while this dimension has been extensively studied in the context of strategic alliances, it has received less attention in the study of cartels. Relying on these resources is justified by the fact that cartels constitute a particular form of alliance (Sheth and Parvatiyar, 1992).

## **Related Literature**

### **Cartels instability**

It is widely acknowledged that cartels tend to be unstable structures. In his seminal work, Stigler (1964) explains how firms that form a cartel have an inherent incentive to cheat on the agreed-upon rules. A firm, if given the opportunity, can increase its profits beyond those of its cartel partners by secretly lowering prices below the agreed-upon level. Such a strategy benefits not only the cheating firm compared to the other cartel members, but also compared to a scenario where no collusion occurs. Consequently, each member of a cartel has an incentive to deviate, which can ultimately lead to the cartel's collapse. This situation can be illustrated using the

prisoner's dilemma framework (Osborne, 1976; Roberts, 1985).

Nevertheless, cartels do exist despite this inherent instability. The persistence of cartels has been explained and demonstrated through various economic models, and we now know that cartels can be stable under a variety of theoretical conditions, including Stackelberg, Cournot, and Bertrand competition models (Shaffer, 1995). Under the assumption that all firms share the same cost structure, d'Aspremont et al. (1983) show that both cartel members and non-cartel firms (the competitive fringe) can benefit from the cartel, and that per-firm cartel profits increase with the size of the cartel. Extending this work, Donsimoni et al. (1986) mathematically demonstrate that cartels can remain stable as long as participating firms are not significantly more cost-efficient relative to market demand.

However, these early studies did not account for the introduction of leniency policies, which have had a profound impact on cartel behavior. Leniency programs alone cannot dismantle cartels, but they serve as a crucial component of broader antitrust policies, enhancing their ex-ante deterrent effects (Wardhaugh, 2013). Leniency programs aim to increase internal instability within cartels, incentivizing whistleblowing and hastening their dissolution, ultimately leading to prosecution. From the perspective of firms, the implementation of leniency programs has a threefold effect (Spagnolo, 2004): it provides protection from fines for those who self-report, shields firms from punishment, particularly in jurisdictions where repeat offenses carry heavier penalties, and increases the risk of collusion by eroding mutual trust among cartel participants, a risk further exacerbated by the fact that leniency benefits only the first firm to report the cartel.

Another significant consequence is the so-called "race to the courthouse" (Harrington, 2008). Strong leniency policies increase the expected future penalty due to the possibility that one member may defect and report the

cartel. This dynamic reduces the expected benefits of collusion and creates a powerful incentive for all firms to self-report first rather than continue participating in the agreement. Furthermore, firms may strategically use leniency as a competitive tool, reporting cartel activity not only to secure immunity but also to harm competitors and gain a strategic advantage (Ellis and Wilson, 2001).

Despite the clear benefits of leniency programs, their impact on cartel formation remains ambiguous. Motta and Polo (2003) show that leniency programs can have two opposing effects, depending on policy design. On one hand, leniency policies can deter firms from colluding by increasing the likelihood of exposure, reducing cartel pricing, and shortening investigations. On the other hand, leniency may have a pro-collusive effect by lowering the expected cost of anticompetitive behavior, allowing convicted firms to pay reduced fines, which may weaken their overall deterrent effect. In reality, the effect of leniency on cartel case duration appears minimal (Ascione and Motta, 2008). While leniency programs increase the number of detected cartels, they also allow convicted firms to pay lower fines, raising concerns about whether they truly serve as a deterrent.

However, empirical evidence suggests that leniency programs still contribute to stronger cartel sanctions. The introduction of leniency policies has led to a significant increase in average fines per cartel case, both before and after considering fine reductions (Borrell et al., 2024). Furthermore, statistical tests confirm that leniency enhances both deterrence and detection capabilities (Miller, 2009). Laboratory experiments suggest that the mere threat of being reported under a leniency program can undermine trust among cartel participants, making them less likely to form cartels in the first place (Bigoni et al., 2015). This finding aligns with Spagnolo's (2000) argument that leniency destabilizes collusive behaviors by eroding internal trust and increasing the likelihood that one participant will defect to enjoy

the program's benefits. Spagnolo also suggests that moderate leniency programs, like those implemented in the EU, may have a limited deterrent effect on long-term cartel agreements.

Despite its destabilizing effects, leniency alone is not always sufficient to end cartels. Some cartels are more likely than others to take advantage of leniency, and several factors influence this decision. Firm size plays an important role, as leniency programs tend to be more effective for smaller firms, which require a lower level of law enforcement to induce self-reporting. Larger firms, on the other hand, may be less likely to form cartels in the first place, as they factor in the risk of future exposure (Motchenkova and van der Laan, 2005). Additionally, legal expertise is a key determinant, as larger firms may be more likely to apply for leniency because they have well-established legal departments that can navigate the application process (Brenner, 2011). The duration of a cartel also matters, as leniency policies, by destabilizing existing cartels, tend to detect longer-lasting cartels, at least in the short run (Borrell et al., 2024). Cultural factors may further shape the effectiveness of leniency, as companies from collectivist cultures may be more inclined to cooperate with antitrust authorities as a means of reducing uncertainty (Brenner, 2011).

Despite the growing body of literature on leniency, research on why some cartels persist despite leniency policies remains scarce. This is why we turn to insights from the literature on strategic alliances to better understand the factors driving the termination of cooperative agreements. While leniency programs aim to destabilize cartels, firms engaged in collusion may rely on coordination mechanisms similar to those found in alliances. Strategic alliance research provides valuable perspectives on trust, organizational structure, and incentive alignment, all of which are crucial to understanding the conditions under which cartels dissolve or persist.

## Trust and alliances instability

Studies in strategic management have shown that, similar to cartels, strategic alliances tend to be unstable (Madhok and Tallman, 1998). Various studies using different approaches have reported different alliance termination rates: approximately 50% of alliances (Brouthers et al., 1997), around 60% (Spekman et al., 1996), or more generally, estimates suggesting a termination rate between 40% and 70% (Duysters et al., 1999). In any case, a significant proportion of alliances end before reaching their natural term, as one or more members determine that continuing the cooperation is no longer beneficial. Unlike cartels, a large body of literature has identified the factors that lead to alliance termination.

A wide range of explanations has been proposed, with two primary perspectives emerging on why alliances come to an end (Madhok et al., 2015). The first explanation attributes termination to errors in the initial decision to engage in the alliance, such as a lack of compatibility between partners or an inadequate strategic fit. Unforeseen costs, including indirect opportunity costs, may also arise, making continued collaboration unviable. The second explanation focuses on post-formation dynamics, where difficulties in managing the relationship lead to coordination failures that ultimately result in dissolution. In reality, these two explanations are closely interdependent, as an initial incompatibility between partners can lead to coordination failures, while coordination issues may stem from fundamental differences between the firms. The overwhelming consensus in the literature is that the inability of partners to cooperate is the primary reason for the eventual breakdown of alliances (Gulati et al., 2012).

One of the most critical elements highlighted in this vast body of research is the necessity of trust between partners to sustain an alliance. As Puranam

and Vanneste (2009) explain, trust is the expectation that a partner will not act opportunistically, even in situations where such behavior cannot be detected. Trust serves as a powerful alternative to formal governance mechanisms, reducing the need for external controls such as monitoring and contractual safeguards. This aspect is particularly relevant when considering cartels, as these alliances cannot rely on legal contracts to enforce cooperation. In interorganizational cooperation, a high level of trust allows informal agreements to compensate for or even replace formal contractual protections (Ring and Van de Ven, 1994). Trust is fundamental in ensuring alliance stability by reducing uncertainty, particularly relational uncertainty (Jiang et al., 2008).

Although an extensive body of research in management has emphasized the importance of trust in interactions between members of an organization or between organizations for a successful alliance (Parkhe, 1998; Nielsen, 2011; Cullen et al., 2000), trust is a complex phenomenon, and various determinants can explain its presence and intensity among organizations. One of them is the presence of similarities between organizations. This phenomenon called homophily is defined as “the tendency to associate with similar others” (Ertug et al., 2022). We identify three main types of proximity based on the literature, which are likely to enhance trust between members of a cartel and so are likely to reduce the likelihood of resorting to leniency.

The first type is geographic proximity. Empirically, geographic proximity has been shown to be associated with higher interfirm trust (Bönte, 2008). Although geographic proximity alone is not sufficient to develop strong ties, it facilitates the development of resilient trust (Nilsson and Mattes, 2015). This is partly because geographically close firms typically engage in more frequent face-to-face interactions (Boschma, 2005). It is interesting to note that this phenomenon remains relevant despite advancements in

communication technologies (Burmeister and Colletis-Wahl, 1997).

The second type is cultural proximity. Research shows that cultural distance negatively affects business relationships (Ng et al., 2007), whereas cultural proximity and compatibility significantly contribute to the success of international alliances (Lane et al., 2001). Shared norms, attitudes, and a mutual understanding of rules foster initial trust (Nilsson, 2019), which in turn facilitates coordination and reduces the risk of cartel dissolution due to leniency applications.

The third type is organizational proximity. While resource complementarity is often considered essential in motivating the initial formation of an alliance between firms (Eisenhart and Schoonhoven, 1996; Gulati, 1995), it is not a sufficient condition for sustaining such a relationship, as a certain level of structural compatibility is also required (Blomqvist, 2000). Organizational similarity is a key factor influencing the quality of interorganizational interactions (Fey and Beamish, 2001). According to Gulati and Sytch (2008), two mechanisms explain this effect. First, organizational similarity facilitates more effective information exchange and continuous learning between firms by reducing the likelihood of conflict. Second, it enhances the transmission of tacit knowledge among members of an organization. Both of these factors are likely to have a positive long-term impact on cartel stability.

A substantial body of literature in strategic management has emphasized the central role of proximity and homophily in fostering trust. These findings are consistent with previous research specifically focused on alliances and their dynamics, which highlights the influence of cultural factors on alliance longevity (Rajan et al., 2020) and demonstrates that dissimilarities between alliance members increase the likelihood of conflict and premature termination (Park and Ungson, 2001). Given that trust, or its absence, is a key factor in alliance dissolution, proximity between firms is expected to

influence the likelihood of terminating an alliance. In the context of cartels, this suggests that proximity should also impact the probability of a firm deciding to break the agreement by resorting to leniency. Greater distance between cartel members, whether geographic, cultural, or organizational, should increase the likelihood of defection, as cooperation becomes more difficult to sustain. We derive the following hypothesis :

**Hypothesis 1** : The more distant the companies in a cartel, the more likely they are to resort to leniency

**Hypothesis 1a** : The larger the geographic distance between the companies, the more likely they are to resort to leniency

**Hypothesis 1b** : The larger the cultural distance between the companies, the more likely they are to resort to leniency

**Hypothesis 1c** : The larger the organizational distance between the companies, the more likely they are to resort to leniency

## **The effect of changes in the composition of alliances**

Apart from the inherent differences between companies forming an alliance, the dynamics and evolution of the alliance structure also influence the likelihood of its success or termination. However, research on governance changes in alliances, including the formal or informal mechanisms by which parent firms adjust their collaborative agreements, remains limited (Reuer and Ariño, 2002). Networks evolve over time, often as a way to address problems of redundancy and overload (Mariotti and Delbridge, 2011). Alliances, in particular, frequently undergo significant transformations, including changes in composition, throughout their existence (Greve et al., 2013). In the case of alliances formed between U.S. biotech and pharmaceutical firms, as

many as 44% experience some form of post-formation change (Reuer et al., 2002). Adjusting the composition of an alliance by adding or removing a member may appear to be a beneficial strategy to adapt to a changing or increasingly uncertain environment (Wiersema and Bantel, 1993).

Empirical studies, however, suggest that partner reconfiguration, whether by removing existing members or incorporating new ones, tends to negatively impact firm performance within an alliance (Liang and Shao, 2019). Bakker (2016), using a dataset of 1,025 production-oriented (rather than knowledge-oriented) interfirm mining alliances, finds that on average, changes in alliance composition significantly increase the likelihood of alliance termination. Several factors contribute to the detrimental effect of partner reconfiguration. Changes in team composition disrupt coordination mechanisms and processes that have already been established (Summers et al., 2012; Liang and Shao, 2019). The entry of new firms places short-term pressure on profit margins due to the increased coordination and adjustment costs associated with integrating a new partner. In the long run, alliances that undergo such changes face a higher risk of failure (Chung and Beamish, 2010). A stable network environment, consisting of homogeneous and relatively unchanging elements, mitigates these negative effects on coordination (Whetten, 1981). This idea is further developed in the "resetting the clock" theory (Amburgey et al., 1990), which posits that significant changes, such as alterations in the composition of alliance members, effectively reset the liability of newness. This process increases the risk of failure, as the alliance must once again navigate the initial challenges of establishing cooperation.

The type of change within an alliance likely has a differentiated impact on risk, with partner exits having a greater negative effect than new entries. Exits tend to be unilateral decisions, often signaling internal dissatisfaction or conflict, whereas new entries are usually the result of a joint agreement between the incoming firm and existing members. This suggests that new

entrants are more likely to be integrated with a clear strategic purpose, making their addition less disruptive than the departure of an existing member (Bakker, 2016).

In the case of cartels, an increase in the number of members over time is more commonly observed than a reduction. This can be explained by the fact that adding new members expands the reach of the cartel and, at least theoretically, enhances its efficiency, allowing it to exert greater market control by resembling a monopoly when members collectively hold a dominant market share. A shift in cartel composition is expected to increase the likelihood of defection, particularly through leniency applications, as internal instability grows with structural changes. Greater fluctuations in membership, as well as an increase in the overall distance, whether geographic, cultural, or organizational, between firms, are expected to amplify these effects.

**Hypothesis 2** : A change in the composition of a cartel will lead to higher probability of resorting to leniency

**Hypothesis 2a** : An increase in the number of members of a cartel will lead to higher probability of resorting to leniency

**Hypothesis 2b** : The greater the changes in the composition of the cartel, the greater the increase in distance between the companies, the more likely they are to resort to leniency

## **The effect of the intensity of interactions**

We argue that a key factor influencing the stability of cartels, and consequently their likelihood of ending through leniency, is the intensity of interactions between cartel members, particularly face-to-face interactions.

Drawing from the literature on alliances, we know that the frequency and quality of communication between members are crucial in fostering stability and effective cooperation. Effective communication plays a fundamental role in ensuring the success of alliances by facilitating coordination and alignment between partners (Shin et al., 2012). This involves ongoing assessment and evaluation of performance among alliance members, which strengthens collaboration and reduces uncertainty (Elmuti and Kathawala, 2001).

Frequent and active communication in an interorganizational setting creates multiple benefits for alliances. One of the most important mechanisms at play is that repeated interactions help firms become familiar with one another, which fosters trust (Gulati, 1995). Trust, in turn, strengthens cooperative behavior and enhances the overall performance of the alliance (Ariño et al., 2005). When trust develops and business partners align their goals, opportunistic behaviors are reduced, leading to better outcomes for the alliance as a whole (Krishnan et al., 2015). This idea aligns with social embeddedness theory, which argues that economic transactions embedded within repeated interactions generate interpersonal trust, which then translates into interorganizational trust (Granovetter, 1985).

Empirical studies confirm the positive effect of communication on interorganizational performance (Fulk and Boyd, 1991; Karayanni, 2015). This effect is particularly strong in environments characterized by high uncertainty, whether in terms of task complexity or relational dynamics (Yan and Dooley, 2013). This point is especially relevant for cartels, which operate under inherently uncertain and high-risk conditions. When relational quality deteriorates due to a lack of communication or trust, barriers to collaboration emerge, often leading to alliance failure (Ariño and de la Torre, 1998). Beyond the intensity of communication flows between firms, the quality of communication is also crucial in generating positive outcomes (Fulk and

Boyd, 1991). Studies have shown that trust and perceived effectiveness of communication within an organization are closely interrelated (Zeffane et al., 2024).

When studying interorganizational communication quality, one of the critical dimensions to consider is the communication medium itself. Daft and Lengel (1984) introduced the concept of "media richness," which suggests that different forms of communication vary in their ability to convey information. The richness of a communication medium depends on the level of ambiguity involved in the task. According to the original framework, face-to-face interactions are the richest form of communication, followed by telephone conversations, with written documents ranking lower. In situations requiring non-routine or complex exchanges, face-to-face communication is considered the most effective, as it enables a higher volume of information to be transmitted more efficiently (Lengel and Daft, 1988). Richer communication channels reduce the cost of information-seeking by allowing for real-time feedback and multidimensional information exchange (Maity et al., 2018). The presence of multiple cues in face-to-face interactions facilitates knowledge-sharing among members, enhancing the effectiveness of exchanges (Thomas, 2013).

Despite advancements in technology, the theory of media richness remains relevant (Ishii et al., 2019). One possible explanation is that newer communication technologies tend to focus primarily on task completion without supporting personal relationships (Kraut et al., 1988). Furthermore, computer-mediated communication is often perceived as less effective than direct interpersonal interaction (Braun et al., 2019). These findings are particularly relevant to our case, as they suggest that face-to-face interactions play a crucial role in interorganizational coordination, and that the frequency of physical meetings may influence the stability of alliances and cartels, as well as the likelihood of members deciding to defect through

leniency.

Given that cartels are inherently illegal, their interactions carry significant risks. Any criminal network faces a dual challenge: maximizing efficiency while ensuring concealment. This situation, which can be analyzed through game theory (Lindelauf et al., 2009), presents organizations with conflicting objectives. On the one hand, members seek to maximize their profits through collusion; on the other hand, they must avoid detection, which would put an end to their activities. This creates a delicate balance between effectiveness and secrecy. Coordination is essential for maintaining cartel performance, yet the need for discretion limits the speed and efficiency of information-sharing (Morselli et al., 2007).

Criminal organizations encounter a fundamental dilemma in structuring their communication networks, as they must optimize both secrecy and operational efficiency. Studies have shown that in most cases, concealment is prioritized over efficiency, particularly in long-term criminal enterprises (Baker and Faulkner, 1993). The trade-off between these two objectives is shaped by the nature of the network and its activities. In cases where tasks require rapid execution, efficiency tends to be prioritized over security, whereas in long-term criminal networks, concealment remains the dominant concern (Morselli et al., 2007).

All these elements provide valuable insights into the role of communication, particularly face-to-face interactions, in the functioning of cartels. Although this relationship has not been directly studied in cartel contexts, existing literature suggests that meetings between members may be crucial for cartel stability. Given the necessity of secrecy, in-person meetings likely occur less frequently than in other interorganizational settings. However, when they do take place, their intensity is likely to be correlated with trust between members, which in turn influences the likelihood of defection through le-

niency. If physical interactions strengthen trust and facilitate coordination, then an increase in face-to-face meetings may reduce the probability of cartel members resorting to leniency.

**Hypothesis 3** : The more frequent the face-to-face meetings between members of a cartel, the less likely they are to resort to leniency.

## Dataset and methods

### Dataset

We use an original database of previously convicted cartels, based on the list provided by the European Commission, which includes information on all cartels sanctioned by the Commission. We include only cartels convicted from 1998 onward to ensure that all cases in our dataset had the possibility of resorting to leniency. This criterion is not particularly restrictive, as there are relatively few antitrust cases handled by the European Commission before this date. Our dataset exhibits significant diversity in terms of cartel size, duration, and nationality. Notably, the majority of the cartels included are international, which is expected, as smaller cartels with a more limited scope and impact are typically handled by national competition authorities. This diversity is a strength, as it captures a wide range of cartel structures and behaviors, providing a more comprehensive and representative basis for analysis.

The database consists of 551 companies forming 91 cartels. Each line of the original database represents a company, which has taken part in a given cartel and has been convicted. We have only kept companies, and have removed governmental activities, as well as business associations.

These latter may have taken part in the cartel indirectly, and are usually considered as facilitators of the collusion, but we have decided to remove them because they do not have a primarily lucrative aim when participating in cartels. Each line contains information about the company, such as the revenue or the localization of the headquarters, as well as information about the country of origin of the company, which we will later describe comprehensively. In order to have consistent measurements, we use the data for a given time for all companies, which is the last year of existence of the cartel. Two reasons explain this choice: first, since it is the most recent date cartels have existed in, there is a better chance to find reliable data, second because we have to find a point of reference which can be the same for all cartels, and there can be ambiguity in several cases about when collusion started, but usually not about when it ended.

The data at the company-level is then aggregated at the cartel-level, using different methods, depending on the original format of the variables. The cartel is the level of analysis we use, and the created variables are referred to as “proximity indexes”. The compilation methods are further developed in the following paragraphs.

## **Variables**

### **Dependent variable**

We use the variable *Leniency* as a dependent variable. It is a dummy variable which is equal to 1 if one or several members of the cartel have used a leniency policy, and 0 otherwise, in other words, if the cartel is detected because of an investigation. It only includes cases where at least one company has effectively benefited from fine reductions because of the

leniency policy. In some rare case, it is possible that the competition authority refuses the grant leniency. It is usually because the authority considers that the company filing for it does not provide enough information to be admissible (HKCC Midland), and so is considered not genuinely willing to cooperate to end the cartel, or because the company breached the leniency agreement and engages in anticompetitive behavior following the beginning of the procedure. Both of these cases are excluded in our situation, and are not considered as leniency-related, per the competition authority's decision.

Our dataset consists of 52 cartels in which one or more members resorted to a leniency program, representing 57% of our sample. This indicates that our data is relatively balanced, which enhances the reliability and robustness of our analysis (Zhang et al., 2021).

### **Static independent variables**

*Distance avg:* We calculate the average geographic distance between the headquarters of cartel member firms using the Haversine formula, which determines the great-circle distance between two points on a sphere. The distance is computed for each pair of firms and then averaged across all pairs. This variable measures the geographic proximity between cartel members and is used to test Hypothesis H1a. The closer the firms are geographically, the lower the average distance.

*Uncertainty CV:* We calculate the coefficient of variation for Hofstede's Uncertainty Avoidance score for all convicted firms within the cartel, based on each firm's country of origin. Countries with high scores share common characteristics regarding their tolerance for unpredictability. This variable is used to test Hypothesis H1b. A high coefficient of variation indicates

significant cultural heterogeneity in terms of uncertainty avoidance within the cartel. Conversely, a low coefficient of variation suggests that firms are homogeneous and similar.

*Individualism CV*: We calculate the coefficient of variation for Hofstede's Individualism vs. Collectivism score for all convicted firms within the cartel, based on their country of origin. In individualistic cultures, autonomy and independence are emphasized, whereas collectivist cultures prioritize group interests over individual interests. This variable is used to test Hypothesis H1b. A high coefficient of variation indicates significant cultural heterogeneity in this dimension within the cartel. Conversely, a low coefficient of variation suggests that firms are homogeneous and similar.

*Long Term CV*: We calculate the coefficient of variation for Hofstede's Long-Term Orientation score for all convicted firms within the cartel, based on their country of origin. Long-term-oriented cultures are more adaptable and open to change, while short-term-oriented cultures are more resistant to change. This variable is used to test Hypothesis H1b. A high coefficient of variation indicates significant cultural heterogeneity in this dimension within the cartel. Conversely, a low coefficient of variation suggests that firms are homogeneous and similar.

*Turnover CV*: We calculate the coefficient of variation for turnover (adjusted to euros of the relevant year) for all firms convicted within the cartel. We use the turnover of each company at the time of the cartel's last year of operation. Turnover serves as a proxy for firm size, which is a key organizational characteristic. This variable is used to test Hypothesis H1c. A high coefficient of variation indicates significant heterogeneity among cartel members in terms of turnover and, therefore, firm size. Conversely, a low coefficient of variation suggests that firms are homogeneous and similar.

*Age CV*: We calculate the coefficient of variation for the age of firms at the

time of the cartel’s last year of existence for all convicted firms within the cartel. Firm age serves as an indicator of its longevity and is a proxy for embeddedness, a crucial organizational characteristic. This variable is used to test Hypothesis H1c. A high coefficient of variation indicates significant heterogeneity in firm age and, consequently, in market experience. Conversely, a low coefficient of variation suggests that firms are homogeneous and similar.

*Governance Proximity* : We construct an index that captures the degree of homogeneity in governance structures among the members of a cartel. We distinguish four types of governance: shareholder-owned, cooperative, public, and family-owned (i.e., firms that are either historically family-run and/or where the family holds at least 20% of the company’s shares). We use the following formula :

$$\text{Governance Proximity} = \sum_{i=1}^k p_i^2$$

where  $p_i$  represents the proportion of firms in the cartel with governance type  $i$ , and  $k$  is the number of governance categories. A value closer to 1 indicates a higher degree of similarity in governance structures within the cartel. This variable is used to test Hypothesis H1c.

*Meeting*: We rely on ”Prohibition Decisions” documents available online from the European Commission, which provide a comprehensive description of the cartel’s activities and the associated legal proceedings, to count the number of physical meetings that took place between cartel members, whether bilaterally or multilaterally. As previously discussed, face-to-face interactions are particularly significant because they demonstrate a higher level of commitment, both in terms of involvement and financial cost, compared to other forms of communication. The number of meetings serves

as a proxy for the intensity of interactions between cartel members. We expect that a higher number of meetings strengthens relationships and trust within the cartel, thereby reducing the likelihood of resorting to leniency. This variable is used to test Hypothesis H3.

## **Dynamic independent variables**

The following variables aim to examine the evolution of the coefficients of variation between the beginning of the cartel and its end (i.e., the moment it is detected). We analyze the characteristics at the time of cartel formation, relying exclusively on the founding members, and compare them to the characteristics observed at the time of detection. The underlying hypothesis is that when cartels expand, they may choose to integrate either firms that are culturally and organizationally similar or firms that are more distant in these aspects.

In the latter case, we hypothesize that such an integration strategy will be detrimental to the cartel, as it increases the likelihood of resorting to leniency. By incorporating dissimilar members, internal cohesion decreases, making reciprocal denunciation to competition authorities more probable.

For technical reasons, we cannot measure this evolution in percentage terms. Instead, we compute it as a simple difference, which does not compromise data integrity, as the variables are already standardized through the coefficient of variation.

*Delta Count*: Calculated as the difference between the number of firms participating in the cartel at the time of detection and at the time of its formation. This variable is used to test Hypothesis H2a.

*Delta Distance*: Calculated as the percentage variation in the average

geographic distance between firms from the beginning of the cartel to the moment of detection. Since geographic distances are not standardized measures like coefficients of variation and cannot be null, we use percentage variation instead of a simple difference to account for this evolution. This variable is used to test Hypothesis H2b.

*Delta Uncertainty:* Calculated as final uncertainty – start uncertainty, representing the difference between the coefficient of variation of the Uncertainty Avoidance score of firms' countries of origin at the time of detection and at the time of cartel formation. This variable is used to test Hypothesis H2b.

*Delta Individualism:* Calculated as final individualism – start individualism, representing the difference between the coefficient of variation of the Individualism score of firms' countries of origin at the time of detection and at the time of cartel formation. This variable is used to test Hypothesis H2b.

*Delta Long Term:* Calculated as final long term – start long term, representing the difference between the coefficient of variation of the Long-Term Orientation score of firms' countries of origin at the time of detection and at the time of cartel formation. This variable is used to test Hypothesis H2b.

*Delta Turnover:* Calculated as final turnover – start turnover, representing the difference between the coefficient of variation of firms' revenue at the time of detection and at the time of cartel formation. This variable is used to test Hypothesis H2b.

*Delta Age:* Calculated as final age – start age, representing the difference between the coefficient of variation of firms' age at the time of detection and at the time of cartel formation. This variable is used to test Hypothesis H2b.

*Delta Governance* : Calculated as final Governance Proximity score - start Governance Proximity score. This variable is used to test Hypothesis H2b.

## **Control Variables**

*Count* : We include the number of companies having taken part in the cartel; this means that it includes both the companies which have paid a fine and those who may have not. We suspect that a high number of companies forming the cartel may increase the instability and so increase the probability of resorting to leniency.

*Cartel Duration* : We include the duration of the cartel (in days), calculated as the difference between the estimated start date and the estimated end date of cartel activities. These dates are determined during the investigation; however, some ambiguity may exist, particularly regarding the start date. Firms involved in the cartel may have an incentive to underreport their participation duration, as cartel duration is one of the key factors influencing the final amount of their fine. There are two possible opposing effects regarding the impact of cartel duration on the likelihood of resorting to leniency. On the one hand, a longer duration may mechanically increase the probability that at least one member decides to report the cartel. On the other hand, trust among members may strengthen over time, thereby reducing the likelihood of resorting to leniency.

*Pre 2006* : We include this binary control variable to account for an incremental regulatory change introduced with the 2006 Leniency Notice, which aimed to increase transparency and predictability in the process for potential applicants, thereby strengthening incentives to report existing cartels.

## Model

We use a logistic regression model to examine the effect of our independent variables on our dependent variable, as the latter is binary and takes only two possible values. The model thus predicts which characteristics of a cartel influence the probability of resorting to leniency.

We aim to test each of our hypotheses individually and then in combination to ensure the robustness of our results. Model (1) tests Hypothesis 1, Model (2) tests Hypothesis 2, and Model (3) tests Hypothesis 3. Complete information is not available for the Meeting variable, meaning that including it in the model significantly reduces the number of observations. For this reason, we test all variables combined in Model (6) but also run the model excluding the Meeting variable in Model (5) to account for potential differences resulting from the reduced sample size.

## Results

Model (1) shows no significant effect of any type of proximity on the probability of resorting to leniency programs for a cartel. This result is surprising as it contradicts the existing literature, which explicitly highlights, in various contexts, the role of proximity in influencing performance, duration, and interorganizational trust within alliances. However, these findings are particularly interesting as they suggest that cartels differ from conventional strategic alliances.

The results for Model (2) are more nuanced. The variable associated with variations in the number of participants, which reflects changes in cartel size, is not significant. This suggests that, unlike alliances, an increase in

Table 1: Logistic Regression Results

VARIABLES	(1)	(2)	(3)	(4)	(5)
Distance avg	-2.59e-05 (0.000122)			0.000173 (0.000148)	0.000221 (0.000183)
Uncertainty CV	-3.772 (2.436)			-5.035 (3.166)	-5.600 (4.271)
Individualism CV	1.853 (2.001)			-1.569 (3.087)	-2.172 (4.077)
Long Term CV	2.943 (2.041)			2.831 (2.467)	2.284 (3.036)
Turnover CV	-0.532 (0.611)			-0.135 (0.730)	-0.490 (1.050)
Age CV	1.441 (1.537)			2.245 (1.927)	4.548* (2.687)
Governance Proximity	-0.332 (1.284)			-1.721 (1.634)	-0.732 (2.111)
Delta Count		-0.486 (0.457)	-0.560 (0.529)		-1.504 (1.129)
Delta Distance		-0.00136** (0.000543)	-0.00169*** (0.000617)		-0.00238*** (0.000874)
Delta Uncertainty		-2.500 (5.269)	-2.403 (5.282)		-7.910 (7.539)
Delta Individualism		13.61** (6.176)	16.65** (6.760)		13.91* (8.412)
Delta Long Term		9.158** (4.634)	10.05** (4.801)		14.35** (6.390)
Delta Turnover		0.260 (0.943)	0.320 (1.121)		-0.727 (1.902)
Delta Age		-0.455 (5.426)	-0.645 (6.049)		-2.411 (8.323)
Delta Governance		-1.692 (2.876)	-0.400 (3.265)		-4.625 (5.456)
Meeting			0.0111 (0.0115)		0.0340** (0.0151)
Count Final	0.251** (0.0990)	0.335*** (0.130)	0.185 (0.118)	0.372** (0.145)	0.518** (0.237)
Cartel Duration	8.73e-05 (0.000114)	4.80e-05 (0.000116)	0.000110 (0.000155)	6.58e-05 (0.000129)	0.000146 (0.000216)
Pre 2006	-1.567*** (0.525)	-1.701*** (0.585)	-2.239*** (0.612)	-1.794*** (0.643)	-3.446*** (1.023)
Constant	-0.465 (1.567)	-0.960 (0.723)	-0.181 (0.714)	-0.202 (2.046)	-1.401 (3.127)
Observations	91	91	77	91	77

*t* statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

Note: Robust standard errors in parentheses

the number of participants does not inherently have a destabilizing effect on the cartel and does not undermine the collusive agreement. This result is particularly interesting when compared to the results for our control variable Count, which we will develop later. The variable Delta Distance has a significant positive effect, indicating that an increase in geographic distance over the cartel's lifespan, when new members are added who are geographically more distant from the original cartel members, reduces the probability of resorting to leniency.

Conversely, two of the three variables derived from Hofstede's work on cultural distance variations within the cartel, Delta Individualism and Delta Long-Term Orientation, show significant effects. This effect is positive, meaning that an increase in cultural distance among cartel members increases the likelihood of resorting to leniency. This finding is consistent with Hypothesis 2b. However, it remains difficult to explain why the variable Delta Uncertainty does not exhibit a significant effect, unlike the other two. This could be because this particular indicator does not fully capture the cultural dimension at play, or because of a certain level of correlation among the three variables. Despite this minor inconsistency, we believe that our interpretation regarding the effect of cultural variations remains valid.

Finally, the two variables related to changes in organizational distance, Delta Turnover and Delta Age, do not show any significant impact on our dependent variable. Contrary to our initial hypothesis, variations in organizational structure do not seem to influence the probability of resorting to leniency, suggesting that such changes may not significantly disrupt cartel stability. We will later explore possible explanations for this lack of observable effect.

Overall, the results from Models (1) and (2) reveal an interesting phenomenon when considered together: increasing the number of companies in

a cartel does not, in itself, impact the probability of resorting to leniency. The disruptive impact of adding new members depends on the profile and characteristics of the firms joining the cartel. More specifically, the inclusion of new companies that are culturally distinct from the original members, or culturally incompatible, threatens the stability of the entire structure.

In Model (3), the main variable Meeting does not appear significant. However, this result should be interpreted with caution, as this same variable becomes significant once included in the more comprehensive Model (5), which incorporates all key variables. The effect of this variable is positive, which is somewhat surprising given our initial hypothesis but is actually consistent with the existing literature and reveals an intriguing phenomenon. The results indicate that an increase in the number of meetings between firms is associated with a higher probability of resorting to leniency. However, rather than a direct causal link, it is likely that these two phenomena occur simultaneously. We believe that the underlying reason is that firms struggle to coordinate effectively, leading to an increased need for meetings. In this sense, a higher frequency of meetings may be a symptom of internal discord within the cartel, ultimately increasing the likelihood of defection.

Initially, we hypothesized that more frequent meetings would strengthen the cartel by reinforcing trust and cohesion among members. However, in the specific context of cartels, the optimal strategy is to minimize face-to-face interactions as much as possible to avoid detection. A high number of meetings, therefore, may reflect not so much a desire to strengthen ties, but rather a necessity to ensure the proper execution of collective actions. Paradoxically, this implies that the most effective cartels are those that can coordinate with minimal interaction, while the least effective ones, those facing coordination difficulties and thus more likely to resort to leniency, are those where members require more frequent interactions, resulting in a

higher number of meetings.<sup>1</sup>

This finding is particularly interesting as it echoes, in the context of cartels, the trade-off between concealment and performance (or stability) that is observed in illegal organizations. For a given level of performance, the degree of concealment directly impacts the probability of coordination failure within an illegal organization.

The results of Model (4), in terms of coefficient significance, are similar to those of the previous models, reinforcing our earlier conclusions. In Model (5), the results remain largely consistent, with the exception of the Meeting variable, which, as mentioned earlier, now appears significant.

Regarding our control variables, it is unsurprising that *Count*, the number of members involved in the cartel, has a positive and highly significant effect across all model specifications. This indicates, as expected, that a larger number of participants has a destabilizing effect on a cartel and increases the likelihood of one member denouncing the others. This effect is both mechanical and strategic, as game theory predicts that collusive agreements become more unstable as the number of participants grows. On the other hand, Cartel Duration does not show any significant effect on our dependent variable. The variable *Pre 2006* has a significant negative effect. This indicates that cartels which ended before the introduction of the 2006 Leniency Notice were less likely to be subject to leniency applications. This supports the idea that the 2006 reform, by increasing procedural transparency, introducing a marker system, and clarifying fine reduction criteria effectively strengthened the incentives for cartel members to come forward.

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<sup>1</sup>A Sasabuchi (1980) test was conducted to assess the potential non-monotonic (U-shaped) effect of the Meeting variable; the result was not significant, suggesting no support for a U-shaped relationship.

## Discussion

Our results yield interesting results with some going against our initial previsions. When looking at Hypothesis 1, we find no significant effect of different indicators of proximity on the likelihood of resorting to leniency. This result contradicts a large body of literature on strategic alliances, which emphasizes the importance of proximity in fostering trust and collaboration to sustain alliances. This divergence suggests that the dynamics within cartels may differ substantially from those in legal cooperative arrangements.

These findings are particularly interesting when considered alongside other studies that highlight the role of different types of proximity at various stages of a cartel's lifecycle, including its formation and the development of its activities. This is especially relevant given that the role of interorganizational proximity and its implications remain relatively understudied. For instance, while this study does not find evidence of an effect of organizational proximity, previous research suggests that it plays a significant role in earlier phases of cartel dynamics. Therefore, this apparent lack of results may actually be entirely consistent when considering the phenomenon as a whole.

It is reasonable to assume that firms pre-select partners with whom they are compatible, meaning those with whom they share a certain degree of proximity. As a result, the effect of proximity appears neutral, not because it is absent, but because firms prone to conflict or distrust were never selected as cartel partners in the first place. The observed differences, although real, have no significant impact because firms have already filtered out both highly compatible partners and those with such substantial differences that they would eventually face coordination difficulties, thereby increasing the likelihood of resorting to leniency.

This suggests the existence of a hypothetical threshold, currently unknown, below which structural distance has no effect, implying a non-linear relationship between structural distance among the members of a cartel and the probability of resorting to leniency.

Hypothesis 2 is partially confirmed: changes in cultural proximity within a cartel over time, as measured by variations in Hofstede’s Individualism and Long-Term Orientation dimensions, significantly increase the likelihood of leniency. This suggests that initial compatibility may be less important than how that compatibility evolves as the cartel grows, and that structural changes, such as an increase in the number of participants, do not have a negative effect as long as the level of cultural proximity remains comparable to that at the cartel’s creation. Culture appears to be the most critical factor in explaining cartel instability, and this finding is consistent with the existing literature on alliances.

The effect of changes in geographic distance is particularly interesting, although at first glance counterintuitive. We argue that this finding reflects a cartel-specific phenomenon. An increase in geographic distance may have a dual impact. First, it may lead to a greater perceived safety from detection when companies operate in different jurisdictions. Because cross-border cartels are inherently more difficult to detect and prosecute, because they require coordination among multiple enforcement authorities, this can influence the subjective perception of the actual detection risk, thereby reducing the incentive to apply for leniency rather than continue operating the cartel.

Second, the efficiency and attractiveness of leniency programs partly depend on the procedural complexity involved. Leniency applicants face high transaction costs and will only apply if they expect substantial rewards (such as a full or near-full fine reduction) in all relevant jurisdictions (Kosten, 2022).

When cartels operate across a variety of jurisdictions, often geographically distant, members may face greater uncertainty as to whether they will successfully obtain leniency in all of them, which mechanically lowers the likelihood of resorting to the program.

As previously mentioned, the role of interactions within cartels, particularly the significance of meetings, has not been extensively studied despite its crucial importance in understanding and quantifying the dynamics between colluding firms. Our results support this idea, yet it is useful to highlight certain aspects of our analysis, particularly regarding the variable Meeting. While it serves as an interesting proxy, it remains an imperfect indicator. One limitation concerns the accessibility of information, as firms involved in a cartel can request that certain elements discovered during an investigation remain confidential. This usually applies to information related to the company's activities, organizational structure, or financial performance, and more generally to strategic elements that could negatively impact the firm in the future. Consequently, researchers may lack complete data, which is why our analysis excludes some cartels when incorporating the meeting variable. Although there is no specific reason to suspect it, a potential selection bias cannot be entirely ruled out.

A more probable bias relates to self-disclosure, as it is reasonable to assume that firms may have underreported their actual involvement in the cartel to some extent. It is likely that firms attempted to understate their participation, including the number of meetings they attended, given that the level of individual fines is partly determined by the degree of involvement in the collusion, for example, whether a firm played a leading or passive role in the coordination process. Additionally, cartel members have an incentive to systematically erase traces of interactions and communications, including records of meetings, to complicate future investigations and reduce the risk of conviction. Reports from investigations often include messages explicitly

acknowledging the illegal nature of cartel activities and emphasizing the necessity of secrecy. It is reasonable to assume that a significant number of such messages were deliberately destroyed. Consequently, if a cartel was particularly effective in eliminating evidence, retrospective traces of meetings may be missing from our analysis.

This effect is, by nature, impossible to measure accurately. However, it is likely that the loss of information is more significant in smaller cartels with fewer members. In larger cartels, information loss would primarily affect records of bilateral or trilateral contacts, as broader conspiracies are inherently more difficult to conceal. As previously explained, the more members involved, the harder it becomes to maintain secrecy. This loss of information however should be put into perspective for several reasons. Concealing evidence of interactions, especially face-to-face meetings, can be technically challenging, as unlike emails, which can be easily deleted, meetings involve logistical costs such as travel expenses, which typically require justification within companies. Furthermore, all cartel members would have to coordinate effectively to simultaneously conceal these expenses. Firms may also have an incentive to disclose information to antitrust authorities once an investigation is underway, as cooperative behavior can be perceived as a sign of goodwill and could lead to reduced fines.

The overall impact of these various scenarios on the final measurement of cartel meetings remains difficult to predict. However, it is reasonable to assume that the loss of information would be more pronounced for other forms of interactions, such as phone calls, which leave no trace, or emails, which can be easily deleted. This is why the number of meetings can be considered a reliable indicator : it minimizes the risk of information loss and represents the most meaningful form of interorganizational communication. Future research could explore ways to integrate other types of interactions into the analysis. Frequent communication, even through lower-richness me-

dia, likely reinforces ties between organizations, meaning that their intensity should either correlate highly with the number of meetings or, in some cases, serve as a substitute. This consideration is especially relevant following the COVID-19 pandemic, which has significantly altered communication practices, particularly with the increased use of videoconferencing tools.

Overall, our results offer meaningful theoretical contributions to the field of strategic alliances. By highlighting the specific nature of cartels, conceived here as a particular form of alliance characterized by illegality and heightened internal and external constraints, our findings help describe the mechanisms at play in alliances operating under such conditions. While building on theories developed in the context of legitimate strategic alliances, our results suggest that these frameworks may not always be directly applicable to illicit arrangements. In particular, the non-significance of static proximity measures and the unexpected effects of meeting frequency call for a reassessment of how trust and coordination operate within criminal networks.

Furthermore, our findings underscore the importance of dynamic changes over time, rather than solely static structural features. Few studies have examined changes in the configuration of multi-partner alliances, and most have focused on how the departure of members may destabilize the group rather than the introduction of new ones. Our results indicate that structural changes do not necessarily increase instability if cultural proximity is preserved. This supports the view that cultural alignment functions as a key integrative mechanism within illicit collaborations, potentially outweighing the influence of other organizational or geographic factors over time.

From a practical perspective, these findings may provide useful insights for competition authorities in their efforts to combat cartels. While the number of meetings can only be determined retrospectively once a cartel

has been detected, indirect indicators of interaction intensity may be more easily observable. One example is the presence of regular sectoral meetings. A glance at the European Commission reports indicates that such officially sanctioned and theoretically legal events often serve as opportunities for collusive meetings to take place around the same time. This observation aligns with studies highlighting the role of trade associations and business groups in facilitating and coordinating cartels (Schuldt and Taylor, 2018). It may also be worthwhile for competition authorities to focus specifically on smaller cartels, or at least those suspected to be small, meaning cartels with fewer members. The reasoning behind this is that cartels with more members tend to be more unstable and are more likely to resort to leniency. As a result, the leniency policy is relatively more effective in dismantling larger cartels. This suggests that, in terms of resource allocation, antitrust authorities may benefit from prioritizing investigations into smaller cartels, as they tend to be more stable and are therefore less likely to be uncovered passively through the leniency program. Although this approach may seem counterintuitive, given that smaller cartels may also be less harmful, it appears to be the most effective strategy to adopt.

Future research could extend these findings to a broader international scale or different jurisdictions. While our focus on a single jurisdiction has advantages, particularly in ensuring temporal consistency, it also has limitations. The dataset may lack diversity, as it primarily includes countries that share similar cultural and economic characteristics. The decision to focus on the European Commission's jurisdiction, particularly since the introduction of the leniency program, was made to ensure consistency over time, as the EC was the first authority to adopt such a program following the United States. However, expanding the analysis to multiple jurisdictions would be highly relevant, particularly given that over 80 jurisdictions had adopted leniency and immunity programs by 2019. The effectiveness of these programs varies

significantly across countries, especially in those that have implemented them more recently. Conducting a large-scale cross-national study in the coming years, once sufficient hindsight is available on the implementation of these programs, could provide valuable insights into the global impact of leniency policies.

It may also be valuable for future research to explore alternative indicators for the different types of proximity and proximity variations to potentially refine and improve our results. While our findings are already insightful and meaningful, some variables, such as Delta Turnover and Delta Age, do not appear to influence the probability of resorting to leniency. This outcome contradicts our initial assumptions, which were supported by the literature, particularly given that the other two types of proximity variations do show a significant impact. For this reason, we believe that future research on cartel organization could benefit from incorporating elements related to the structural evolution of collusion.

## Conclusion

This study has allowed us to gain a deeper understanding of how cartels operate by analyzing their potential evolution over time and the effects of these changes on their organization and stability. We now have a clearer picture of the optimal strategy for a cartel: integrating new members who are culturally similar. While increasing the size of a cartel carries certain risks, it also presents significant advantages. Expanding allows the cartel to incorporate additional competing firms, increasing its cumulative market share and, consequently, its market power. This enables it to move closer to a monopolistic economic structure, thereby enhancing the overall value creation of the cartel and its member firms. However, to ensure the stability

of the collusive agreement, it is crucial to integrate members who share cultural proximity with existing participants.

These findings also provide valuable insights for competition authorities. Since larger cartels tend to be more unstable and more likely to be dismantled through leniency programs, enforcement efforts should be particularly effective when targeting smaller, more resilient cartels. Additionally, identifying indirect indicators of cartel interactions, such as participation in industry meetings, could strengthen detection strategies. Future research could extend this analysis across multiple jurisdictions to further assess the global effectiveness of leniency programs.

From a theoretical perspective, this study also sheds light on the functioning of illegal organizations, a topic that is inherently difficult to analyze. One of the key takeaways is the dual phenomenon at play: on the one hand, the composition of a cartel appears to have a neutral effect on its overall stability; on the other hand, cultural changes within the cartel significantly destabilize the organization.