

How Long Do Cartels Last in Developing Countries? An Economic Analysis of the Determinants of Cartel Duration in Brazil

Paulo Burnier Da Silveira

Research Group on Trade and Competition, GECC, University of Brasilia. Email: burnier@gmail.br

Article Info

How to cite this paper Paulo Burnier Da Silveira. (2025). How Long Do Cartels Last in Developing Countries? An Economic Analysis of the Determinants of Cartel Duration in Brazil. *World Competition*, 48(1), 51–72. <https://doi.org/10.54648/woco234291>

Copyright © 2026 The Authors

This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0). <https://creativecommons.org/licenses/by/4.0/>

ISSN Online: 1875-8436
ISSN Print: 1011-4548

Received: 25.03.2024
Revised: 09.07.2024
Accepted: 14.02.2025
Article Type: **ORIGINAL Research**



ABSTRACT

This paper analyses the determinants of cartel duration by using a dataset of 120 cases sanctioned by the Brazilian Competition Authority (CADE) between 1999 and 2022, which corresponds to all cartels sanctioned by CADE in Brazil from its inception until December 2022. The research considers the starting and the ending dates of the infringement as indicated in the case files, and it reveals an average duration of four years per cartel. Around 20% of the cartels had a very short duration (less than three months), while the longest cartel durations were around twenty years per cartel (i.e., the cartels in the markets of cement, salt extraction and marine hoses). The research then focuses in exploring the key determinants that may affect the duration of cartels, including the affected economic sector, the number of defendants and the geographic scope (i.e., local, national or international cartel). For this purpose, the research provides a statistics description of the database, which includes more than 2,500 defendants and total fines of around ten billion BRL (two billion Euros). The paper also explores possible correlations between these key determinants and the duration of cartels, by applying tests to measure the intensity of the correlations and its statistical significance, in addition to a regression exercise using ordinary least squares (OLS) and weighted least squares (WLS) to complete the analysis. Last, a cartel survival estimation based on a Kaplan-Meier modelling indicates the probability of a cartel surviving after a given number of years, as done in similar academic work related to other jurisdictions. The paper concludes with a summary of the key findings and suggestions for future work.

Keywords:

cartel duration, key determinants, correlation analysis, cartel survival estimation, Brazilian Competition Authority (CADE), economic analysis of law enforcement

1.Introduction

The fight against cartels has been a priority for many governments in the last decades. The negative effects of cartels in the economy, particularly for consumers, are widely known and well-accepted by policy makers, which explains why competition authorities prioritize cartel enforcement in their work streams. Indeed, recent studies confirm that competition authorities dedicate a substantial part of their resources to detection, investigation, and prosecution of cartels (OECD, 2022).

In Brazil, cartel enforcement follows a similar trend, with an increasing number of cartel cases sanctioned by the Brazilian Competition Authority (CADE) in the past two decades. Since 1999, a total of 120 cartel cases have been sanctioned (until December 2022).

This paper explores a specific angle of cartel enforcement, namely the factors that affect the duration of cartels. This dimension is relevant because cartels are widely considered the most harmful infringement in competition law, and longer cartel duration leads to greater harm to both consumers and the economy more broadly. As an obstacle to calculate cartel duration, one should note that cartels are often a secret conspiracy (between competitors to fix prices and/or share markets), which makes it difficult to identify the precise length of the infringement.

To examine the duration of cartels, this research analyses the entire case law of 120 cartel cases sanctioned by CADE between 1999 and 2022, which correspond to all cartel cases sanctioned in Brazil until December 2022. The same dataset was used by Porto (2023) for a study related to non-pecuniary sanctions in Brazil. The research considers the starting and the ending dates of the infringement as indicated in the case files, and it reveals an average duration of 4 years per cartel. While the longest duration is around 20 years per cartel (i.e. the cartels in the markets of cement, salt extraction and marine hoses), around 20% of the cartels had a very short duration (i.e. less than 3 months).

The key determinants that may affect the duration of cartels are at the core of the research. Cartels may last for decades or a very short period depending on different factors, for instance the economic sector affected by the infringement, the number of defendants and/or the geographic scope (i.e. local or international cartel).

In this context, this research selected 6 (six) possible factors, based on the available data, which may affect the duration of cartels: (i) number of defendants, (ii) economics sectors, (iii) existence (or not) of public procurements, (iv) involvement of trade associations in the wrongdoing, (v) existence (or not) of leniency application and (vi) geographic scope of the cartel. Indeed, these elements may have an impact in the duration of a cartel infringement as suggested by Hay and Kelley (1974), Abrantes-Metz, Connor and Metz (2013) and Feinberg, Kim and Park (2016).

For the part related to the analysis of correlations between cartel duration and the key listed factors, the research aims to address the following questions:

Is there a correlation between the duration of cartels and the **number of defendants**? The hypothesis is that the duration will be larger in cartels with a smaller number of defendants since cartelists may benefit of a more trustful environment and thus stability.

1. Is there a correlation between the duration of cartels and the **economic sectors** affected by the infringement? The hypothesis is that the duration will vary depending on the economic sector, with longer cartel periods in sectors involving homogenous products (e.g. energy sector) when compared to markets with greater product differentiation (e.g. health sector) since similar pricing patterns are common in the first category of homogenous products, thus more difficult to detect the wrongdoing.

2. Is there a correlation between the duration of cartels and **public procurement** (i.e. bid-rigging cases)? The hypothesis is that bid-rigging cartels will have smaller periods because they accept a one-shot infringement type of cartel, namely when limited to one specific public procurement proceeding.

3. Is there a correlation between the duration of cartels and the presence of **trade associations**? The hypothesis is that the duration will be larger in cartels that enjoy the participation of trade associations, since they tend to play a role in the cartel coordination and stability.

4. Is there a correlation between the duration of cartels and the existence of **leniency applications**? The hypothesis is that the duration will be smaller in cartels uncovered via leniency applications (otherwise these cartels would still be in force).

5. Is there a correlation between the duration of cartels and its **geographic scope**? The hypothesis is that local cartels (i.e. at municipal level) are more stable than national and international cartels since cartelists may interact more easily with each other at local level.

To address these questions, the paper will first provide an overview of the literature related to the topic of cartel duration. It will then examine the dataset of 120 cartel cases, including a statistics description and techniques to measure the intensity of the potential correlations between the duration of cartels and the key selected factors. Finally, the paper will conclude with a summary of the key findings and a suggestion for future research.

The Brazilian dataset is valuable for a number of reasons. First, all information is publicly available in the case files which allows an open access to research and cross-checking by other researchers if needed. Also, the dataset allows an economic analysis of law enforcement in the reality of a developing country, which is rare in the economic literature (as seen by the related literature review below). Last and related to the earlier aspect, Brazil has particularities that may affect the economic analysis of law enforcement, for instance a younger competition law regime (when compared to developed countries such as Canada, France and the US), a significant social and economic inequality, as well as a large geographic area.

1. Related literature

The duration of cartels has been subject to several academic publications, ranging from early 1970s to present days, which attempted to address the topic by using different methods and databases.

Hay and Kelley (1974) examined US criminal cartel cases, which were won or settled by the US Department of Justice during ten years (1963-1972), and discussed factors related to the

incentives of firms to engage and maintain cartels (e.g. number of firms, concentration of market, product homogeneity, demand elasticity, lumpiness (infrequency) of orders, high fixed costs and industry structure). Applying a methodology of descriptive statistic, they found that almost 80% of the cartels involved 10 or fewer firms, and that trade associations were often involved when cartels enjoyed a larger number of cartelists to support cartel coordination. They also revealed that cartels lasted longer on markets with higher concentration markets and homogenous products.

Marquez (1994) investigated the factors affecting the duration of 52 international cartels covering a wide period from the late 1880s through the early 1980s, by applying an econometric analysis using Amemiya's maximum likelihood estimator, with findings indicating that increases in either market shares or concentration led to longer life duration of cartels.

Levenstein and Suslow (2011) performed a more sophisticated analysis to estimate a proportional hazard model for 81 international cartels (active from 1990 to 2007), which attempted to distinguish between factors related to natural cartel collapse and those related to cartel death as a consequence of an antitrust investigation. They found empirical evidence that enhanced antitrust enforcement (e.g. via leniency programs) led to the collapse of weak cartels, and did not found significant results in relation to the number of firms, the concentration of industry or macroeconomic factors affecting the duration of cartels. In sum, the internal mechanisms of the cartel, such as market allocation, internal monitoring and compensation procedures, seemed to have played a greater role in the duration of these infringements. The authors expanded earlier research, which argued that the biggest challenges cartels face are entry and adjustment of the collusive agreement in response to changing economic conditions, so cartels that develop organizational structures that allow them the flexibility to respond to these changing conditions are more likely to survive (Levenstein and Suslow, 2006).

Abrantes-Metz, Connor and Metz (2013) modelled cartel duration using a mixed proportional hazard model including a Kaplan-Meier estimate and considered, for this purpose, certain cartel characteristics (e.g. the agency first detecting the cartel, the industry, the existence of public procurements, the number of countries affected, the affected sales, and measures of the economic cycle and trend). The findings indicate that cartels first detected by the US or in Europe tend to last longer, probably because those detected by other jurisdictions are primarily follow-ups of related larger and older cartels first uncovered in the US or Europe. In addition, bid-rigging cartels tend to be longer, while cartels distributed across geographies tend to be shorter. The duration of cartels tends to increase with higher affected sales and sanctions by competition authorities. The duration also varies across industries: petroleum, finance, insurance and transportation have shorter cartels, whereas electronic products have longer durations. Last, cartels where the leading firm has a market share of at least 40% last longer, although the authors recognize that market-share data was often unavailable.

Feinberg, Kim and Park (2016) consider a database of 388 cartel cases sanctioned by the Korean Fair Trade Commission (KFTC) from 1989 and 2013 to explain the determinants of reported cartel duration. The paper notes a wide variability in cartel stability with durations ranging from 1 month to almost 15 years (with a median duration of 14 months). The number of cartel participants varied between two and 67 (with a median value of five firms). The authors also found that larger number of participants firms generally reduces cartel stability, while the presence of foreign firms tend to increase its duration. In addition, the existence of leniency programs seems to play a role towards a lower duration of cartels, at least in the short-term after the introduction of this public policy tool, which aims to improve cartel detection. It applies regressions with industry fixed effects using both OLS regressions and WLS estimations, which adds to the regression analysis of a semi-parametric Cox proportional hazard model. The role of heterogeneity emerges as an important dimension of the research, namely in the probability of detection and collapse of cartels. Amongst the findings, the authors suggest that the number of firms often plays a role in cartel stability, reducing cartel duration as it increases, and foreign company involvement tends to promote greater cartel stability. The same variables could be applied to the Brazilian dataset, which would also allow testing once again the robustness of related findings.

Bertrand and Lumineau (2016) explores a dataset of 41 cartel cases sanctioned by the European Commission from 2001 and 2011 to assess the longevity of cartels. They apply a survival modelling approach (more precisely, a Kaplan-Meier survival non-parametric estimation), which indicate an average duration of 7.95 years per cartel. The probability of a cartel surviving 5, 10 or 15 years is 60%, 35% and 12% respectively.

As additional results of this study, Bertrand and Lumineau (2016) argue that the number of participants in a cartel affects its longevity significantly and negatively (0.03, $p < .001$). In addition, cartels are less likely to survive when group members have similar backgrounds (i.e. low variety of age-based experience), they do not share the same values (i.e. high separation in uncertainty avoidance) and when there is no leader to conduct the group (i.e. low power disparity).

Haucap and Heldman (2022) examine 15 cartel cases in Germany and focus on the individual participants, including the evidence of communication (e.g. personal meetings, e-mails and phone calls) and internal structure, to explore the sociology of cartels and how the conspiracies ended. The research provides an overview of the individual participants dividing them per age, gender, firm hierarchy and number of years of professional activity in the affected industry. Most participants were men, aged between 45 and 60 years, and of high management corporate positions. The research suggests that homogenous networks, such as “old boys club”, may contribute to the creation of personal bonds and trust, which are necessary to engage in cartels. In addition, the authors argue that the biggest threat to cartel stability comes from leniency programs (in their dataset, leniency applications caused the break-up of 10 out of 15 cartel

cases). As admitted by the authors, the research may nevertheless suffer from a selection bias since the 15 cartel cases were selected by the *Bundeskartellamt*, the German Competition Authority.

Harrington *et al.* (2015) examine a specific cartel collapse case, namely the one related to the cement cartel in Germany that lasted from 1991 to 2002. The authors highlight the importance of understanding why cartels collapse, which seems indeed important to research the duration of cartels. They argue that cartel instability is often related to cartel members being discontent with the evolution of the illegal arrangement. By exploring a pricing data set, the authors argue that the firm Readymix became discontent with the agreed market allocation and deviated from the cartel arrangement. The other firms responded, and this finally led to the collapse of the cartel according to the authors.

Leslie (2004) also explores the element of trust and distrust, particularly the fear of cartel members deviating and reporting the illegal practice, by using both the theoretical and empirical framework of the prisoner's dilemma. The author argues that if all participants trust each other not to cheat, then individuals are less likely to defect. Hence, based on game theory insights, it seems that successful cartels are those that can establish mutual trust among cartel members. The elements of trust and distrust may involve personal relationships, goodwill gestures, price transparency, consistent communication, cross-ownership, interlocking directorates, and prior cartel experience. When cartelists cannot establish trust, they rely on trust substitutes such as contracts, government regulation, or private enforcement systems, based on the monitoring and punishment of cheating – in the attempt to maintain stable cartels.

Jaspers (2017) builds on this idea of needing trust and explores a dataset of 14 Dutch cartel cases to understand how cartel members organise their illegal agreements in the absence of legal means. The paper highlights the role of informal coordinating mechanisms, and how they enable cartel stability outside the scope of formal legal control. These include informal social mechanisms to coordinate, monitor, enforce, and compensate for the longevity of business cartels. Furthermore, the results emphasise that in order to explain cartel stability, social mechanisms that induce trust need to be considered. It found an average cartel duration of 5 years.

Despite the indicated literature, there is limited research related to the duration of cartels focused on developing countries. One rare example is provided by Maphwanya (2017) in South Africa using a dataset of 28 cartel cases sanctioned by the Competition Commission of South Africa (CCSA). The study found that the average duration of a cartel sanctioned in South Africa is 6 years and 7 months, with the shorter duration of 1 month and longest duration of 11 years and 4 months. The research also indicates that South African cartels present features that may increase cartel stability and that more than half of the cartels detected involved less than five firms and homogenous products. In addition, the cartels with a large number of firms appear to

rely on industry association. Last, the study expects that this average duration will decrease with greater enforcement actions taken by the South African authorities in the fight against cartels.

Table 1. Summary of publications with empirical evidence related to cartel duration

Author(s)	Year	Title	Type	Dataset	Period	Duration	Location
Abrantes-Metz, Connor and Metz	2013	The determinants of cartel duration	PRJ	187	1990-2004	5.92 years (average)	Worldwide
Bertrand and Lumineau	2016	Partners in crime: the effects of diversity on the longevity of cartels	PRJ	41	2001-2011	7.95 years (average)	European Union
Feinberg, Kim and Park	2016	The determinants of cartel duration in Korea	PRJ	288	1989-2013	2.08 years	Korea
Harrington <i>et al.</i>	2015	The discontent cartel member and cartel collapse: the case of the German cement cartel	PRJ	1	2002	N/A	Germany
Haucap and Heldman	2022	The sociology of cartels	WP	15	2001-2021	N/A	Germany
Hay and Kelley	1974	An empirical survey of price fixing conspiracies	PRJ	62	1963-1972	N/A	U.S.
Jaspers	2017	Managing cartels: how cartel participants create stability in the absence of law	PRJ	14	2007-2012	5 years (average)	Netherlands
Levenstein and Suslow	2011	Braking up is hard to do: determinants of cartel duration	PRJ	81	1990-2007	N/A	Worldwide
Maphwanya	2017	Cartel likelihood, duration and deterrence in South Africa	CH	28	1999-2012	6.58 years (average)	South Africa
Marquez	1994	Life expectancy of international cartels: an empirical analysis	PRJ	52	1880-1980	N/A	Worldwide

* CH = Chapter in book; PRJ = Peer-Reviewed Journal; RP = Report; WP = Working Paper

This research builds on the prior economic literature and applies a similar methodology, particularly the one used in Feinberg, Kim and Park (2016), to the Brazilian dataset of 120 cartel cases. It intends to contribute to the economic research on the topic of cartel duration, while adding to the limited empirical research concerning developing countries.

2. Data, methodology and descriptive statistics

The research uses official and public data available in cartel administrative proceeding files at the Brazilian Competition Authority (CADE) from 1999 to 2022. This period corresponds to the entire dataset of cartels sanctioned by CADE in Brazil until December 2022 (i.e. 120 cartel sanctioned cases in total). The dataset indicates an average duration of a cartel in Brazil of 4 years, ranging from 1 month to 22 years, and a median of 1 year.

The Annex consolidates the data gathered, which includes the following columns: the identification of CADE's administrative proceeding, the affected economic sector, the number of defendants (subdivided in firms and individuals), the presence of trade association amongst the defendants, the existence of leniency application in the case files, the existence of public procurements when related to bid-rigging, the geographic scope of the cartel (namely if it is limited to a local, national or international), and the duration of the infringement accordingly to CADE's administrative proceeding.

The descriptive analysis included calculation of mean, standard deviation (SD), median, maximum, and minimum values for continuous variables, as well as absolute and relative frequencies for categorical variables. The Shapiro-Wilk test was performed to check the adherence of the variables to a normal distribution so that the type of statistical tests to be performed could be determined.

To assess correlations between duration of cartels and quantitative variables, we used the Spearman's rank correlation coefficient. The analysis of associations for categorical variables was performed using the non-parametric Mann-Whitney test for variables with 2 categories and Kruskal-Wallis for variables with 3 or more categories.

In addition, we performed a survival analysis with the Kaplan–Meier method to estimate the probability of surviving in each time interval, both overall and in accordance with the independent variates evaluated. Survival time was defined as the time (years) from the date of the cartel's formation until its termination date. The log-rank test was used to compare accumulated survival curves between the categories of independent variables, and those presenting $p < 0.200$ were selected for multiple Cox analysis.

Cox regression analysis with the stepwise forward method was used to evaluate the effect of independent variables on the outcome. The assumption of risk proportionality was verified through log-log plots and the Schoenfeld test for each variable for the final model. Independent variables were excluded if they did not meet the fundamental assumption. The model fit was evaluated using the likelihood ratio test. Hazard ratios (HR) were used to measure risks. Values

above 1.0 indicate a greater probability of cartel termination as a function of the length of follow-up.

A descriptive $p < 0.050$ level was used in all the analyses.

The following sub-chapters will address each of the questions previously indicated and propose possible explanations when applicable for the selected key determinants of cartel duration (namely the economic sectors, the involvement in public procurements, the number of defendants, the presence of trade associations, the existence of leniency application, and the geographic scope of the infringements).

2.1. Number of defendants

The dataset indicates that cartels in Brazil have in average 22 defendants including 11 firms and 11 individuals per cartel case. In total, the number of defendants is 2,595 – including 1,336 firms and 1,259 individuals in the dataset of 120 cartel cases. The figure below presents the cartel average duration based on the number of defendants (divided by number of firms and number of individuals):

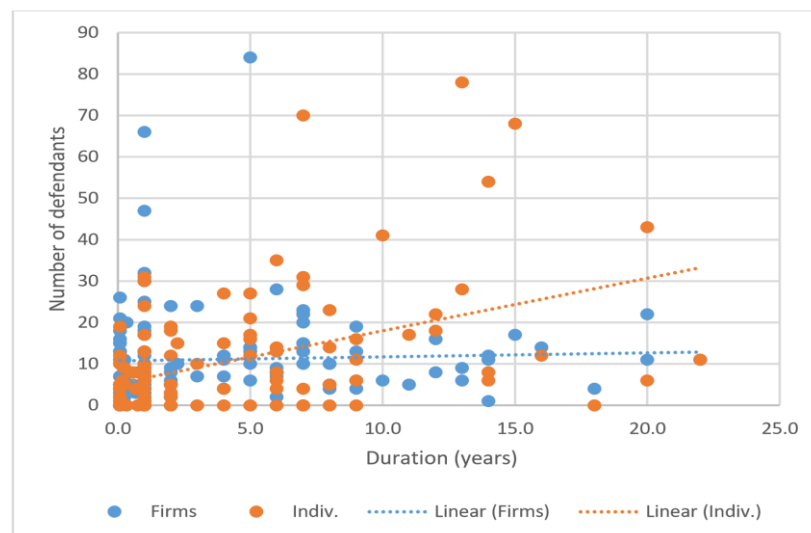


Figure 1. Cartel duration and number of defendants

The statistics analysis shows that duration of cartels is higher in cartels with many defendants: 5.3 years for cartels with 10 or more defendants-firms, compared to 3.2 years for cartels with less than 10

defendants-firms. This result goes against the hypothesis that cartels with a small number of defendants would have greater stability and thus larger average duration as speculated, also

claimed by Hay and Kelley (1974) who argue that risks of cartel are greater in markets with fewer players.

Possible explanations may include the fact that defendants are not necessarily cartelists. The database did not cover firms that were convicted by CADE, but rather those that were included in the investigation and may have been acquitted at the end of the administrative proceeding. The number of individuals is a variable less reliable because a given cartel proceeding may include several individuals (e.g. employees) from the same company as defendants (and they are all part of the same cartel member).

2.2. Economic sectors

A first possible correlation to be analysed concerns the interplay between the duration of cartels and the economic sectors of the infringements. For this purpose, the dataset of 120 cartel cases were divided into main economic categories, namely energy (23), transportation (15), construction (9), health (27), automobile (6), electronics (7), heavy industry (4) and others (29) for the remaining markets that did not fall into any of the earlier categories.

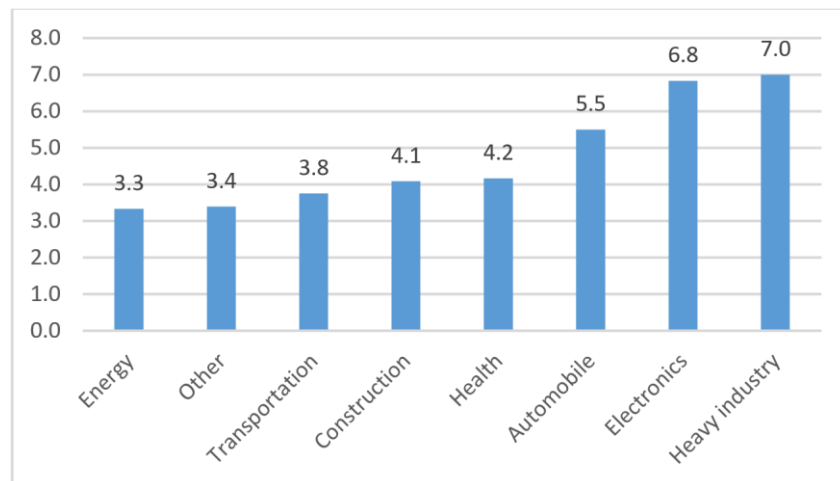


Figure 2. Cartel duration by economic sector

Source: created by author based on information available on CADE's public database.

The figure indicates that cartels in the energy sector have an average duration of around 3 years whereas cartels related to electronics and heavy industries lasted for around 7 years. In other sectors, cartels had an average duration of around 4-5 years including transportation, construction, health, and automobile. It is difficult to cross-check with the economic literature on homogenous products since each of these sectors may have different markets (with different

levels of product homogeneity). As a reminder, Hay and Kelley (1974) claim that cartel duration tend to be larger in markets involving homogenous products.

2.3. Public procurements

Public procurement is another component that may provide insights in the study of cartel duration. Indeed, bid-rigging cases may take place in very short periods, sometimes a “one-shot” cartel to win an important public contract (and then share the award between cartelists through sub-contracting or other bid-rigging strategies). However, this hypothesis was not confirmed when analysing the data of 120 cartel cases (84 non bid-rigging cases; and 36 bid-rigging cases):

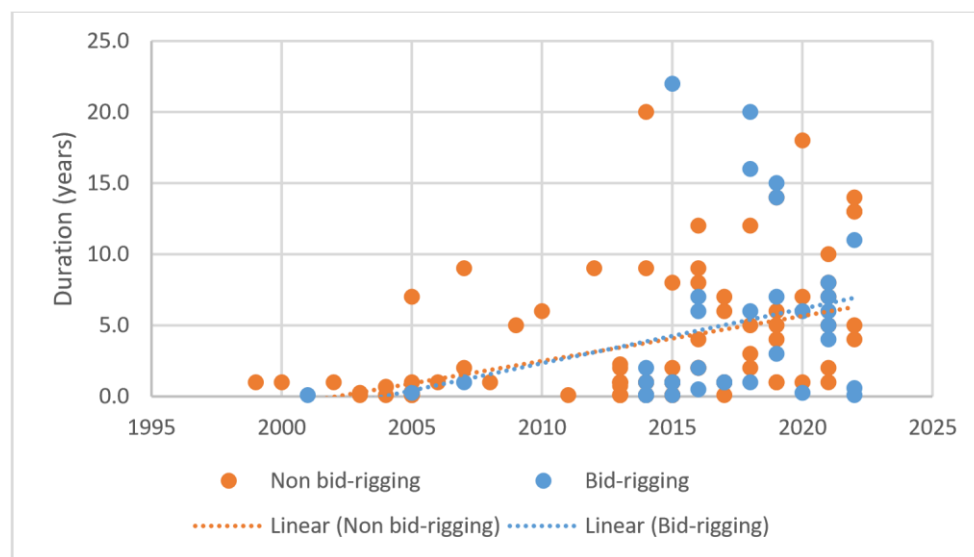


Figure 3. Cartel duration and bid-rigging

Furthermore, the figure indicates that the average duration of bid-rigging cartel cases is actually higher (5 years) than non bid-rigging cartel cases (3.7 years), which is also different from the hypothesis that bid-rigging cases would be shorter in duration than non bid-rigging cases. However, this finding is consistent with Abrantes-Metz, Connor and Metz (2013) who claim that bid-rigging cartels tend to be longer than non bid-rigging cases.

2.4. Trade associations

Another possible correlation relates to the presence of trade associations in cartel arrangements. In practice, it is often the case that trade associations have a role in *the modus operandi* of the cartel, for instance serving as a forum for meetings and exchanges between competitors – either legally on legitimate issues, or illegally such as in cartel infringements.

In this sense, the initial hypothesis was that the duration would be larger in cartels that enjoy the participation of trade associations since they tend to play a role in the cartel coordination and stability. However, the figure below indicates that there is not a significant difference between the duration of cartels in which a trade association integrates or not the defendants list (3.9 and 4.2 years, respectively). Rather the opposite, the cartel cases in which trade associations are not involved have slightly higher duration average and trend.

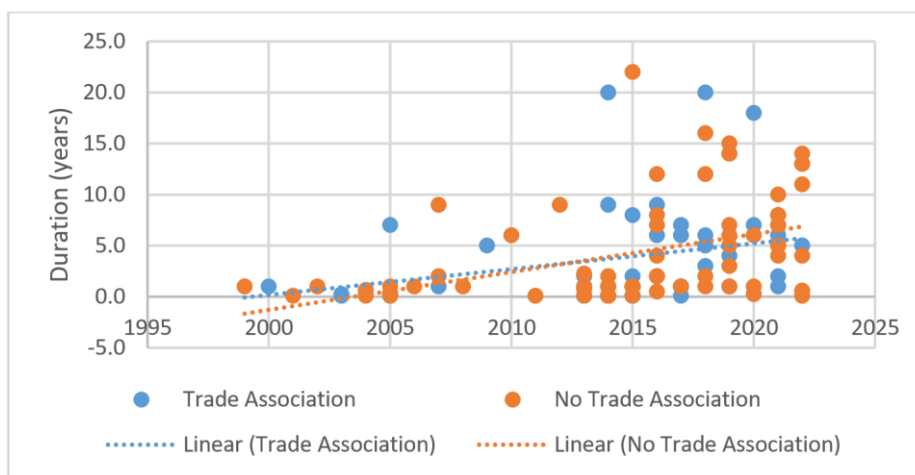


Figure 4. Cartel duration and trade associations

Source: created by author based on information available on CADE's public database.

2.5. Leniency application

The figure below indicates the cartel duration of cartel cases that were opened with a leniency agreement compared to those that did not benefit from a leniency application:

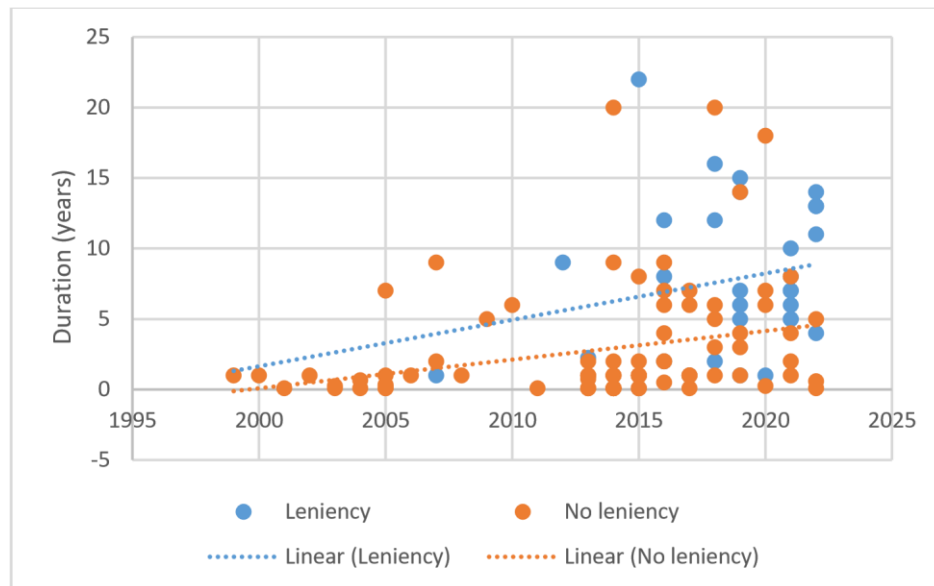


Figure 5. Cartel duration and leniency

Source: created by author based on information available on CADE's public database.

The cartel duration of leniency cases is higher (8 years) than non-leniency cases (3 years). While this may seem against certain empirical work that suggest that leniency reduces cartel duration (Levenstein and Suslow, 2011; and Feinberg, Kim and Park, 2016), it might be explained by the fact that leniency cases often benefit from better set of evidence than non-leniency cases. Indeed, leniency applicants are expected to tell the full story of the cartel and present proof of the wrongdoing, which helps to understand the way the cartel operated and provides a more comprehensive narrative that may support the adjudication body to base in the cartel sanction in a longer life period.

2.6. Geographic scope

The hypothesis is that local cartels (e.g. cartels at municipal or state level) are more stable than national and international cartels since cartelists may interact more easily with each other at local level.

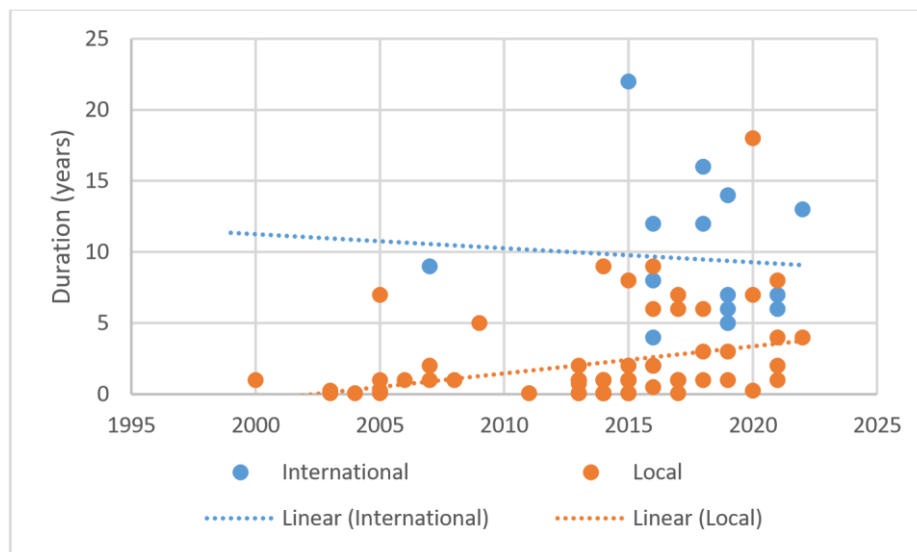


Figure 6. Cartel duration and geographic scope

Source: created by author based on information available on CADE's public database.

The average duration of an international cartel is significantly higher (9.5 years) than a local cartel (2.2 years), which does not match the initial hypothesis nor findings suggested by Abrantes-Metz, Connor and Metz (2013) for whom cartels distributed across geographies tend to be shorter than local cartels. One possible explanation to this difference relates to the profile of the international cartel cases sanctioned in Brazil, which often originated through leniency application of well-standing international cartels under investigation in Europe and the U.S. (e.g. vitamin cartel, marine hoses cartel, electronic cartels, and auto-part cartels).

3. Economic analysis and results

This section will focus on the economic analysis and results. In the first sub-section, we tackle the correlation analysis, including a positive or a negative correlation, as well as the statistical relevance, related to the duration of cartels and the key selected determinants. Then, we perform a cartel survival analysis, based on a Kaplan-Meier survival estimator and Cox. Finally, we employ OLS and WLS to test the robustness of results. When applicable, the duration of cartels will serve as dependent variable, while the other factors will act as independent variables.

3.1. Correlation analysis

The table below indicates a descriptive analysis of the quantitative variables involving the duration of cartels and the number of defendants divided by firms, individuals and total (firms and individuals):

Table 2. Descriptive analysis of quantitative variables on determinants of cartel duration in Brazil

Variable	n°	Mean	Median	SD	Minimum	Maximum
Duration of cartel (years)	120	4.1	1.0	5.0	0.1	22.0
Number of defendants - firms	120	11.1	8.0	11.4	0.0	84.0
Number of defendants - individuals	120	10.5	6.0	14.4	0.0	78.0
Number of defendants - total	120	21.6	16.5	20.6	1.0	101.0

The average of cartel duration is 4.1 years (sd = 5.0), ranging from 1 month to 22.0 years, and a median of 1 year. The average cartel duration in Brazil of 4.1 years is shorter than the average duration of 7.95 years identified by Bertrand and Lumineau (2016) and 5.92 years found by Abrantes-Metz, Connor and Metz (2013), but above the average of 2.08 years identified by Feinberg, Kim and Park (2016). A wide variability in cartel stability was also identified, with durations ranging from 1 month to 22 years, and a median duration of 12 months, which are similar indicators to those found by Feinberg, Kim and Park (2016) in Korea.

The table above also indicates the mean and standard deviations of cartel duration in years based on the number of defendants, including defendants-firms (mean = 11.1, sd = 11.4, and median = 8.0), defendants-individuals (mean = 10.5, sd = 14.4, and median = 6.0), and defendants-total (mean = 21.6, sd = 20.6, and median = 16.5).

The table below indicates the correlation results between the number of defendants (firms, individuals and total) and the duration of cartels:

As seen, the analysis of the correlations indicates a positive, weak, and statistically significant correlation between the number of defendants-firms and the cartel duration ($r=0.196$; $p=0.032$). A positive (although moderate) and statistically significant correlation was also observed for the number of defendants-individuals ($r=0.402$; $p<0.001$) and the number of defendants-total ($r=0.393$; $p<0.001$).

The table below presents initially a descriptive analysis of qualitative variables involving the duration of cartels and five qualitative variables (i.e. economic sector, trade association, leniency, bid-rigging and geographic scope):

Table 4. Descriptive analysis of qualitative variables on determinants of cartel duration in Brazil

Variable	n°	%
Economic sector Automotive	6	5,0
Construction	9	7,5
Electronics	7	5,8
Energy	23	19,2

Variable	n°	%
Health	27	22,5
Heavy industry	4	3,3
Transportation	15	12,5
Other	29	24,2
Trade association No	76	63,3
Yes	44	36,7
Leniency application No	89	74,2
Yes	31	25,8
Bid rigging No	84	70,0
Yes	36	30,0
Geographic scope Local	69	57,5
National	36	30,0
International	15	12,5
Total	120	100,0

Subsequently, the table below presents the results of the association tests of categorical variables with the cartel duration:

Table 5. Correlation analysis between qualitative variables and cartel duration in Brazil

Variable	n°	%	Mean (Standard deviation)	p
Economic sector Health	27	22.5	4.2 (4.3)	0.122 *
Energy	23	19.2	3.4 (5.9)	
Transportation	15	12.5	3.7 (3.6)	
Automotive / Construction	15	12.5	4.6 (5.5)	
Electronics / Heavy industry	11	9.2	6.9 (5.5)	
Other	29	24.2	3.4 (5.1)	
Trade association No	76	63.3	4.2 (5.0)	0.636 **
Yes	44	36.7	3.9 (5.1)	
Leniency application No	89	74.2	2.8 (4.2)	<0.001 **
Yes	31	25.8	7.7 (5.5)	
Bid rigging No	84	70.0	3.7 (4.6)	0.551 **
Yes	36	30.0	4.9 (6.0)	
Geographic scope ^{T1} Local	69	57,5	2,2 (3,1)	<0.001 *
National	36	30,0	5,5 (5,8)	
International	15	12,5	9,5 (5,3)	
Total	120	100.0	4.1 (5.0)	--

* Kruskal-Wallis test ** Mann-Whitney test

While the results indicate an absence of association between duration of cartels and the economic sector ($p=0.122$), the presence of trade associations ($p=0.636$) and the presence of bid rigging ($p=0.551$), they show a statistically significant association for the other two variables.

The cartel duration was longer in cases with leniency application, with a statistically significant difference ($p<0.001$). Similarly, there was a statistically significant association between the geographic scope and duration of the cartel, with the mean duration longer in the presence of a national or international cartel ($p<0.001$). The Tukey test was applied for the multiple comparisons: local cartels had lower averages than national cartels ($p=0.001$) and international cartels ($p<0.001$), and national cartels had lower averages than international cartels ($p=0.009$).

3.2. OLS and WLS regressions

To complete the analysis, we performed a regression using the ordinary least squares (OLS) and the weighted least squares (WLS) as indicated in the table below and similarly done by Feinberg, Kim and Park (2016). A logarithmic transformation was applied when necessary to adjust the variables to a more normalized dataset for linear regressions.

Table 6. OLS and WLS regression analysis of cartel duration in Brazil

Independent variables	All cartels (N=120)			
	OLS		WLS	
	(1)	(2)	(1)	(2)
Total Defendants	-1.3588***	0.6505***	-0.204054	0.027254***
	(0.4290)	(0.1517)	(0.219097)	(0.006773)
Defendants-Firms	-0.14782	0.01569	0.22652	0.01285
	(0.22056)	(0.01386)	(0.21016)	(0.01104)
Defendants-Individuals	-0.14782	0.04923***	-0.030170	0.039360***
	(0.17894)	(0.01007)	(0.173475)	(0.005752)
Bid-Rigging	0.3094	0.1977	0.3094	0.1977
	(0.1891)	(0.3452)	(0.1837)	(0.3594)
Trade Associations	0.4306**	-0.1689	0.4306*	-0.1689
	(0.1988)	(0.3283)	(0.1962)	(0.3314)

Independent variables	All cartels (N=120)			
	OLS		WLS	
	(1)	(2)	(1)	(2)
Leniency	-0.06862	1.69295***	-0.06862	1.69295***
	(0.16600)	(0.32659)	(0.18102)	(0.27132)
Scope-International	0.1216	1.9769***	0.1216	1.9769***
	(0.1566)	(0.4430)	(0.1660)	(0.2260)
Scope-Local	1.1283***	-1.3210***	1.1282	-1.3244***
	(0.2248)	(0.2964)	(0.2253)	(0.2961)***

Robust standard errors in parenthesis

*** $p < 0.01$ (1%) ; ** $p < 0.05$ (5%) ; * $p < 0.1$ (10%)

The results indicate a strong statistical significance to the following variables: total defendants, defendants-individuals, leniency, and geographic scope (all $p < 0.01\%$). These regression results generally follow the previous regression exercise, thus adding to the robustness of the economic analysis. Indeed, (i) cartels with higher number of cartelists have longer duration, (ii) cartels uncovered through a leniency application have longer duration, and (iii) local cartels have a shorter duration than international cartels.

The results in relation to the other variables were either weak in significance, or insufficient to draw any findings.

3.3. Cox regression for cartel survival estimation

In this section, a survival modelling approach is applied using Kaplan-Meier curves to measure the probability that a cartel still exists after a given number of years. The same model was used by Bertrand and Lumineau (2016) for a dataset of 41 cartel cases sanctioned by the European Commission from 2001 and 2011 to assess the longevity of cartels:

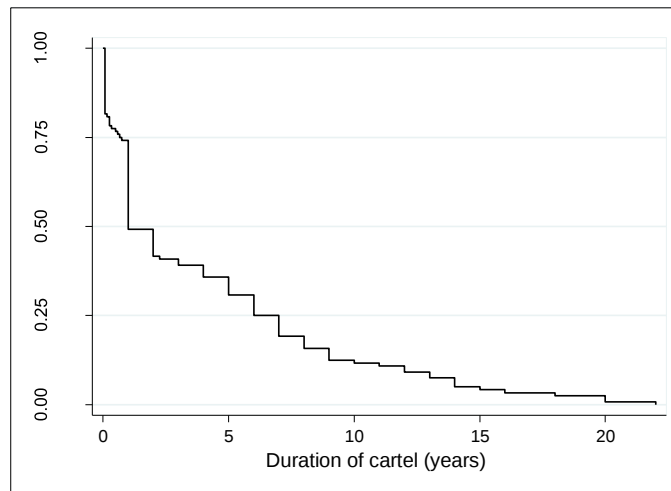


Figure 7. Kaplan-Meier Survival Estimate for Cartels in Brazil

The figure above shows that survival time (duration) was up to 5 years for 30.8% of the cartels, up to 10 years for 11.7% of the cartels, up to 15 years for 4.2% of the cartels, and up to 20 years for 0.8% of the cartels. In other words, the probability of a cartel surviving 5, 10, 15 and 20 years was 30.8%, 11.7%, 4.2% and 0.8%, respectively.

In addition, log-rank tests were applied to the Kaplan-Meier curves to compare the probabilities of survival according to independent variables. The assumption of risk proportionality was verified through log-log plots. The variables that presented different survival probabilities in relation to the cartel duration were: number of defendants-firms ($p=0.009$), number of defendants-individuals ($p=0.002$), number of defendants-total ($p=0.002$), leniency application ($p<0.001$), geographic scope ($p<0.001$).

No relevant statistic association was observed to the economic sector ($p=0.194$), trade association ($p=0.767$) nor bid rigging ($p=0.259$).

The most meaningful results are indicated below.

The cartel survival estimator based on the number of defendants-individuals indicates that cartels with 11 or more defendant-individuals have larger survival rates than cartels with 10 or less defendant-individuals:

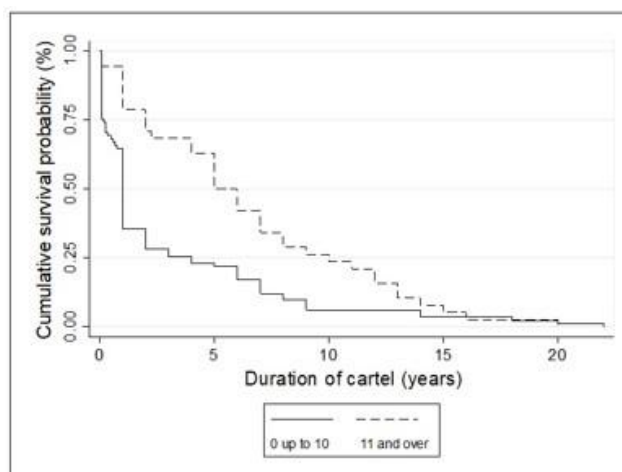


Figure 8. Cartel survival estimator based on the number of defendants (individuals)

Similarly, cartels uncovered by a leniency application have larger survival rates than those that were detected by other means (e.g. *ex officio* investigation by the competition authority). As previously mentioned, a possible explanation may relate to the fact that cases uncovered by leniency often benefit from good quality of evidence, which may enable competition authorities to better assess the duration of the infringement (e.g. by exchange of e-mails submitted by the leniency applicant).

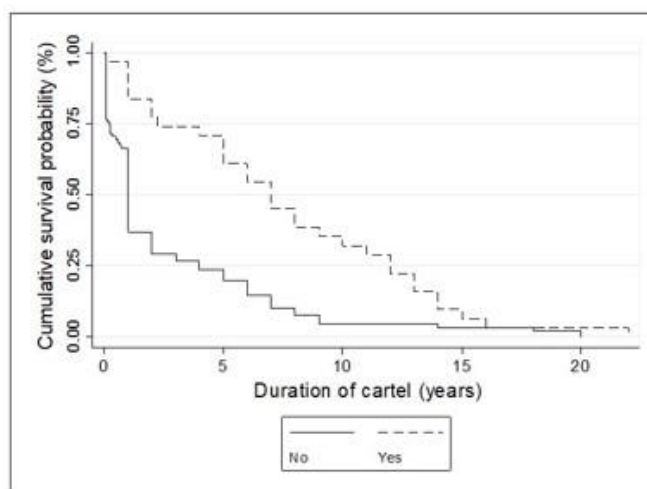


Figure 9. Cartel survival estimator based on the existence of leniency application

As for the geographic scope, international cartels have longer survival rates than national cartels, while national cartels have longer survival rates than local cartels, as indicated in the figure below.

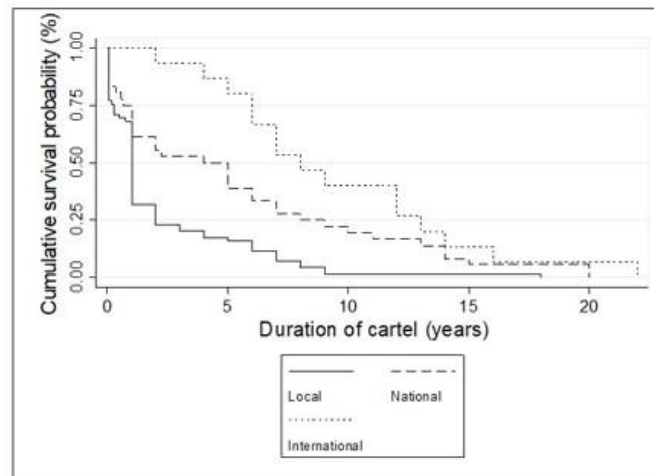


Figure 10. Cartel survival estimator based on the geographic scope

The table below consolidates the effects of certain key independent variables in cartel duration, with significant results for the following factors leading to a lower probability of cartel duration (survival estimation): number of defendants (10 or less defendants-individuals, as well as 20 or less totaldefendants including firms and individuals), inexistence of leniency application, and local geographic scope (all with $p < 0,01$).

Table 7. Cox regression analysis of cartel duration in Brazil

Variable		HR	95%CI		p
			Low	Upper	
Number of defendants-total					
More than 20					1,00
Equal or less than 20		1,70	1,17	2,47	0,006
Number of defendants-individuals					
More than 10					1,00
Equal or less than 10		1,74	1,18	2,58	0,005
Leniency application					
Yes		1,00			
No		2,20	1,44	3,37	<0,001
Geographic scope					
Local					1,00
National		0,51	0,33	0,78	0,002
International		0,30	0,16	0,54	<0,001
Geographic scope					
National or international					1,00
Local		2,35	1,58	3,48	<0,001

The results indicate that the termination risk (probability) of a cartel with 10 or less defendantsindividuals is 1,74 higher than cartels with more than 10 defendants-individuals. A similar finding exists when considered the total number of defendants (defendants-total): cartels with 20 or less defendants-total are 1,70 more likely to terminate earlier in time than

cartels with more than 20 defendants-total. In other words, cartels with less defendants have a shorter survival rate than cartels with many defendants, suggesting that **cartels with higher number of cartelists have longer duration**. This finding goes against our initial hypothesis that the duration would be larger in cartels with a smaller number of defendants since cartelists may in theory benefit of a more trustful environment and thus stability.

As for the existence of a leniency application, the results indicate that cartels without a leniency application have a higher termination risk (probability of 2,38 times) than cartels with a leniency application. Thus, **cartels uncovered through a leniency application have longer duration than cartels uncovered by other detection tools**. This also goes against our initial hypothesis that the duration would be shorter in cartels uncovered via leniency applications (otherwise these cartels would still be in force). This finding may be explained by the quality of evidence that is often submitted by leniency applicants, which may increase the length of cartels (at least in the “formal legal truth” presented in the case files).

The geographic scope also indicates a relevant difference: the risk (probability) of a local cartel to terminate in a given moment of time is 2,35 larger than a national or international cartel. This means that **local cartels have a shorter duration than national/international cartels**. This finding also goes against our initial hypothesis that local cartels (i.e. at municipal level) are more stable than national and international cartels since cartelists may interact more easily with each other at local level.

As for the other independent variables (i.e. economic sectors, public procurements and trade association), the Cox regression analysis and corresponding cartel survival estimator modelling did not indicate any significant result, so no relevant finding in relation to their possible effect on cartel duration.

4. Concluding remarks

The paper analysed the duration of cartels in Brazil using a dataset of 120 cases sanctioned by the Brazilian Competition Authority (CADE) between 1999 and 2022. The analysis benefited from a description of the main statistics related to this dataset, as well as from econometric tests to measure the intensity of the correlation between key factors and the duration of reviews.

The research revealed an average duration of 4 years for a cartel sanctioned in Brazil. This is shorter than the average duration found by Maphwanya (2017) in South Africa: 6 years and 7 months for a dataset of 28 cartel cases sanctioned by the Competition Commission of South Africa. It is also shorter than the average duration found by Bertrand and Lumineau (2016) in the European Union: 8 years per cartel using a dataset of 41 cartel cases sanctioned by the European Commission.

In addition, the research found that around 20% of the cartels had a very short duration (less than 3 months), while the longest cartel durations were around 20 years per cartel in Brazil (i.e. the cartels in the markets of cement, salt extraction and marine hoses). This is similar to the findings of Feinberg, Kim and Park (2016) who observed durations ranging from 1 month to almost 15 years for a dataset of 388 cartel cases sanctioned by the Korean Fair Trade Commission (KFTC).

As for the probability of a cartel surviving 5, 10 or 15 years, this research found the following: 30.8%, 11.7%, 4.2% and 0.8% respectively. This is shorter than the same exercise made by Bertrand and Lumineau (2016) for a dataset of 41 cartel cases sanctioned by the European Commission from 2001 and 2011 to assess the longevity of cartels: 60%, 35% and 12% respectively. For these exercises, a Kaplan-Meier Curves was applied to measure the probability that a cartel still exists after a given number of years.

As for the determinants of cartel duration, this research selected 6 (six) possible factors, based on the available data, which may affect the duration of cartels: (i) number of defendants, (ii) economics sectors, (iii) existence (or not) of public procurements, (iv) involvement of trade associations in the wrongdoing, (v) existence (or not) of leniency application and (vi) geographic scope of the cartel.

Concerning the **number of defendants**, the results of this research were unclear when considered the number of defendants-firms. However, when considering the number of individuals participating in the cartels, the results pointed to a different direction of our initial hypothesis a larger number of individuals indicated more cartel stability (and not less cartel stability). The initial hypothesis suggested that the duration would be larger in cartels with a smaller number of defendants since cartelists may benefit of a more trustful environment and thus stability – similarly indicated by While Feinberg, Kim and Park (2016) that a larger number of participant-firms reduces cartel stability. Nonetheless, it should be noted that the “number of individuals” differ from “number of cartelists” (firms) since one firm-cartelist can have several individuals listed as defendants in a cartel case investigation.

As for **economic sectors** affected by the cartels, the research was unable to confirm our hypothesis which suggested that the cartel duration would vary depending on the economic sector, with longer cartel periods in sectors involving homogenous products (e.g. energy sector) when compared to markets with greater product differentiation (e.g. health sector). While the research confirmed different average duration depending on the economic sector (i.e. 3 years in the energy sector, 7 years in sectors related to electronics and heavy industry, and 4-5 years for transportation, construction, health, and automobile), it was unable to draw clear differences based on homogeneity of products as initially speculated.

Another correlation analysed concerned **public procurement cartels**, with a hypothesis that this type of cartels (bid-rigging cartels) would have smaller periods because they accept a one-shot infringement type of cartel, namely when limited to one specific public procurement proceeding. However, this hypothesis was not confirmed. The dataset had 36 bid-rigging cases (and 84 non bid-rigging cases), and indicated a higher average duration for bid-rigging cartel cases: 5 years as opposed to 3.7 years for non bid-rigging cases.

Trade associations can sometimes serve as a facilitator of cartels, so another hypothesis suggested that cartel duration would be larger when involving trade associations since they could help cartel coordination and cartel stability. However, the research indicated that there is not a significant difference between the duration of cartels in which a trade association integrates or not the defendants list (3.9 years and 4.2 years, respectively – with slightly larger duration for cartels without the involvement of trade associations). This finding was also in the opposite direction of the initial hypothesis.

As for **leniency applications**, the initial hypothesis was that the duration would be smaller in cartels uncovered via leniency applications since the wrongdoing would have lasted more time otherwise. However, the results showed that cartel duration of leniency cases is much higher (8 years) than nonleniency cases (3 years). While this finding goes against our initial hypothesis and may seem inconsistent with prior empirical work suggesting that leniency reduces cartel duration (Levenstein and Suslow, 2011; and Feinberg, Kim and Park, 2016), the results might be explained by the fact that leniency cases often benefit from a better set of evidence than non-leniency cases. In practice, leniency applicants are expected to tell the full story of the cartel and present proof of the wrongdoing, which helps to understand the way the cartel operated and provides a more comprehensive narrative, including a larger portion of the cartel's life and thus duration.

The last determinant is **geographic scope**, with an initial hypothesis that local cartels (i.e. at municipal level) would be more stable than national and international cartels since cartelists may interact more easily with each other at local level. However, the research indicated that the average duration of an international cartel is significantly higher (9.5 years) than a local cartel (2.2 years), so against the initial hypothesis. One possible explanation to this difference relates to the profile of the international cartel cases sanctioned in Brazil, which often originated through leniency application of well-standing international cartels under investigation in Europe and the U.S. (e.g. vitamin cartel, marine hoses cartel, electronic cartels, and auto-part cartels), and may benefit from stronger evidences and thus larger calculation of the duration.

This paper indicates that there is still much room for future work in the field of the economic analysis of competition law enforcement. Indeed, competition law is a field in which the notion of welfare seems well suited for economic analysis and evaluation of legal policies as generally

defended by Kaplow and Shavell (2001). The significant increase of competition law enforcement around the world (OECD, 2022) also contributes to the relevance of additional research related to this area. These studies may indeed add to the economic literature, shed light on recent developments and suggest possible areas of future improvement for competition policy.

In the field of cartel enforcement, further research may explore the probability of cartel detection (Combe et al., 2008), which was estimated in around 13% for a cartel to be detected in Europe, based on a detection model that uses the duration of 86 cartel cases convicted by the European Commission from 1969 to 2007. The same model could be applied to the Brazilian cartel cases, namely the 120 cases used for this research. This anti-cartel enforcement record offers a valuable dataset for economic analysis to assess the evolution of competition law enforcement.

The same goes for the topic of calculation of damages in antitrust violations, as well as quantification of competition benefits in general (OECD 2023), which may also benefit from empirical economic research.

References

1. Silveira, P. B. da. (2025). The determinants of cartel duration in Brazil (Working Paper No. 2025-18). EconomiX, University of Paris Nanterre. <https://hal.science/hal-05013557>
2. Abrantes-Metz, R. M., Connor, J. M., & Metz, A. D. (2013). The determinants of cartel duration. Working paper.
3. Feinberg, R. M., Kim, H., & Park, J. (2016). The determinants of cartel duration in Korea. *Journal of Industry, Competition and Trade*, *16*(3), 279–296.
4. Hay, G. A., & Kelley, D. (1974). An empirical survey of price fixing conspiracies. *Journal of Law and Economics*, *17*(1), 13–38.
5. Levenstein, M. C., & Suslow, V. Y. (2011). Breaking up is hard to do: Determinants of cartel duration. *Journal of Law and Economics*, *54*(2), 455–492.
6. Maphwanya, M. (2017). Cartel likelihood, duration and deterrence in South Africa. Chapter in book.
7. Marquez, S. (1994). Life expectancy of international cartels: An empirical analysis. *Peer-Reviewed Journal*.
8. Bertrand, O., & Lumineau, F. (2016). Partners in crime: The effects of diversity on the longevity of cartels. *Academy of Management Journal*, *59*(3), 983–1008.
9. Harrington, J. E., Jr., & Chen, J. (2015). The discontent cartel member and cartel collapse: The case of the German cement cartel. Working paper.
10. Haucap, J., & Heldman, C. (2022). The sociology of cartels. Working paper.
11. Jaspers, J. D. (2017). Managing cartels: How cartel participants create stability in the absence of law. Working paper.

12. Porto, G. V. (2023). Non-pecuniary sanctions in Brazil. (Study using the same dataset of 120 CADE cases).
13. OECD. (2022). OECD Competition Trends 2022. OECD Publishing.
14. Connor, J. M. (2011). Price-fixing overcharges: Revised tables and charts. Working paper.
15. Ivaldi, M., Khimich, A., & Jenny, F. (2014). Measuring the economic effects of cartels in developing countries (Final Report). CEPR PEDL Program / UNCTAD RPP.
16. Suslow, V. Y. (2005). Cartel contract duration: Empirical evidence from inter-war international cartels. Working paper.
17. Levenstein, M. C., & Suslow, V. Y. (2002). What determines cartel success? Working paper.
18. Brazilian Competition Law No. 12,529/11. (2011). (Establishing CADE's current leniency and enforcement framework).
19. Tapia, J. (2018). The Latin American experience with leniency. *Revista do IBRAC*, *24*(1), 49–64.
20. Martinez, A. P. (2015). Challenges ahead of leniency programmes: The Brazilian experience. *Journal of European Competition Law & Practice*, *6*(4), 259–266.