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Did Markets Anticipate an Effective European Leniency Programme? An Event Study.

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Executive summary.

The objective of this thesis is to determine whether financial markets anticipated the effectiveness of the European Leniency Programme. In the first part, the theoretical framework is established with a literature review and the creation of hypothesis. The second part constitutes the empirical analysis, where an event study was used to measure the stock price effect of the European Commission's announcements regarding the implementation and reforms of its leniency program. Three typical models were used: the Market Model, the Market Adjusted Model and the Mean Adjusted Model. Based on a sample of 57 firms from the chemical sector and 15 announcements, it appears that markets did anticipate an efficient European Leniency Programme, and that information leaked at least one day before publication. However, the price impact may be too small to constitute an additional deterrent effect. Finally, the American market delayed the incorporation of the news but anticipated more than other markets.

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Introduction.

During the last decade, fines imposed by the European Commission to cartel members raised by more than 45% (European Commission, 2021). This increase has been attributed to the European Leniency Programme, the most powerful tool of the European Commission to fight cartels (European Commission, n.d.).

Since its implementation in 1996, the European Leniency Programme has been revised two times (in 2002 and 2006) to increase its effectiveness. It takes example on the American leniency program, the first leniency initiative ever created. The later has been launched in 1976 and showed great results since its revision in 1993 (Bell & Millay, 2019), The American leniency program proved the effectiveness of such programs to the world, which may have led observers to believe in the success of the European version. Hence, this thesis aims at determining markets' reaction to the announcements of the European Programme, and the research question has been formulated as follows: "*Did markets anticipate an effective European Leniency Programme?*". The interest of this study lies in the potential deterrent effect that a stock price loss could have on cartels.

The method chosen to analyze this question is the event study, which has been performed on a sample specifically constructed for this thesis. The event set is composed of 15 official press releases regarding the European Leniency Programme, archived on the EU Bookshop platform, which represents the event window of this study (1995 until 2015). The historical prices have been collected for 15 stock indexes and 57 chemical firms convicted for collusion during the event window. Prices information came from Bloomberg Terminal, while the information regarding colluding firms have been assembled from the Cartel Cases Search Platform of the European Commission. The event study uses three typical models: the Market Model, the Market Adjusted Model and the Mean Adjusted Model.

Results showed that the European Commission's announcements induced an immediate drop in the stock prices, showing that markets anticipated an effective European Leniency Programme. It also appears that prices lowered the day before announcements, suggesting a leak of information. Finally, the American market delayed the incorporation of the announcements but reacted more intensely than other markets, which shows a stronger

anticipation of an effective European Leniency Programme and could be due to his familiarity with the leniency policy.

This thesis will revolve around a review of the literature intended to build the theoretical framework that supports the creation of hypotheses around the research question. Then, a detailed description of the sample constitution and the methodology used will introduce the empirical analysis. Finally, the statistical results will be interpreted, and the work will be globally discussed before wrapping up the general content in a conclusion.

First Part: Theoretical framework.

Chapter 1: Literature review.

The literature contains an extensive body of research and studies concerning the different leniency programs and their effects. In particular, many authors examined their impact on firms through the stock price effect of leniency-related prosecutions announcements (Bosch & Eckard, 1991 ; Langus & Motta, 2009 ; Günster & van Dijk, 2011). However, no study examines the stock price effect of announcements concerning the implementation or reforms of leniency programs. This is the focus of this thesis, which might determine whether markets anticipated and effective leniency program or not.

This chapter aims at building the theoretical framework of this thesis in order to support the empirical analysis. As the European Union is the geographic scope chosen for this work, the literature review will focus on the European Leniency Policy. This chapter deeply explores the concepts of cooperation and cartels before analyzing the European Leniency Programme. Finally, the literature review will incorporate the effect of leniency programs on stock markets to define research hypothesis.

1.1. Cooperation.

The European Commission (2012) sees competition as the best way to ensure well-functioning markets; under continuous competitive pressure, companies are strained to offer the most qualitative product possible, at the best price possible. Preserving competition is hence, for the European Commission (2012), the best means to reach a competitive game where the consumers are the beneficiaries in terms of welfare. However, firms can adopt some behavior to distort competition. This is called cooperation.

1.1.1. Definition and typology.

Bouwens and Dankers (2013) state that cooperation between firms is a mechanism used to ease the pressure of competition. Such a conduct is supposed to happen when it is seen as more profitable for cooperating firms than regular competition. According to Polenske (2004, p.1031), "*Cooperation relationships are defined to include when two or more actors agree*

through formal or informal arrangements to share information, support managerial and technical training, supply capital and/or provide market information".

Cooperative arrangements are usually external and horizontal since they do not imply a joint participation in the production process. Hence, according to Polenske (2004), cooperation should not be confused with collaboration, which is an internal and often vertical agreement, defined as a "*direct participation by two or more actors in designing, producing and or marketing a product (process)*" (p.1031). Unlike Polenske, Bouwens and Dankers do not consider the internal/external nor the vertical/horizontal characteristics of agreements and hence do not differentiate cooperation from collaboration.

In 2005, Porter stated in its analysis that cooperation is beneficial in many social settings and should be encouraged. In their research, Bouwens and Dankers (2013) confirmed that cooperation does not always harm consumers. However, even if it is not systematic, it is rather common that some types of cooperation are detrimental to consumers or society. This point will be deepened in the next sections.

Cooperation can take many different forms and degrees according to Bouwens and Dankers (2013) who differentiate four main types of cooperation: mergers and acquisitions, joint ventures, business interest associations, and collusion. The last one will be the focus of the next subchapter.

1.1.2. Collusion.

According to the OECD (2013), "*Collusion refers to combinations, conspiracies or agreements among sellers to raise or fix prices and to reduce output in order to increase profits*" (Definition, para. 1). This definition can be completed with a characteristic added by Porter (2005), namely that collusion benefits engaging firms at the expense of their suppliers and/or customers. Hence, this links collusion to surplus, which is a concept that can be considered from a producer, consumer, or even aggregate view as explained below.

Boulding (1945) defines the producers' surplus as the gain that a producer benefits from selling at a price higher than the least he would sell for. Similarly, consumers' surplus represents the monetary gain realized by a consumer when purchasing at a price lower than the highest that

they would be willing to pay for (Boulding, 1945). According to Porter (2005), collusion lowers the total welfare (the aggregation of producer and consumer's surpluses) because the losses outweigh the gains. However, Deltas, Salvo and Vasconcelos (2012) mitigate this thought; under certain circumstances, collusion can be efficient and raise both consumer surplus and social welfare. This will be discussed in sub-chapter *1.2.3. Economic and welfare implications.*

Finally, collusion can be divided into two categories: formal and informal. Informal (or tacit) collusion does not require an explicit agreement between cooperating firms, on the contrary of formal collusion (also called "cartel") (Bouwens & Dankers, 2013). The formal or informal characteristic is the only difference between these two types of collusion. Hence, the OECD (2013) specifies that economic effects of tacit collusion and cartels are the same, and that both terms are generally used interchangeably. Based on OECD's typology (2013), this thesis will focus on cartels as a broad type of cooperation, including the concept of collusion.

1.2. Cartels.

1.2.1. Definition and typology.

The European Commission (2017) defines a cartel as a specific type of cooperation formed by "*(...) a group of similar, independent companies which join together to fix prices, to limit production or to share markets or customers between them*" (Overview, para. 1). It is also possible for cartelists to collude on innovation or on product quality. Members of a cartel rely on one another to act as agreed instead of competing, which decreases the incentives to offer new or better products or services at a competitive price (European Commission, n.d.).

According to Parenti (2020), the European Parliament mainly considers three types of cartels: price, production and market cartels. Price cartels agree on a determined price for the good and service to distort competition, usually allowing engaging firms to price higher than they would do under competition. Similarly, production (or quota) cartels agree on a level of output, often lower than it would be under competition. Finally, firms engaging in market cartels collude to attribute markets, geographic areas, suppliers or customers between them, allowing cartelists to act as a monopolist on their attributed segment. Market cartels can also be referred to as "quota cartels" (Hyytinen, Steen & Toivanen, 2019) or "specialization cartels" (Fink, Schmidt-Dengler, Stahl & Zulehner, 2017).

This typology can be deepened by the works of several authors. For example, Phutkaradze (2020) highlighted collective boycott and bid rigging cartels. Collective boycott refers to a group of colluding firms agreeing to boycott some customers or suppliers to force a certain behavior from other suppliers or competitors. Boycott cartels are considered as a sort of quota cartel by the OECD (2000). Bid rigging cartels (or submission cartels) are agreements when firms collude on the bids and decide beforehand which one of them will win the auction, often in public markets. In addition, Hyytinen, Steen & Toivanen (2019) discussed the concept of mixed cartels, which are cartels using two or more of the strategies cited above, even if the most common is the combination of price and market cartels.

Several notions can complete this typology of cartels, such as common sales cartels (Dick, 1996), technology sharing cartels (Petit & Tolwinski, 1997), patent cartels (Priest, 1997), condition cartels (Fink, Schmidt-Dengler, Stahl & Zulehner, 2017), standardization cartels (Audretsch, 1989) and compulsory cartels (Fear, 2008). Common sales cartel (or "syndicate" cartels) is a group of cartelists that centralizes its activity (order taking, billing, shipping, etc.) through a central selling agency (Dick, 1996). Technology sharing cartels and patent cartels respectively share (information about) technology (Petit & Tolwinski, 1997) and scientific information or patents (Priest, 1997) between one another. These three types of cartels can be referred to as "rationalization cartels" according to Audretsch (1989). Condition cartels are composed by firms who join to impose unified contractual clauses, which concerns a variety of modalities such as the payment methods, delivery means, warranty duration, etc. (Fink, Schmidt-Dengler, Stahl & Zulehner, 2017). Like condition cartels, standardization cartels promote unified norms (such as features or quality standards), here concerning the product or service offered to consumers or bought from suppliers (Audretsch, 1989). Standardization cartels also belong to the category of rationalization cartels according to Audretsch (1989). Finally, compulsory (or "forced") cartels are companies colluding under the external pressure of an administrative or legal entity (Fear, 2008).

1.2.2. Industries and cartel indicators.

Many authors study cartels with respect to the industry in which they occurred. We can find many descriptive studies in the literature about the sectors in which cartels are the more prosecuted. For example, Antonelli and Mariniello (2014) ranked colluding sectors across five major European economies (France, Germany, Italy, Spain and the United Kingdom).

Levenstein and Suslow (2011) did the same for a sample of American and European firms, and Haucap, Heimeshoff and Schultz did it for Germany (2010).

In 2010, Carree, Günster and Schinkel analyzed all the decisions of the European Commission related to cartel cases prosecutions since the creation of the European antitrust law enforcement in 1957. This study is particularly relevant for this thesis, given that the scope covers all countries of the European Union, and establishes a ranking of sectors with respect to the number of prosecuted cartels. The results showed that European sectors colluding the most are metal products & engineering (19%) and chemicals (18%). Plastics, rubber and glass (12%) is ranked third, followed by food and drinks (11%) and transport (11%).

Antonelli and Mariniello (2014) identified several factors impacting the formation of cartels: market concentration, firm entry, market stability and market symmetry. Indeed, a high market concentration eases coordination and hence the likelihood of collusion. Concerning the entry on the market, entering firms decrease the expected profits for colluding firms, making deviation more probable. Market stability (i.e., foreseen events such as demand growth) favors collusion by raising the ability to capture other player's behaviors, unlike unstable markets (i.e., demand shocks). Market symmetry, or a homogeneous market share among firms, eases the formation of a cartel since smaller firms are the ones with higher incentives to deviate from agreements. Finally, Bernheim and Whinston (1990) add that multimarket contacts (i.e., firms competing on multiple markets) usually flattens out market shares asymmetry between firms, making collusion more likely.

1.2.3. Economic and welfare implications.

It has been previously seen, as a rule of thumb, that cartels are a way for firms to mitigate the pressure, risks and uncertainties linked to competition, hence increasing their profits (Bouwens & Dankers, 2013). However, it is possible to highlight more specific economic implications of cartels by examining the typology established previously (c.f., *1.2.1. Definition and typology*).

Price cartels induce a higher price, meaning that consumers would buy at a higher price or in a smaller quantity. Production cartels (including collective boycott cartels) reduce the quantity offered to consumers, implying that not every person willing to buy will be able to. This kind of cartels may also raise the price. Market cartels enable firms to act as a monopolist on their

segment, implying an overpricing. Here also, consumers would have to choose between paying more or buying less. Bid rigging cartels allow firms that have won the tender (and the market) to raise prices or lower the quantity and/or quality of goods or services offered. These four types of cartels are called “hard-core cartels” by the OECD, create market inefficiency and harm consumers by raising prices and restricting supply. Furthermore, it reduces competitive pressures to control costs, to improve the quality or to innovate (OECD, 2002). The OECD concluded in 2000 that hard-core cartels reduce consumer surplus in a way that is not compensated by the increase of colluding firm’s surplus, hence decreasing the total surplus.

Concerning compulsory cartels, Greszler (2020) stated that the administrative or legal entity forcing the cartel might do so to protect incumbent firms from potential entrant offering better products or services, or at a lower price. Rothbard (2004) also asserted that compulsory cartels may be forced to respect governmentally imposed quotas of production, which inevitably goes with a governmental minimal price control. This preserves inefficient firms at the expense of new efficient firms (Rothbard, 2004), inducing the same economic implication as hard-core cartels. Consumer and society surplus are negatively affected by this type of cartel.

However, several authors examined the possibility of welfare-enhancing cartels. This is namely the case of Audretsch (1958) and Haucap, Heimeshoff and Schultz (2010) who studied cartels that increased total surplus in Germany and were authorized to operate. Audretsch (1958) found out that certain types of cartels could be profitable for consumers and society under two conditions: if their arrangement resulted in increased efficiency and productivity, and if these gains were passed on to consumers under the form of lower prices.

Haucap, Heimeshoff and Schultz (2010) define rationalization cartels as cartels rationalizing economic activities of members, hence increasing their efficiency and productivity. By nature, rationalization cartels fulfill hence Audretsch’s first condition for a cartel to improve consumer and society’s welfare. As cited in subchapter *1.2.1. Definition and typology*, common sales, standardization, technology sharing, and patent cartels are forms of rationalization cartels (Audretsch, 1958). If one of these cartels passed on the efficiency gains realized to consumers, society and consumer’ surplus would raise. Otherwise, it would represent an agreement on price, involving the economic effects cited above for hard-core cartels. According to Audretsch’s study (1958), the majority of rationalization cartels observed induced an increase of price or a reduction of quantities.

In addition, condition cartels "*(…) are likely to improve market transparency, thereby improving the efficiency of market transactions (by reducing search and bargaining costs) so that they have been considered to be pro-competitive*." (Haucap, Heimeshoff & Schultz, 2010, p.3). Even if it is not systematic, condition cartels can be welfare-enhancing.

To conclude this subchapter and introduce the following one, it is possible to make the link between legality and cartels' effects on competition and welfare. Hard-core cartels, which have anti-competitive effects and reduce total welfare, are prohibited by the competition law. However, certain types of cartels, namely ones improving competitive efficiency and welfare, are exempted from such prohibition (Parenti, 2020).

1.2.4. Competition law and enforcement.

As exposed previously, collusion benefits engaging companies at the expense of their competitors, suppliers and/or customers (Porter, 2005). Such practice goes against the wish of the European Commission (2012) to reach a competitive game where the consumers are the beneficiaries in terms of welfare. Thereby, cartels are the one of the subjects of competition policy in Europe, as well as globally. At the European level, competition policy is a set of rules intended to "*(…) enable the proper functioning of the Union's internal market as a key driver for the well-being of EU citizens, businesses and society as a whole*." (Parenti, 2020, Competition Policy, para. 1). The Treaty on the Functioning of the European Union (TFEU) has been constituted to this end in 2007 and contains rules to preserve competition in the European market (Parenti, 2020). This TFEU hence represents the legal basis of the three instruments of the European competition policy: State aid, merger and antitrust rules (European Commission, 2019). The latter covers decisions and actions against cartels.

The antitrust rules (also called "EU Antitrust policy") of the European competition policy are composed by the Articles 101 and 102 of the TFUE. These two articles respectively prohibit anti-competitive agreements between two or more independent market operators, and abusive behavior by companies holding a dominant position on any given market. (European Commission, n.d.)

Prohibition of cartels is hence a specific branch of antitrust policy regulated by the Article 101 of the TFUE. However, only "*(…) agreements between undertakings which have as their object or effect a distortion of competition and which may affect trade between Member States are prohibited (…) and automatically void (…)"* (Parenti, 2020, Competition Policy Tools, para. 2), namely due to negative effects on consumer surplus and, more globally, society welfare. Agreements improving competitive efficiency and welfare are exempted from such prohibition (Parenti, 2020).

Concerning the enforcement of regulations, cartels can be prosecuted by national courts according to national law (Buxbaum, 2004). However, at the European level, the enforcement of competition rules is regulated by the Article 103 of the TFUE which gives the full powers to the European Council. Hence, the Council has set up an enforcement system, composed of fines for infringing firms. This kind of penalty fulfills two objectives: deterring cartels before their formation and punish cartelists. Given that it is profitable to infringe competition law as long as it is not sanctioned, it is necessary to consider the duration of the cartel in the fine setting. (European Commission, 2011)

The fining process also accounts for the relevant sales, which represent the sales value of the product(s) or service(s) covered by the infringement. The rationale is that the economy and the consumers are more harmed by breaches concerning a high value of sales than by breaches concerning a low value of sales. Depending on three factors (the implementation, the nature, and the geographic scope of the infringement), the fine starts as a percentage up to 30% of the relevant sales. This amount is then multiplied by the number of months during which the agreement lasted, in order to link the sanction to the duration of the infraction. This fine setting can be used to sanction every competition infringement, except for cartels. This specific type of offense is fined with an additional 15 to 25% of the relevant sales value, which acts as an additional deterrence mechanism. (European Commission, 2011)

The fine for firms breaking competition law can also be increased or decreased under certain circumstances, as long as it remains under the threshold of 10% of the company's annual turnover. Aggravating factors (such as being a repeated offender, obstructing the investigation, or being the leader of the agreement) will increase the severity of the penalty. On the contrary, the fine can be lowered with the presence of mitigating factors (such as having a limited role in

the agreement, being unable to fully repay the fine or participating in a settlement or leniency programme). (European Commission, 2011)

1.3. European Leniency Programme.

1.3.1. Definition, functioning and objectives.

The leniency programme is one of the European Commission's tools to detect and investigate competition infringements. The European Leniency Programme covers horizontal hard-core cartels (i.e., price, production, market and bid rigging cartels), but leaves vertical agreements out of its scope (European Commission, n.d.).

"*In essence, the leniency programme offers those undertakings involved in a cartel which self-report and hand over evidence, either total immunity from fines or a reduction in the fines which the Commission would have otherwise imposed on them.*" (European Commission, n.d., Leniency Programme, para. 4). It uses the prisoner's dilemma, a classic scenario where each actor pursues its own interests in a self-serving way even if collaboration would produce a better outcome for them (Carmeliet, 2011). According to Carmeliet (2011), the "winner takes all" approach of the Leniency Programme (only the first firm to apply for leniency will be immunized) incentivizes cartel participants to reveal the cartel to the authorities.

Fine's reduction or immunity depend on the temporal ranking of applicant firms. Indeed, the first colluding company to reveal the existence of a cartel to the Commission and to bring sufficient information to start an investigation will be granted with a full immunity from fines. The second firm will benefit from a reduction of the fine between 30 and 50%, if it provides significant added-value evidence (i.e., information increasing the Commission's ability to prove the infringement). Similarly, the third firm will receive a reduction of fine between 20 and 30%, while subsequent companies will be granted up to 20%. (European Commission, n.d.)

To be eligible for the Leniency Programme and benefit from a reduced fine, applicant firms must meet additional conditions: fully and genuinely cooperate with the Commission during the whole administrative procedure, without informing other cartel members of the leniency application; immediately end its involvement in the cartel (except if the Commission asks not

to, to preserve the investigation) and never have destroyed, concealed or falsified evidence about the cartel. (European Commission, n.d.)

The Leniency Programme has been implemented to fulfill several objectives. It allows detection of hidden cartels, as well as gathering insider evidence of the violation due to the cooperation of colluding firm(s). In addition, the Leniency Programme can deter the formation of cartel and undermine the functioning of existing cartels due to the creation of a feeling of suspicion concerning other cartel members' trustworthiness. (European Commission, n.d.)

1.3.2. History.

In 1976, the American DOJ Antitrust Division started to discuss the creation of a leniency program, which was officially introduced in 1978 (Ghosal & Sokol, 2014). Due to a poor number of utilizations, the American leniency program was revised in 1993 to simplify and clarify its structure and the conditions to obtain amnesty or fines reduction (Bell & Millay, 2019). After its revision, this first leniency initiative in cartel prosecution became very successful (accounting for two-third of American antitrust investigations), and rapidly spread across the different continents (Bell & Millay, 2019).

Following the American model, the European Commission launched the European Leniency Program in 1996 (European Commission, 1996). This first version reduced the fine up to 50% for the first firm bringing evidence about the cartel's existence, if it ended its involvement in the agreement and fully cooperated with the Commission (European Commission, 1996). It also granted immunity to the first firm providing decisive evidence about a secret cartel and if it did not play a determinant role nor acted as in instigator (European Commission, 1996). However, uncertainty raised concerning the meaning of "decisive information" and the actions covered by a "determining role" or "an instigator". Hence, the European Commission decided to revise the Leniency Notice in 2002 to improve legal certainty and transparency, making it more attractive for firms to apply for leniency (European Commission, 2002).

The 2002 revision has widened the scope of full immunity. It could be granted to a colluding firm that reveals a cartel and provides sufficient information to launch an investigation, or to the first firm to provide evidence that enables the Commission to establish an infringement and prosecute other members of the cartel, even if the cartel was already known by the authorities.

This revision also established the scale for the percentage of fines reduction that is still in application today and described in the sub-chapter *2.1. Definition, functioning and objectives* of this thesis. (European Commission, 2002)

Finally, the European Leniency Notice was revised again in 2006. The objectives were to better guide (potential) applicants in the leniency procedure and to increase the overall transparency of the protocol. To this end, several requirements have been specified to qualify for immunity, such as the exact type of information and evidence that the applicant must provide and the timing of submission (information and evidence must not be produced in the initial application but during the continuous cooperation with the Commission). The revision also states that evidence requiring little or no corroboration have greater value and will imply a higher reduction of fine. (European Commission, 2006)

1.3.3. Criticisms.

In 2008, Stephan stated that leniency programs attract only non-profitable, near to death cartels. However, this critic was refuted by Günster and van Dijk (2011) who found out that the European Leniency Programme did attract profitable cartels. Another argument in disfavor of leniency programs is that they can be used as a tool to punish other cartels members according to Ellis & Wilson (2001). The two authors found that under certain circumstances, applying for leniency and reveal the cartel might be a punishment strategy (hence acting as an enforcement mechanism destined to improve the cartel equilibrium). This ties in with Marvão's theory according to which colluding firms can learn how to play with leniency: "*(…) repeat (and multiple) offenders receive larger leniency related penalty reductions, which shows some evidence that firms can learn the "rules of the game", repeatedly colluding and reporting the cartels in which they take part, thus substantially damaging their partners*" (2016, p.23).

In addition, leniency programs are questioned in a social justice point of view, since it allows wrongdoers to be exempted or granted with a reduced sentence because they revealed the cartel and/or cooperated (Han, 2015). Furthermore, sanctioning firms with a fine paid to the European Commission is not a means to compensate harmed consumers (Johnen, 2020). In an equality point of view, leniency programs have also proven to be more lenient (concerning the fine reduction) with big firms than with small firms (Han, 2015). Carmeliet (2011) pointed out that the European Leniency Programme is often ambiguously formulated, hence lacking in legal

certainty for applicants. This fails to guarantee a fair procedure because much is left to the discretion of the European Commission according to the author.

Other critics came out of the literature, such as the lack of incentives of the European Leniency Programme compared to its American counterpart. Unlike in the United States, individuals are not liable in Europe concerning cartels (Aubert, Rey & Kovacic, 2006), which means that the European Leniency Program does not provide any amnesty or sentence reduction to individuals (which could still be prosecuted on national courts). Wils (2007) also pointed out that the costs to set up such programs are substantial.

Finally, Houba, Motchenkova and Wen (2015) describe leniency programs as ex-post measures, which do not prevent the formation of cartels ex-ante. Even though this kind of program does not directly prevent the formation of cartels, it acts on the incentives of firms to form one. This point will be deepened in the next sub-chapter with Bos, Davies, Harrington Jr and Ormosi finding that leniency programs constraint the profitability of future cartels (2018).

1.3.4. Efficiency and consequences for cartel members.

The European Leniency Programme directly showed efficiency after its implementation in 1996 thanks to its strong incentives to collaborate (Brenner, 2009). It may be due to the fact that it was based on the revised American model (which was almost not used before its update in 1993) (Bell & Millay, 2019). Overall, Ordóñez-de-Haro, Borrell and Jiménez (2018) found out that the European Leniency Programme represented the key innovation in the improvement of antitrust policy and cartel enforcement in the European Union.

Right after the implementation of the European Leniency Programme, the European Commission identified many cartels and gathered solid evidence against them. The European Leniency Programme was involved in 94% of the cartel cases between 1998 and 2014. Moreover, 70% of leniency applications have led to the opening of an official investigation, and the number of prosecuted and sanctioned cartels significantly went up. (Borrell, García, Jiménez & Ordóñez-de-Haro, 2019)

Most of the European long-running cartels that remained undetected have been identified in 1996, due to the Leniency Programme implementation. This can be linked to a cartel discovery

pattern identified by Ordóñez-de-Haro & al (2018), where the number of cartels discovered highly increases after the implementation of the Leniency Programme or any of its revisions. This short-term effect is also coupled to a long-term impact of the European Leniency Programme, which has been proven to increase the deterrence of cartels (Borrell & al., 2019).

The discovery pattern of leniency can be linked to the duration of cartels. Since long-running cartels are detected through leniency policy, the short-term effect of leniency policy is to lower the duration of cartels (Harrington & Chang, 2009). The long-term impact of the European Leniency Programme, which increases the deterrence of cartels, implies a lower cartel duration as well (Borrell & al., 2019).

Cartel duration can also be linked to revenues and profits. García (2018) proved that in comparison of other cartels, long-duration cartels (that are, cartels operating for 8 years or more) generate 29 to 50% more revenues and 82 to 91,5 million euros more profits. The link between cartel duration and profits has been proved positive and significant. By putting this in parallel with the findings of Harrington & Chang (2009) and Borrell & al. (2019), the European Leniency Programme decreases the duration of cartels, which also lowers the revenues and profits made by cartel members. This is in line with the results according to which leniency programs constraint the price set by cartels, hence preventing abnormal profitability (Bos, Davies, Harrington Jr & Ormosi, 2018). These findings are also in line with Dong, Massa & Žaldokas' analysis (2019) revealing that leniency programs improve consumer welfare. It has also been shown that firms' profits are linked to their stock price (Collins, 1957); this relationship will be deepened in the next chapter.

1.4. Cartels, leniency programs and stock market.

According to Bosch and Eckard's findings in 1991, equity markets consider hard-core cartels as profitable. This is in line with the literature previously cited. Furthermore, higher profits means that the firm's stock price should increase according to Collins (1957). Following this reasoning, firms engaging in a cartel should see their equity price go up.

As seen previously, leniency programs increase the number of prosecuted firms (Borrell, García, Jiménez & Ordóñez-de-Haro, 2019) and decrease the profitability of colluding firms (Bos, Davies, Harrington Jr & Ormosi, 2018). Using the positive relationship between profits

and equity price (Collins, 1957), leniency programs should hence decrease the stock market price of companies engaged in a cartel. This idea has been extensively tested out by several authors using an event study of prosecutions (Bosch & Eckard, 1991 ; Langus & Motta, 2009 ; Günster & van Dijk, 2011). In all these studies, the effect of leniency programs on colluding firms is observed through the stock price variation during prosecution. Garbade, Silber & White developed the rationale as follows: "*If the market is efficient, there should be a significant and rapid drop in the price of a defendant's stock in response to the negative information communicated by the filing of an antitrust suit.*" (1982, p.686).

At the European level, the stock price of firms prosecuted due to the Leniency Programme registered on average a decrease of 4,7% on the announcement date and of 1,9% on the day of the final verdict. Concerning appeal sentences, prosecuted companies saw their stock price rise by 2 to 4% if the original decision was softened. If the original decision was maintained, the stock market responded negatively, but in a proportion that was unsignificant. (Günster & van Dijk, 2011)

The European Leniency Programme has a significant impact on the profitability, and hence the market value of firms that are prosecuted (Günster & van Dijk, 2011). In 1991, Bosch and Eckard decomposed the stock price decrease of companies prosecuted for collusion into three elements: legal costs, losses due to a tarnished reputation, and anticipated unrealized profits due to the end of the cartel. In their study, Günster and van Dijk (2011) found out that prosecuted firms registered market value losses following antitrust decision that were higher that the legal costs incurred (including the fine received). According to the two authors, this suggests that the market anticipated the effects of the prosecution to be greater than the fine and legal costs, and that the expected future profits would be lowered by the bad reputation and the end of the cartel. Aguzzoni, Langus and Motta confirmed this thought in 2013, and inferred that most of the market loss is due to the market's anticipation of future unrealized profits after the cartel termination. This confirms Bosch and Eckard's findings (1991) according to which equity markets consider hard-core cartels as profitable.

According to Günster and van Dijk (2011), the magnitude of the stock price reaction depends on several factors. The main ones are the newspaper coverage of the prosecution increases the (negative) market response (Fang & Peress, 2009), as well as the size of the firm; smaller firms suffer more than large ones from cartel convictions, probably because the illegal activity

represents a higher share of the business than for large, diversified firms. This also suggests that the effect of the conviction on reputation is also important.

Finally, the stock price loss after a prosecution in the context of a leniency program could act as an additional deterrent of cartels (Günster & van Dijk, 2011). However, Bosch and Eckard stated that a rational market would expect recidivism from former cartel members (1991). Thompson and Kaserman (2001) used stock market data and observed that 85% of cartel members' stock price returned to its pre-indictment level within one year after the conviction. This represents, according to the two authors, that the market expects a return to collusive behavior in one year or less after the prosecution. These findings greatly contest the additional deterrent effect of price drop induced by leniency program's prosecution.

Chapter 2: Research hypothesis.

The literature review provided insights about the possible stock price reaction following the implementation of the European Leniency Programme. This section aims at presenting the research hypothesis that will be used to verify such market behavior.

Hypothesis 1: Financial markets anticipated an effective European Leniency Programme.

This first hypothesis aims at analyzing if the European Leniency Program's implementation and amendments impacted the stock price of supposedly colluding firms. Indeed, it has been highlighted in the literature review that leniency programs lower the profitability of colluding firms, hence reducing their profitability (Bos, Davies, Harrington Jr & Ormosi, 2018 ; Günster & van Dijk, 2011). Following the rationale of Garbade, Silber and White (1982), efficient markets should hence anticipate a profitability decrease at the announce of leniency program-related news for (supposedly) colluding firms, translating into a drop in the stock price for such companies.

Hypothesis 2: The American market's anticipation of an effective European Leniency Programme was stronger than other markets'.

As seen in the literature review, the United States launched the first leniency program (Ghosal & Sokol, 2014), which became effective after its first revision in 1993 (Bell & Millay, 2019).

Hence, it might be possible that the American market was more familiar than other markets with the implications of leniency programs regarding firms' profitability (and stock price reaction). This may have led to a stronger anticipation from the American market than other markets regarding the effectiveness of the European Leniency Programme.

Second Part: Empirical Analysis.

Chapter 3: Sample constitution, data description and methodology.

An event study is the methodology used in this thesis to determine and analyze markets' anticipation regarding the effectiveness of the European Leniency Programme. According to Hendricks and Singhal (1996), this technique is known for putting in evidence the component of price change (called "abnormal return") that is implied by specific events. In the light of the hypothesis and the method used to test them, a database has been composed.

3.1. Sample selection and data description.

The event study is typically realized around specific events. The general focus of this paper being the anticipated effectiveness of the European Leniency Programme, the relevant events are the communications regarding the implementation and amendments of such program. These communications are exclusively composed of official press releases made by the European Commission regarding the European Leniency Programme. The event set is composed of 15 press releases, from the Commission's intention to implement the Leniency Programme in December 1995 to its latest amendment in June 2015 (a detailed list of the events is provided in *Appendix 3.1*). Press and blog articles have been intentionally left out of the scope, given the ancient nature of some events (mid 1990's and early 2000's); news took several days to be relayed by medias and the Internet, and eventual abnormal returns could not be imputed only to the events.

In addition, a sample has been created, composed of 57 firms convicted for collusion during the event window (1995 to 2015) in the European Union. The information regarding convictions have been found on the Cartel Cases Search Platform of the European Commission. The selection process focused on all companies of the chemical sector, the second most colluding industry according to Carree, Günster and Schinkel (2010), in order to ensure a sufficiently large sample. Among all cartel cases (116), 266 chemical firms have been convicted, and 57 were listed on financial markets at the time.

During the event window (1995 to 2015), 57 chemical firms were convicted for collusion and hence compose the sample used in this study[1]. The historical stock prices (between 1995 and 2015) of these companies have been collected on the Bloomberg Terminal to realize the event study. For each firm, a stock market index is required as a reference in the realization of the event study (see *3.2. Methodology*). The major national indexes have been chosen to compare each colluding firm to an index of other domestic firms (see *Appendix 3.2*). As for companies, the historical prices of the major national stock market indexes have been collected on the Bloomberg Terminal between 1995 and 2015.

3.2. Methodology.

The methodology used in this study follows the one of Hendricks and Singhal (1996) due to the similarity between both works. The market anticipation regarding the effectiveness of the European Leniency Programme was analyzed through an event study, which measured the stock price impact of the European Commission's press releases about its leniency programme. Such price effect is referred as the "abnormal return" of a stock, and the average abnormal returns must be tested for a statistical significance in order to prove the relationship.

Abnormal returns are computed over the events' period of interest, also called observation period (Telang & Wattal, 2007). In this study, the observation period was intentionally kept short. According to Hendricks and Singhal (1996), a short period lowers the chance that abnormal returns are influenced by factors unrelated to the event study, hence allowing a better statistical estimation of the stock price impact of the events. To be more accurate, the event date ("day 0") is defined depending on the publication date of the information. If the press release was published on a trading day, the event date corresponds to the publication date. Otherwise, the event date corresponds to the next trading day. This allows a precise determination of the event date (the trading day on which the market incorporates the news) and strengthens the analysis (Hendricks & Singhal, 1996). The observation period is composed of the event day (day 0), as well as the trading day before (day-1) and after (day+1) the event. It allows to analyze the abnormal returns for days surrounding the event day and identify a potential leak of the information or a delay in markets' response.

[1] An extensive list is provided in *Appendix 3.2*

Abnormal returns are defined as the actual return of a stock on the days of the observation period minus its expected return (Telang & Wattal, 2007). The computation of abnormal returns is usually realized with three models: the Market Model, the Market Adjusted Model and the Mean Adjusted Model (Hendricks & Singhal, 1996). Each one of them uses different parameters to compute the expected return of a stock, leading to different abnormal returns. However, the "estimation period", defined as the period prior the event day over which the parameters and the expected return are computed, is the same (Telang & Wattal, 2007). In this work, the estimation period of events has been chosen to avoid overlapping with the observation period of the previous event. Given the temporal proximity of some events, the maximum number of days between two events is 64. In addition, the estimation period ends one week before the day of the event, to protect the estimated parameters from the potential effect of the event announcement. The estimation period is here composed of 57 days, from day-64 until day-8, and is large enough to include at least 40 trading days (as required for the Market Model). A scheme of both estimation period and observation period is provided in *Appendix 3.3*.

Market Model.

In this model, the abnormal return of a stock is computed according to this formula:

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt} \quad (3.1)$$

$$\text{with } R_{it} = (P_{it} - P_{it-1})/P_{it-1} \quad (3.2)$$

where i designates the stock (i = 1, 2, …, 57), t designates the day of the event (t = 0 is the day on which the market incorporates the news) and m refers to the market. AR_{it} is the abnormal return of stock i on day t, R_{it} is the return of stock i on day t, P_{it} is the price of stock i on day t, R_{mt} is the market return on day t based on sock i's corresponding stock index, and α_i and β_i are parameters obtained by regressing the price of stock i over the price of its corresponding index (OLS regression requiring a minimum of 40 observations). $\alpha + \beta_{it} R_{mt}$ constitutes the expected return of the stock and is computed over the estimation period (from day-64 to day-8).

Market Adjusted Model.

In this case, the abnormal return of a stock is computed as follows:

$$AR_{it} = R_{it} - R_{mt} \quad (3.3)$$

where terms have the same interpretation as in the previous model.

Mean Adjusted Model.

In this model, the abnormal return is given as:

$$AR_{it} = R_{it} - \overline{R}_i \quad (3.4)$$

$$\text{with } \overline{R}_i = \left(\frac{1}{D_{est}}\right) \sum_{s=1}^{D_{est}} R_{it} \quad (3.5)$$

where $\overline{R}_i$ is the average of stock i's returns R_{it} over the estimation period D_{est}. Other terms are the same as in previous models.

Then, for each model, the average abnormal return $\bar{A}$ on day *t* is computed as:

$$\overline{A_t} = \left(\frac{1}{N_t}\right) \sum_{i=1}^{N_t} A_{it} \quad (3.6)$$

where N_t is the number of stocks on day *t*.

Calculations for the three models were realized on the statistical software SPSS. In total, 7695 abnormal returns were computed for the entire sample, including 2565 linear regressions for the Market Model.

3.2.1. Treatment of Hypothesis 1.

If markets anticipated an effective European Leniency Programme, the stock price of allegedly colluding firms should have significantly decreased on/around the publication day of press releases concerning this program. Hence, the test of this hypothesis aims at determining if the

average abnormal returns are significantly lower than zero:

$$H_0 : \overline{A_t} \geq 0$$
$$H_1 : \overline{A_t} < 0$$

Under the central limit theorem, the distribution of the average abnormal return $\overline{A_t}$ can be approximated by a Student law of mean 0 and standard deviation estimated with the sample standard deviation of $\overline{A_t}$ over the estimation period (Hendricks & Singhal, 1996). According to Brown and Warner (1985), the t-test is well adapted for the three models used in this study, even with event clustering. The testing of the null hypothesis has been realized on SPSS and the outputs are presented in *Appendix 3.4.*

To increase the robustness to the analysis, the same rationale will be used to test the proportion of abnormal returns lower than zero and whether the median abnormal returns are negative. Two nonparametric tests were performed: a Wilcoxon Signed Rank Test to compute the statistical significance of the median abnormal returns, and a Sign Test for the significance of the percentage of negative abnormal returns.

3.2.2. Treatment of Hypothesis 2.

As United States launched the first leniency program, it may be possible that the American market was more familiar than other markets with the implications of leniency programs. The American market would have had a stronger anticipation (and hence a lower average abnormal return) than other markets:

$$H_0 : \overline{A_{USA,t}} \geq \overline{A_{Other,t}}$$
$$H_1 : \overline{A_{USA,t}} < \overline{A_{Other,t}}$$

The typical non-normality of daily stock returns (Karoglou, 2010) has been confirmed for all the sub-samples with a Kolmogorov-Smirnov test. Hence, the comparison of the average abnormal returns between the United States and other countries has been realized by discriminating the abnormal returns between two groups ("USA" and "Other") and gathering descriptive statistics about the mean. Then, the significance between the average abnormal returns of the two groups was

performed with a non-parametric test of Mann-Whitney. The SPSS outputs are presented in *Appendix 3.5.*

Chapter 4: Results.

Hypothesis 1: Financial markets anticipated an effective European Leniency Programme.

$$H_0 : \overline{A_t} \geq 0$$
$$H_1 : \overline{A_t} < 0$$

Table 4.1: Abnormal returns of 57 colluding chemical firms following 15 press releases of the European Commission about its Leniency Programme (between 1995 and 2015) according to the Market Model, the Market Adjusted Model and the Mean Adjusted Model (one-tailed *p*-values are in parentheses).

	Day - 1	Day 0	Day +1
Market Model			
Average abnormal return	-0.27 (0.10)	-0.27 (0.01)*	-0.09 (0.23)
Median abnormal return	-0.04 (0.28)	-0.17 (0.01)**	0.00 (0.47)
Percent lower than zero	50.88 (0.5)	59.65 (0.09)	50.88 (0.5)
Market Adjusted Model			
Average abnormal return	-0.15 (0.22)	-0.15 (0.08)	-0.16 (0.09)
Median abnormal return	0.09 (0.24)	-0.05 (0.1)	-0.04 (0.15)
Percent lower than zero	42.11 (0.14)	57.89 (0.14)	52.63 (0.4)
Mean Adjusted Model			
Average abnormal return	-0.45 (0.01)**	-0.23 (0.03)*	0.01 (0,46)
Median abnormal return	-0.19 (0.01)**	-0.14 (0.05)*	0.12 (0.12)
Percentage lower than zero	70.18 (0.01)**	57.89 (0.15)	43.86 (0.21)

*p ≤ 0.05 ; **p ≤ 0.01

Table 4.1: stock prices significantly lowered on announcement days and the day before, but not on the day after.

Table 4.1 quantifies the effect of Leniency Programme announcements by the European Commission on the stock prices of colluding chemical firms (according to the three models

used). To strengthen the analysis, the median abnormal returns and the percentage of abnormal return lower than zero have been computed and are also reported in Table 4.1.

For day 0, which is the primary focus of this event study, the average abnormal returns (AAR) are negative for the three models and vary between -0.15 to -0.27%. In addition, this negative tendency is significant at the 10% level for the Market Adjusted Model ($p = 0.08 < 0.1$), at the 5% level for the Mean Adjusted Model ($p = 0.03 < 0.05$) and at the 1% level for the Market Model ($p = 0.01 \leq 0.01$). The median abnormal return fluctuates between -0.05 and -0.17%. Here again, values are statistically significant at the 10% level for the Market Adjusted Model ($p = 0.1 \leq 0.1$), at the 5% level for the Mean Adjusted Model ($p = 0.05 \leq 0.05$) and at the 1% level for the Market Model ($p = 0.01 \leq 0.01$). The percentage of abnormal returns lower than zero is 59.65 for the Market Model (significant at the 10% level: $p = 0.08 < 0.1$) and 57.89 for both the Market Adjusted Model and the Mean Adjusted Model. These results show that the stock price dropped on the announcement days, confirming that markets anticipated an effective Leniency Programme. This is in line with the rationale of Garbade, Silber & White (1982), according to which on efficient markets, firms' stock price should incur a significant drop in reaction to negative information that concern them.

Regarding the day preceding announcements, a negative trend can also be observed for the average abnormal returns. They range from -0.15% for the Market Adjusted Model to -0.45% for the Mean Adjusted Model. Results are significant the for the latter at the 1% level ($p = 0.01 \leq 0.01$). The AAR of -0.27% for the Market Model can also be considered as statistically significant at the 10% level ($p = 0.1 \leq 0.1$). Median abnormal returns are negative for two out of the three models, but only the median of -0.19% is significant at the 1% level. Moreover, 42.11 to 70.18% of abnormal returns are negative depending on the model (the latest value is significant at the 1% level: $p = 0.01 \leq 0.01$). Based on these results, it appears that stock prices also dropped the day before the announcements, suggesting a leak of information.

For the day following the event, only the average abnormal return (-0.16%) for the Market Adjusted Model is significant ($p = 0.09 < 0.1$). The median abnormal returns are positive for two models, but they cannot be accepted at any reasonable level of significance. Therefore, it is not possible to statistically prove that the majority of abnormal returns was negative on these days. The lack of significance does not allow to refute the null hypothesis. Hence, the results do not strongly prove that the market still reacted negatively the day after the announcements.

Overall, the first hypothesis is confirmed. The announcements of the European Commission induced an immediate drop in the stock prices, showing that markets anticipated an effective European Leniency Programme. Results also show that stock prices also lowered the day before the announcements, which suggests a leak of information. Finally, markets do not seem to delay the incorporation of the news.

Hypothesis 2: American market's anticipation of an effective European Leniency Programme was stronger than other markets.

$$H_0 : \overline{A_{USA,t}} \geq \overline{A_{Other,t}}$$
$$H_1 : \overline{A_{USA,t}} < \overline{A_{Other,t}}$$

Table 4.2: Comparison between the average abnormal returns of the United States and other countries following 15 press releases of the European Commission about its Leniency Programme (between 1995 and 2015) according to the Market Model, the Market Adjusted Model and the Mean Adjusted Model (one-tailed *p*-values are in parentheses).

	Day - 1	Day 0	Day +1
Market Model			
Average abnormal return (USA)	-0.02	-0.36	-0.96
Average abnormal return (Other)	-0.31	-0.26	0.05
Difference (USA-Other)	0.29 (0.48)	-0.1 (0.28)	-1.01 (0.01)**
Market Adjusted Model			
Average abnormal return (USA)	-0.17	-0.32	-0.98
Average abnormal return (Other)	-0.02	-0.12	-0.02
Difference (USA-Other)	-0.15 (0.23)	-0.2 (0.11)	-0.96 (0.06)
Mean Adjusted Model			
Average abnormal return (USA)	-0.14	-0.24	-1.17
Average abnormal return (Other)	-0.51	-0.23	0.21
Difference (USA-Other)	0.37 (0.19)	0.01 (0.47)	-1.38 (0.01)**
**$p \leq 0.01$			

Table 4.2: the American market reacted more intensely thank other markets, but delayed the incorporation of the news

Table 4.2 compares the stock price effect of Leniency Programme announcements by the European Commission between United States and other countries' colluding chemical firms (according to the three models used).

On the days of the events, the average abnormal returns are lower for the United States than for other countries according to two out of the three models. The differences range between -0.1% and 0.01%, however none of these values can be accepted at a reasonable level of significance. There is a tendency for a stronger reaction from the American market, but which cannot be statistically verified.

Concerning the day preceding the events, non-American markets reacted more strongly, and related firms incurred higher price losses. Their average abnormal returns were more negative than the ones of American firms for two out of the three models, and differences stay between -0.15% and +0.37%. Here again, results are not statistically significant, even if a general trend shows that the American market reacted less than other financial markets on those days.

Finally, the American market reacted way strongly than other markets on the day after the announcements. For the three models, the average abnormal returns are lower for American firms than for firms coming from other countries. The difference between AAR is significant at the 1% level for the Market Model ($p = 0.01 \leq 0.01$) and the Mean Adjusted Model ($p = 0.01 \leq 0.01$). The difference for the Market Adjusted Model (-0.96%) can also be accepted at the 10% level ($p = 0.06 < 0.1$). These results show that the American market delayed the incorporation of the news and anticipated an effective European Leniency Programme more than other markets.

Globally, results show the American market delayed the incorporation of the announcements, but reacted more intensely than other markets, which shows a stronger anticipation of an effective European Leniency Programme. This could be due to his familiarity with the leniency policy.

Chapter 5: Discussion.

This chapter aims to provide a critical look at this study, as well as avenues for improvement or further research.

The first implication of this work is directly linked to the research question, which focuses on the stock price effect of leniency announcements. Hence, the results obtained cannot be extrapolated to the valuation of firms that are not listed on financial markets.

Another important point is that results obtained directly depend on the sample selection. Markets' anticipation regarding allegedly colluding firms has been tested out on chemical companies convicted for engaging in a cartel. It implies that the results are only based on discovered cartels from only one sector of activity and cannot be extended to the whole population.

The methodology used also suffers from several limitations. Indeed, clustering of event dates can imply cross-sectional dependance among abnormal returns, which transgresses the OLS assumptions (Bosch & Eckard, 1991). According to the two authors, this would result in the underestimation of the variance of the average abnormal returns, leading to increased rejections of the null hypothesis of the absence of abnormal returns. In addition, the event study methodology may also provide abnormal returns that are influenced by other factors than the one(s) considered in the event study. The last limitation of the methodology is that markets' response to leniency announcements depends on when the events became known. The assumption made was that markets received the information when it was officially released by the European Commission, but the observation period was extended by one day to determine whether information leaked. This was the case as confirmed by the abnormal returns on the day prior announcements, but it is possible that the information leaks occurred several days before the events date. In that case, markets' anticipation prior the day before announcements would not be measured by the observation period selected in this work. The observation period was also extended by one day after the event to capture a potential delay in markets' response, which was the case for the United States. Here again, the delay subsequent to the day after the event would not have been measured in this study.

Finally, additional tests could be realized on the collected data. For example, it might be interesting to observe whether the stock price effect of leniency-related announcements was stronger during the period in which cartels were operating, or to increase the observation period to better measure information leaks and news incorporation delays. Testing whether the implementation of the European Leniency Program had a bigger price effect than the two reforms could also provide interesting insights. These ideas might represent valuable hypothesis to test in a further work.

Conclusion.

The purpose of this exploratory thesis was to enrich existing literature by analyzing whether markets anticipated an effective European Leniency Programme. A review of the literature was realized to build the theoretical framework needed to formulate hypothesis about the research question.

The empirical analysis was then realized based on a collected sample of the historical price of 15 stock indexes and 57 chemical firms convicted for collusion between 1995 and 2015. The event study methodology was chosen to observe the stock price effect of 15 press releases of the European Commission concerning the implementation or reforms of its Leniency Programme.

Global results showed that the European Commission's announcements induced an immediate drop in the stock prices, showing that markets anticipated an effective European Leniency Programme. However, the price effect might be too small to constitute an additional deterrent effect of leniency programs. It also appeared that prices lowered the day before announcements, suggesting a leak of information. Finally, a focus was also made to analyze the difference between American and other financial markets. It came to light that the American market delayed the incorporation of the announcements, but reacted more intensely than other markets, which shows a stronger anticipation of an effective European Leniency Programme. This could be due to his familiarity with the leniency policy.

Finally, limitations of this work were discussed to keep a critical look at the results obtained, especially the fact that they cannot be extended to the whole population. Enounced avenues for improvement and new hypothesis lay de foundations for further research about this topic.

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Appendixes.

Appendix 3.1: Event set.

Publication date	Subject	Source	URL
19 December 1995	Draft on the non-imposition or reduction of fines for cartels	European Commission	https://eur-lex.europa.eu/legal-content/FR/ALL/?uri=OJ:C:1995:341:TOC
18 July 1996	Commission Notice on the non-imposition or reduction of fines for cartels	European Commission	https://eur-lex.europa.eu/legal-content/FR/ALL/?uri=CELEX%3A31996Y0718%2801%29
7 December 1996	Publication of the first Leniency Notice	European Commission	https://ec.europa.eu/competition/cartels/legislation/leniency_legislation.html
18 July 2001	Debate about revision (draft Notice)	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_01_1011
13 February 2002	Adoption of a New Leniency notice	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_02_247
19 February 2002	Publication of the New Leniency notice	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_02_247
29 September 2006	Draft of new notice ("Model Leniency Programme")	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_06_1288
6 December 2006	Commission adopted a revised Notice	European Commission	https://ec.europa.eu/competition/publications/cpn/2007_1_7.pdf
7 December 2006	Communication on the adoption of the Notice	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_06_1705
8 December 2006	Publication of the Notice which enters in force	European Commission	https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2006:298:0017:0022:EN:PDF
26 October 2007	Draft to introduce settlement procedure for cartels	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_07_1608

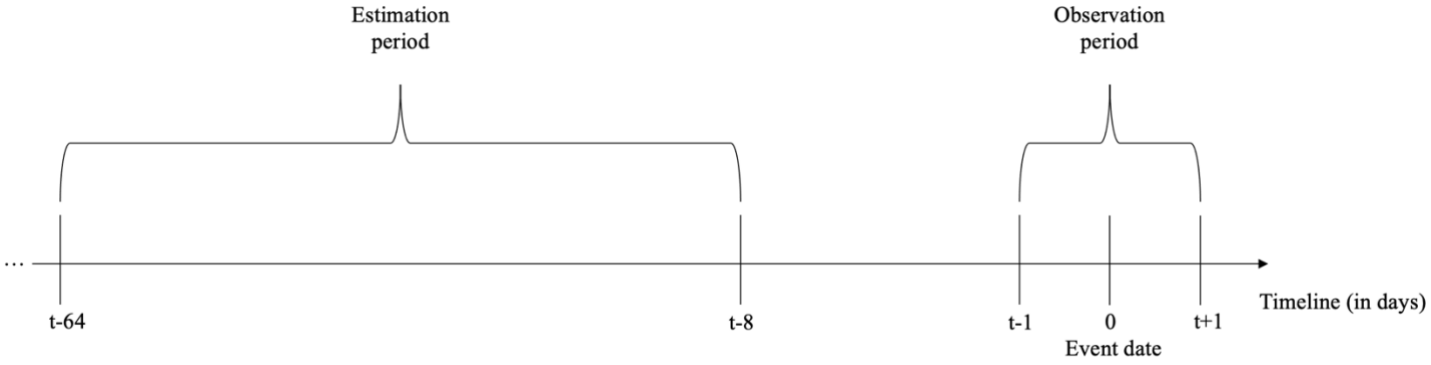
30 June 2008	Introducing of settlement procedure for cartels	European Commission	https://ec.europa.eu/commission/presscorner/detail/en/IP_08_1056
1 July 2008	Amendment of the draft Notice on the conduct of settlement procedures	European Commission	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32008R0622
2 July 2008	Publication of the Commission Notice on the conduct of settlement procedures	European Commission	https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52008XC0702%2801%29
5 August 2015	amendments to the Commission Notice on the conduct of settlement procedures	European Commission	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2015.256.01.0002.01.ENG

Appendix 3.2: List of 57 chemical firms convicted for collusion in the European Union between the events window (1995 to 2015) and their corresponding stock market indexes.

Firm	Country	Reference Index
UCB S.A.	Belgium	BEL20
Solvay SA	Belgium	BEL20
Tessenderlo Chemie N.V.	Belgium	BEL20
BP plc	England	FTSE 100
Unilever NV	England	FTSE 100
Elementis plc	England	FTSE 100
L'Air Liquide SA	France	CAC40
Rhône-Poulenc Biochimie SA	France	CAC40
Le Carbone-Lorraine S.A.	France	CAC40
Elf Aquitaine SA	France	CAC40
Total SA	France	CAC40
Arkema SA	France	CAC40
Degussa AG	Germany	DAX
Merck KgaA	Germany	DAX
SGL Carbon AG	Germany	DAX
BASF A.G.	Germany	DAX
Hoechst AG	Germany	DAX
Bayer AG	Germany	DAX
H&R ChemPharm GmbH	Germany	DAX
RWE AG	Germany	DAX
ARQUES Industries AG	Germany	DAX
SKW Stahl-Metallurgie Holding AG	Germany	DAX
Henkel AG & Co. KGaA	Germany	DAX

GEA Group AG	Germany	DAX
MOL Nyrt.	Hungary	BUX
Snia SpA	Italy	FTSE MIB
Eni S.p.A.	Italy	FTSE MIB
Nippon Soda Company Ltd	Japan	NIKKEI225
Ibiden Co., Ltd	Japan	NIKKEI225
Tokai Carbon Co., Ltd.	Japan	NIKKEI225
Toyo Tanso Co., Ltd.	Japan	NIKKEI225
Ajinomoto Company Incorporated	Japan	NIKKEI225
Takeda Chemical Industries Limited	Japan	NIKKEI225
Daicel Chemical Industries, Ltd.	Japan	NIKKEI225
Denki Kagaku Kogyo K.K.	Japan	NIKKEI225
Tosoh Corporation	Japan	NIKKEI225
Zeon Corporation	Japan	NIKKEI225
ORBIA ADVANCE CORPORATION, S.A.B. de C.V	Mexico	MEXBOL IPC
Akzo Nobel N.V.	Netherlands	AEX
Ballast Nedam NV	Netherlands	AEX
Koninklijke BAM Groep NV	Netherlands	AEX
Heijmans NV	Netherlands	AEX
Sasol Limited	South Africa	FTSE/JSE40
Daesang Corporation	South Korea	KOSPI
Cheil Jedang Corporation	South Korea	KOSPI
Uralita	Spain	IBEX35
Ercros S.A.	Spain	IBEX35
Kemira OYJ	Sweden	OMXS30
Clariant AG	Switzerland	SMI
Archer Daniels Midland Company Inc.	United States	S&P500
FMC Corporation	United States	S&P500
The Dow Chemical Company	United States	S&P500
E.I. DuPont de Nemours and Company	United States	S&P500
Exxon Mobil Corporation	United States	S&P500
The Procter & Gamble Company	United States	S&P500
Westlake Chemical Corporation	United States	S&P500
Celanese Corporation	United States	S&P500

Appendix 3.3: Scheme of the estimation period and observation period for each event.



Appendix 3.4: SPSS output for Hypothesis 1.

Market Model output for the average abnormal returns' significance on t-1, t and t+1 :

Test T

[DataSet1]

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
t-1	57	-,26628767	1,55897222	,206490915
t	57	-,27330442	,920683621	,121947525
t+1	57	-,08911191	,904162823	,119759292

Test sur échantillon unique

Valeur de test = 0

	t	df	Signification p unilatéral	Signification p bilatéral	Différence moyenne	Intervalle de confiance de la différence à 95 % Inférieur	Supérieur
t-1	-1,290	56	,101	,202	-,26628767	-,67993867	,147363343
t	-2,241	56	,014	,029	-,27330442	-,51759467	-,02901418
t+1	-,744	56	,230	,460	-,08911191	-,32901860	,150794783

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance Inférieur	Supérieur
t-1	d de Cohen	1,55897222	-,171	-,432	,091
	Correction de Hedges	1,58024710	-,169	-,426	,090
t	d de Cohen	,920683621	-,297	-,561	-,030
	Correction de Hedges	,933247947	-,293	-,553	-,030
t+1	d de Cohen	,904162823	-,099	-,358	,162
	Correction de Hedges	,916501693	-,097	-,354	,160

a. Dénominateur utilisé pour estimer les tailles d'effet.
Le d de Cohen utilise l'écart type échantillon.
La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

Market Adjusted Model output for the average abnormal returns' significance on t-1, t and t+1:

Test T

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
t-1	57	-,14698115	1,40577579	,186199552
t	57	-,15208283	,821085194	,108755391
t+1	57	-,15568461	,845001099	,111923130

Test sur échantillon unique

Valeur de test = 0

	t	df	Signification p unilatéral	Signification p bilatéral	Différence moyenne	Intervalle de confiance de la différence à 95 % Inférieur	Intervalle de confiance de la différence à 95 % Supérieur
t-1	-,789	56	,217	,433	-,14698115	-,51998367	,226021377
t	-1,398	56	,084	,168	-,15208283	-,36994605	,065780400
t+1	-1,391	56	,085	,170	-,15568461	-,37989358	,068524359

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance Inférieur	95% Intervalle de confiance Supérieur
t-1	d de Cohen	1,40577579	-,105	-,364	,156
	Correction de Hedges	1,42496004	-,103	-,360	,154
t	d de Cohen	,821085194	-,185	-,446	,077
	Correction de Hedges	,832290326	-,183	-,440	,076
t+1	d de Cohen	,845001099	-,184	-,445	,078
	Correction de Hedges	,856532605	-,182	-,439	,077

a. Dénominateur utilisé pour estimer les tailles d'effet.
Le d de Cohen utilise l'écart type échantillon.
La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

Mean Adjusted Model output for the average abnormal returns' significance on t-1, t and t+1 :

Test T

[DataSet1]

Statistiques sur échantillon uniques

	N	Moyenne	Ecart type	Moyenne d'erreur standard
t-1	57	-,45479294	1,50807653	,199749617
t	57	-,23262622	,912955542	,120923916
t+1	57	,014144803	,985055440	,130473780

Test sur échantillon unique

	Valeur de test = 0						
			Signification		Différence moyenne	Intervalle de confiance de la différence à 95 %	
	t	df	p unilatéral	p bilatéral		Inférieur	Supérieur
t-1	-2,277	56	,013	,027	-,45479294	-,85493950	-,05464637
t	-1,924	56	,030	,059	-,23262622	-,47486593	,009613491
t+1	,108	56	,457	,914	,014144803	-,24722559	,275515193

Tailles d'effet pour échantillon unique

		Standardisation[a]	Estimation des points	95% Intervalle de confiance	
				Inférieur	Supérieur
t-1	d de Cohen	1,50807653	-,302	-,566	-,035
	Correction de Hedges	1,52865685	-,298	-,558	-,034
t	d de Cohen	,912955542	-,255	-,518	,010
	Correction de Hedges	,925414405	-,251	-,511	,010
t+1	d de Cohen	,985055440	,014	-,245	,274
	Correction de Hedges	,998498231	,014	-,242	,270

a. Dénominateur utilisé pour estimer les tailles d'effet.
Le d de Cohen utilise l'écart type échantillon.
La correction de Hedges utilise l'écart type échantillon, plus un facteur de correction.

Market Model output for the median abnormal returns' significance on t-1, t and t+1 :

Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t-1 est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,492	Garder les hypothèses nulles.

a. Le niveau de signification est de ,050.

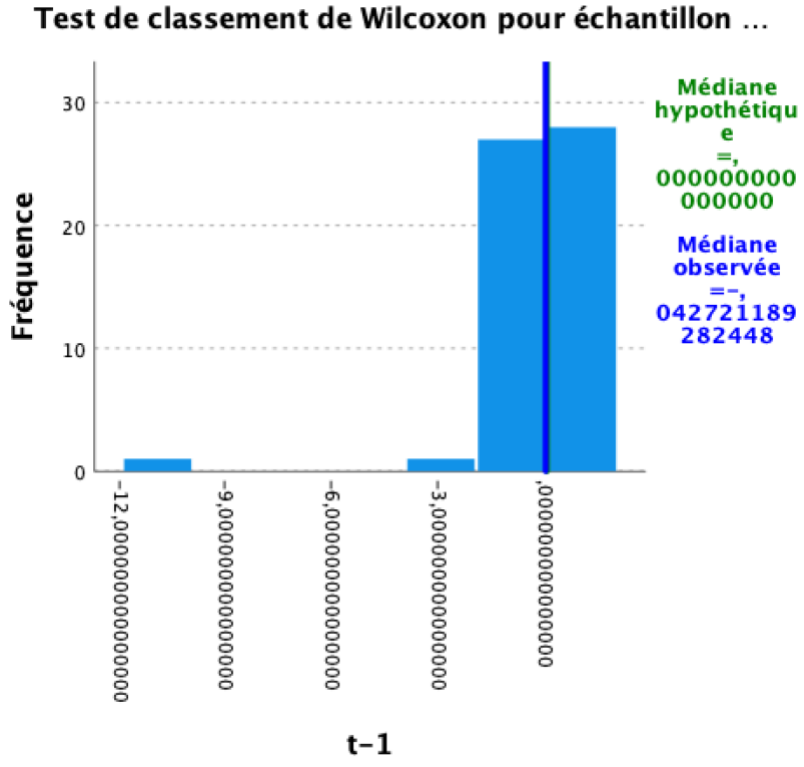
b. La signification asymptotique est affichée.

Test de classement de Wilcoxon pour échantillon unique

t-1

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	740,000
Erreur standard	125,862
Statistiques de test standardisées	-,687
Sig. asymptotique (test bilatéral)	,492



Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,006	Rejeter les hypothèses nulles.

a. Le niveau de signification est de ,050.

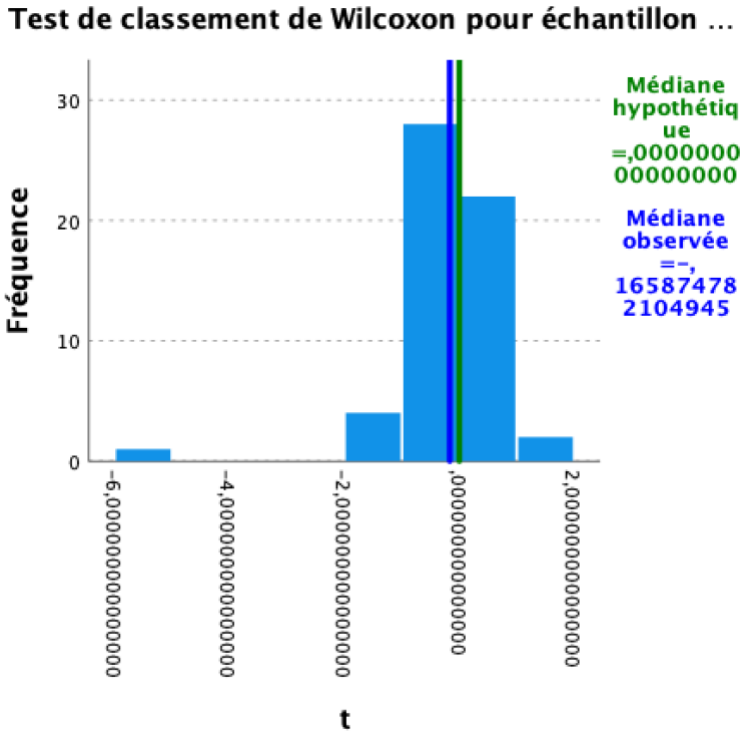
b. La signification asymptotique est affichée.

Test de classement de Wilcoxon pour échantillon unique

t

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	482,000
Erreur standard	125,862
Statistiques de test standardisées	-2,737
Sig. asymptotique (test bilatéral)	,006



Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t+1 est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,934	Garder les hypothèses nulles.

a. Le niveau de signification est de ,050.

b. La signification asymptotique est affichée.

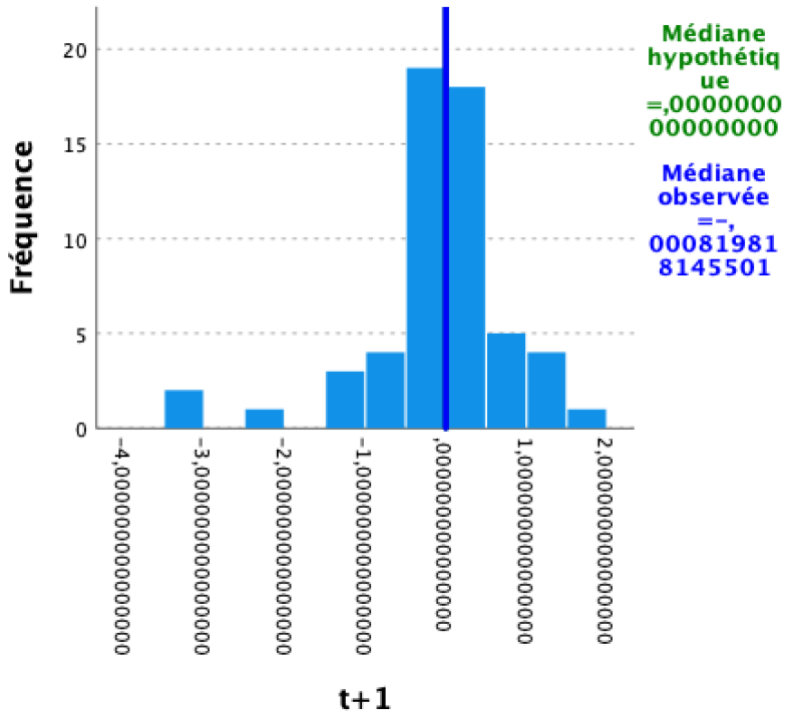
Test de classement de Wilcoxon pour échantillon unique

t+1

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	837,000
Erreur standard	125,862
Statistiques de test standardisées	,083
Sig. asymptotique (test bilatéral)	,934

Test de classement de Wilcoxon pour échantillon ...



Market Adjusted Model output for the median abnormal returns' significance on t-1, t and t+1:

Tests non paramétriques

[Jeu_de_données1]

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t-1 est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,434	Garder les hypothèses nulles.

a. Le niveau de signification est de ,050.

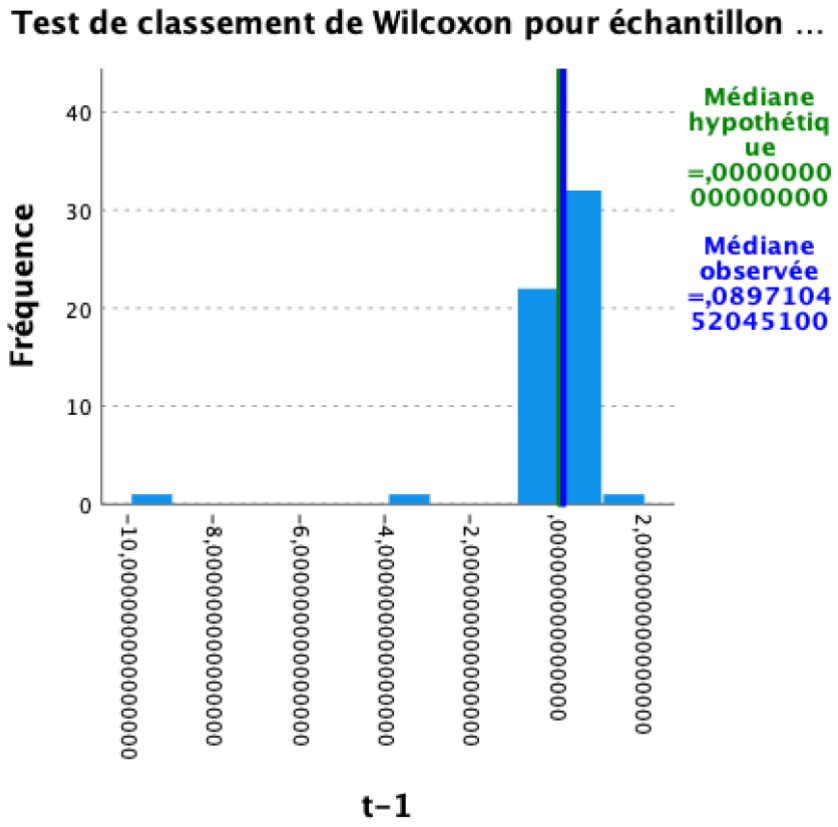
b. La signification asymptotique est affichée.

Test de classement de Wilcoxon pour échantillon unique

t-1

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	925,000
Erreur standard	125,861
Statistiques de test standardisées	,783
Sig. asymptotique (test bilatéral)	,434



Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t est égale à , 000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,199	Garder les hypothèses nulles.

a. Le niveau de signification est de ,050.

b. La signification asymptotique est affichée.

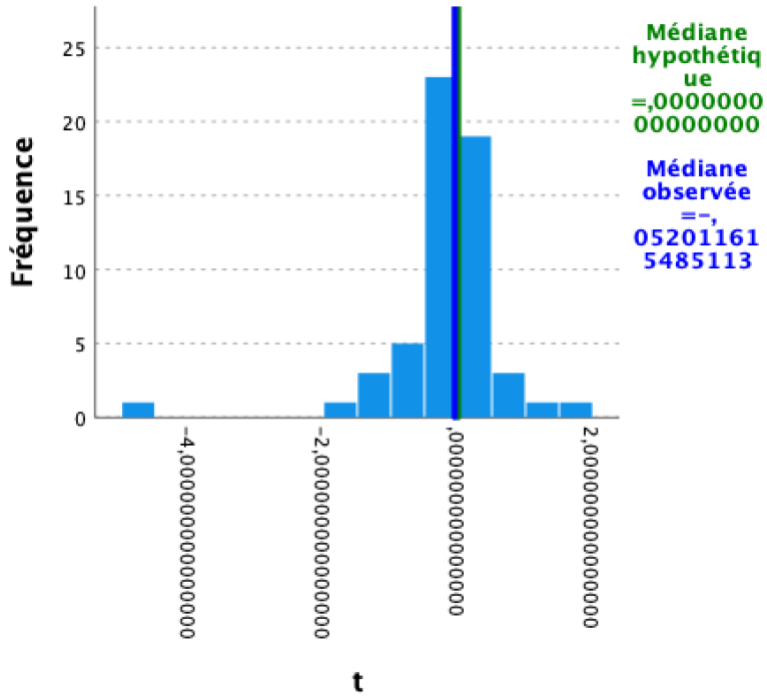
Test de classement de Wilcoxon pour échantillon unique

t

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	665,000
Erreur standard	125,862
Statistiques de test standardisées	-1,283
Sig. asymptotique (test bilatéral)	,199

Test de classement de Wilcoxon pour échantillon ...



Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t+1 est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,307	Garder les hypothèses nulles.

a. Le niveau de signification est de ,050.

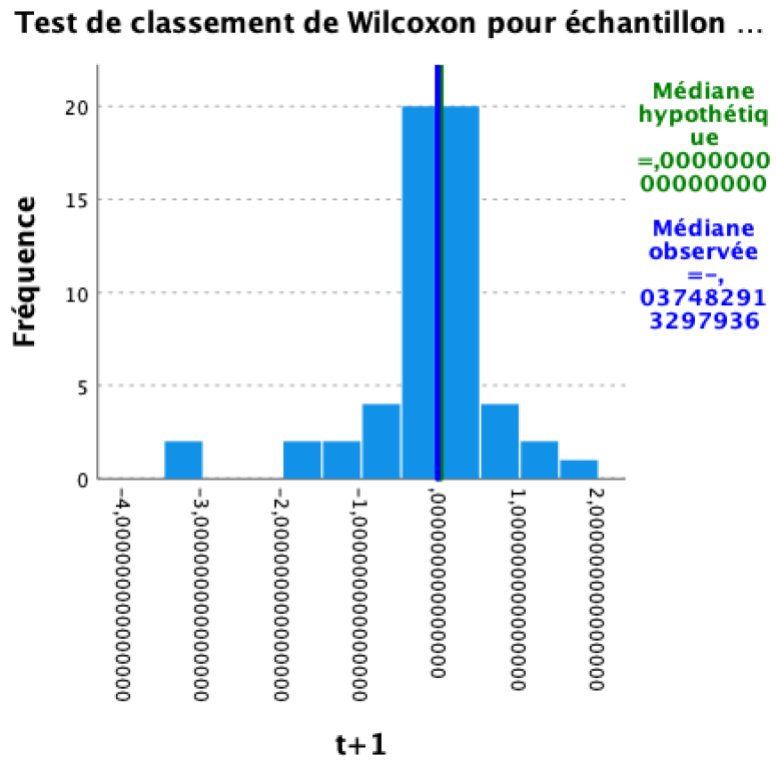
b. La signification asymptotique est affichée.

Test de classement de Wilcoxon pour échantillon unique

t+1

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	698,000
Erreur standard	125,862
Statistiques de test standardisées	-1,021
Sig. asymptotique (test bilatéral)	,307



Mean Adjusted Model output for the median abnormal returns' significance on t-1, t and t+1 :

Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t-1 est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	<,001	Rejeter les hypothèses nulles.

a. Le niveau de signification est de ,050.

b. La signification asymptotique est affichée.

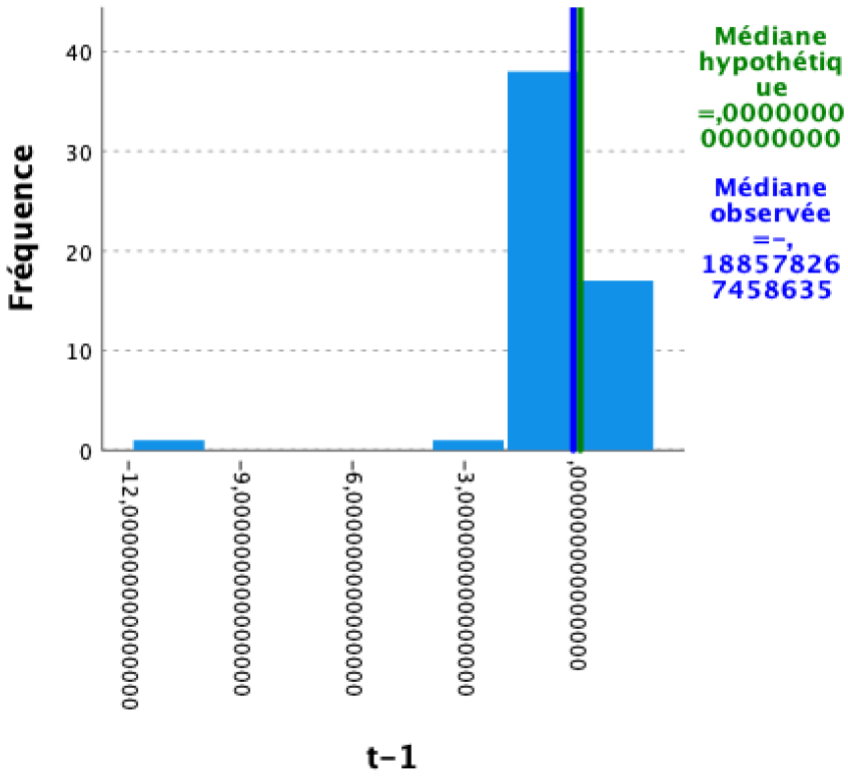
Test de classement de Wilcoxon pour échantillon unique

t-1

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	406,000
Erreur standard	125,861
Statistiques de test standardisées	-3,341
Sig. asymptotique (test bilatéral)	<,001

Test de classement de Wilcoxon pour échantillon …



Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t est égale à , 000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,047	Rejeter les hypothèses nulles.

a. Le niveau de signification est de ,050.

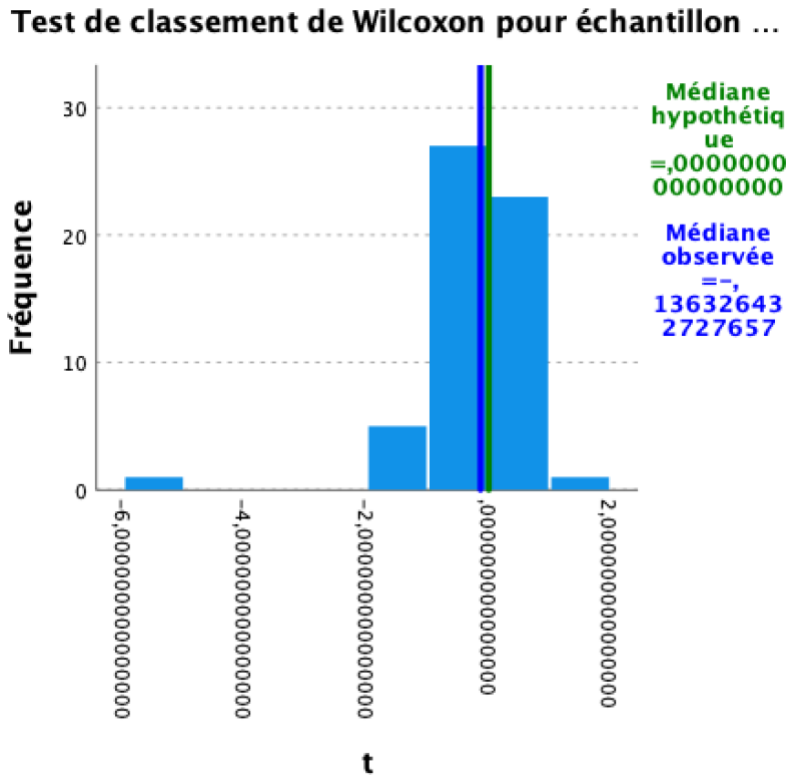
b. La signification asymptotique est affichée.

Test de classement de Wilcoxon pour échantillon unique

t

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	577,000
Erreur standard	125,862
Statistiques de test standardisées	-1,982
Sig. asymptotique (test bilatéral)	,047



Tests non paramétriques

Récapitulatif du test d'hypothèse

	Hypothèse nulle	Test	Sig.[a,b]	Décision
1	La médiane de t+1 est égale à ,000000000000000.	Test de classement de Wilcoxon pour échantillon unique	,235	Garder les hypothèses nulles.

a. Le niveau de signification est de ,050.

b. La signification asymptotique est affichée.

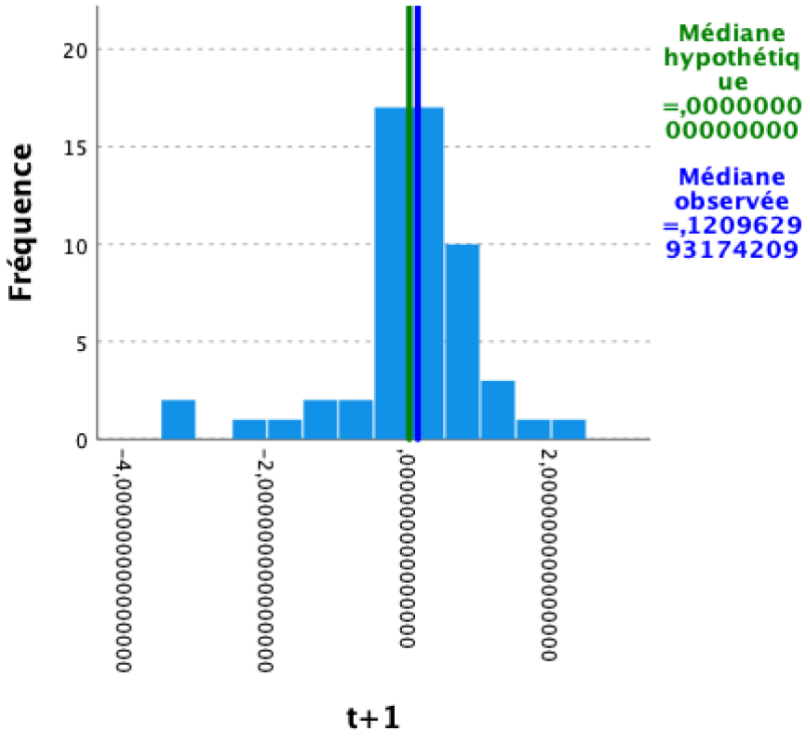
Test de classement de Wilcoxon pour échantillon unique

t+1

Récapitulatif du test Classement de Wilcoxon pour échantillon unique

N total	57
Statistiques de test	976,000
Erreur standard	125,862
Statistiques de test standardisées	1,188
Sig. asymptotique (test bilatéral)	,235

Test de classement de Wilcoxon pour échantillon ...



Market Model output for the significance of the percentage of abnormal returns lower than zero on t-1, t and t+1 :

Test des signes

Fréquences

		N
t−1 − Zero	Différences négatives[a,d,g]	29
	Différences positives[b,e,h]	28
	Ex aequo[c,f,i]	0
	Total	57
t − Zero	Différences négatives[a,d,g]	34
	Différences positives[b,e,h]	23
	Ex aequo[c,f,i]	0
	Total	57
t+1 − Zero	Différences négatives[a,d,g]	29
	Différences positives[b,e,h]	28
	Ex aequo[c,f,i]	0
	Total	57

a. t−1 < Zero
b. t−1 > Zero
c. t−1 = Zero
d. t < Zero
e. t > Zero
f. t = Zero
g. t+1 < Zero
h. t+1 > Zero
i. t+1 = Zero

Tests statistiques[a]

	t−1 − Zero	t − Zero	t+1 − Zero
Z	,000	−1,325	,000
Sig. asymptotique (bilatérale)	1,000	,185	1,000

a. Test des signes

Market Adjusted Model output for the significance of the percentage of abnormal returns lower than zero on t-1, t and t+1 :

Fréquences

		N
t−1 − Zero	Différences négatives[a,d,g]	24
	Différences positives[b,e,h]	33
	Ex aequo[c,f,i]	0
	Total	57
t − Zero	Différences négatives[a,d,g]	33
	Différences positives[b,e,h]	24
	Ex aequo[c,f,i]	0
	Total	57
t+1 − Zero	Différences négatives[a,d,g]	30
	Différences positives[b,e,h]	27
	Ex aequo[c,f,i]	0
	Total	57

a. t−1 < Zero

b. t−1 > Zero

c. t−1 = Zero

d. t < Zero

e. t > Zero

f. t = Zero

g. t+1 < Zero

h. t+1 > Zero

i. t+1 = Zero

Tests statistiques[a]

	t−1 − Zero	t − Zero	t+1 − Zero
Z	−1,060	−1,060	−,265
Sig. asymptotique (bilatérale)	,289	,289	,791

a. Test des signes

Mean Adjusted Model output for the significance of the percentage of abnormal returns lower than zero on t-1, t and t+1 :

Test des signes

Fréquences

		N
t−1 − Zero	Différences négatives[a,d,g]	40
	Différences positives[b,e,h]	17
	Ex aequo[c,f,i]	0
	Total	57
t − Zero	Différences négatives[a,d,g]	33
	Différences positives[b,e,h]	24
	Ex aequo[c,f,i]	0
	Total	57
t+1 − Zero	Différences négatives[a,d,g]	25
	Différences positives[b,e,h]	32
	Ex aequo[c,f,i]	0
	Total	57

a. t−1 < Zero

b. t−1 > Zero

c. t−1 = Zero

d. t < Zero

e. t > Zero

f. t = Zero

g. t+1 < Zero

h. t+1 > Zero

i. t+1 = Zero

Tests statistiques[a]

	t−1 − Zero	t − Zero	t+1 − Zero
Z	-2,914	-1,060	-,795
Sig. asymptotique (bilatérale)	,004	,289	,427

a. Test des signes

Appendix 3.5: SPSS output for Hypothesis 2.

Market Model output for the significance of the difference between the average abnormal returns of US versus compared to countries in t-1, t and t+1:

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t-1	0	49	28,96	1419,00
	1	8	29,25	234,00
	Total	57		

Tests statistiques[a]

	t-1
U de Mann-Whitney	194,000
W de Wilcoxon	1419,000
Z	-,046
Sig. asymptotique (bilatérale)	,963
Sig. exacte [2*(sig. unilatérale)]	,973[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t-1

0	N	Valide	49
		Manquant	0
	Moyenne		-,30632400
	Ecart type		1,67791960
1	N	Valide	8
		Manquant	0
	Moyenne		-,02106512
	Ecart type		,239818039

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t	0	49	29,51	1446,00
	1	8	25,88	207,00
	Total	57		

Tests statistiques[a]

	t
U de Mann-Whitney	171,000
W de Wilcoxon	207,000
Z	-,574
Sig. asymptotique (bilatérale)	,566
Sig. exacte [2*(sig. unilatérale)]	,580[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t

0	N	Valide	49
		Manquant	0
	Moyenne		-,25898196
	Ecart type		,967395051
1	N	Valide	8
		Manquant	0
	Moyenne		-,36102950
	Ecart type		,594774469

Descriptives

t+1

	N	Moyenne	Ecart type	Erreur standard	Intervalle de confiance à 95 % pour la moyenne		Minimum	Maximum
					Borne inférieure	Borne supérieure		
0	49	,053931088	,695034970	,099290710	-,14570626	,253568440	-2,3031740	1,70907496
1	8	-,96525025	1,48562151	,525246523	-2,2072609	,276760421	-3,2005896	,421265054
Total	57	-,08911191	,904162823	,119759292	-,32901860	,150794783	-3,2005896	1,70907496

ANOVA

t+1

	Somme des carrés	df	Carré moyen	F	Sig.
Entre groupes	7,144	1	7,144	10,169	,002
Intra-groupes	38,637	55	,702		
Total	45,781	56			

Market Adjusted Model output for the significance of the difference between the average abnormal returns of US compared to other countries in t-1, t and t+1:

Tests non paramétriques

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t-1	0	49	29,53	1447,00
	1	8	25,75	206,00
	Total	57		

Tests statistiques[a]

	t-1
U de Mann-Whitney	170,000
W de Wilcoxon	206,000
Z	-,597
Sig. asymptotique (bilatérale)	,550
Sig. exacte [2*(sig. unilatérale)]	,565[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

[DataSet1]

Statistiques

t-1

0	N	Valide	49
		Manquant	0
	Moyenne		-,16759194
	Ecart type		1,51544645
1	N	Valide	8
		Manquant	0
	Moyenne		-,02074002
	Ecart type		,201232472

Tests non paramétriques

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t	0	49	30,06	1473,00
	1	8	22,50	180,00
	Total	57		

Tests statistiques[a]

	t
U de Mann-Whitney	144,000
W de Wilcoxon	180,000
Z	-1,195
Sig. asymptotique (bilatérale)	,232
Sig. exacte [2*(sig. unilatérale)]	,242[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t

0	N	Valide	49
		Manquant	0
	Moyenne		-,12404204
	Ecart type		,854879054
1	N	Valide	8
		Manquant	0
	Moyenne		-,32383264
	Ecart type		,585582090

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t+1	0	49	30,39	1489,00
	1	8	20,50	164,00
	Total	57		

Tests statistiques[a]

	t+1
U de Mann-Whitney	128,000
W de Wilcoxon	164,000
Z	-1,562
Sig. asymptotique (bilatérale)	,118
Sig. exacte [2*(sig. unilatérale)]	,123[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t+1

0	N	Valide	49
		Manquant	0
	Moyenne		-,02106983
	Ecart type		,640984441
1	N	Valide	8
		Manquant	0
	Moyenne		-,98020012
	Ecart type		1,41105994

Mean Adjusted Model output for the significance of the difference between the average abnormal returns of US compared to other countries in t-1, t and t+1:

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t-1	0	49	28,24	1384,00
	1	8	33,63	269,00
	Total	57		

Tests statistiques[a]

	t-1
U de Mann-Whitney	159,000
W de Wilcoxon	1384,000
Z	-,850
Sig. asymptotique (bilatérale)	,395
Sig. exacte [2*(sig. unilatérale)]	,409[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t-1

0	N	Valide	49
		Manquant	0
	Moyenne		-,50609871
	Ecart type		1,62001613
1	N	Valide	8
		Manquant	0
	Moyenne		-,14054508
	Ecart type		,258514111

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t	0	49	28,94	1418,00
	1	8	29,38	235,00
	Total	57		

Tests statistiques[a]

	t
U de Mann-Whitney	193,000
W de Wilcoxon	1418,000
Z	-,069
Sig. asymptotique (bilatérale)	,945
Sig. exacte [2*(sig. unilatérale)]	,955[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t

0	N	Valide	49
		Manquant	0
	Moyenne		-,23076959
	Ecart type		,950421629
1	N	Valide	8
		Manquant	0
	Moyenne		-,24399808
	Ecart type		,688233089

Test de Mann-Whitney

Rangs

	Country	N	Rang moyen :	Somme des rangs
t+1	0	49	31,43	1540,00
	1	8	14,13	113,00
	Total	57		

Tests statistiques[a]

	t+1
U de Mann-Whitney	77,000
W de Wilcoxon	113,000
Z	-2,734
Sig. asymptotique (bilatérale)	,006
Sig. exacte [2*(sig. unilatérale)]	,005[b]

a. Variable de regroupement : Country

b. Non corrigé pour les ex aequo.

Fréquences

Statistiques

t+1

0	N	Valide	49
		Manquant	0
	Moyenne		,207873455
	Ecart type		,733560042
1	N	Valide	8
		Manquant	0
	Moyenne		-1,1724432
	Ecart type		1,48355187