Leniency and damage liability for cartel members in Brazil

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Abstract: A recent debate on leniency policies is the interplay between the public and the private competition law enforcement. The lack of a well-established set of rules regarding damage claims may be harming the effectiveness of the Brazilian Leniency Program, either by discouraging the wrongdoers from applying for leniency in already formed cartels or by not being threatening enough to deter the cartel formation. The paper objective is to analyze the best policies for leniency applicants regarding the damage liability in Brazil. We conclude that the optimal policy is providing immunity to the leniency applicant, and after that the damage claim lawsuits can be encouraged with no undesirable effects. Extensions confirm the following: the immunity is even more effective when there is risk of betrayal; the immunity is the best policy in the case of ex-

post leniency; the immunity is the optimal policy when there is no bankruptcy, otherwise the applicant liability should be the minimum necessary to avoid the bankruptcy; in case of criminalization, immunity regarding criminal sanctions is the optimal policy; the optimal policy for international cartels is a combination of immunity regarding damage liability in all jurisdictions.

Keywords: collusion, leniency, damage claim, damage liability, infinitely repeated game

JEL code: L13, L41, L44

1. Introduction

In the 90s a new tool for fighting cartels was released by antitrust authorities in developed countries, the so-called leniency programs. According to Spagnolo (2008), these policies aim at reducing sanctions against colluding firms that report information on the cartel to the antitrust authority and cooperate with it along the prosecution phase. Harrington (2008) informs that a well-designed leniency program was first adopted by the United States (USA) in 1993, although some antitrust policies related to fines amnesty can be observed since 1978. In 1996, the European Commission introduced its own leniency program in the European Union (EU), with some differences in comparison to the USA[1]. Recently, a great number of countries have adopted leniency programs, generally based on USA and EU policies.

In Brazil, the Brazilian System of Competition Policy, led by the Administrative Council for Economic Defense (*Conselho Administrativo de Defesa Econômica - CADE,* in Portuguese), began a public fight against cartels in the mid-2000s, releasing booklets aiming at explaining people about their adverse effects and how to denounce collusions,

[1] See Spagnolo (2008) for a comparison between USA and EU leniency policies.

improving mechanisms to prosecute cartels and highlighting the importance of the Brazilian Leniency Program adopted in 2000. Martinez (2015) informs that the Brazilian Leniency Program was inspired by the USA antitrust policies. A winner-takes-all approach is observed, therefore only the first one to confess can be granted. Companies and individuals can apply for leniency, meaning that corporations can avoid government fines, while individuals escape fines and prison sentences.

A recent debate on leniency policies is the interplay the between the public and the private competition law enforcement. As noted by Spagnolo and Marvão (2016), damage claims may reduce the attractiveness of leniency application for cartel participants if their cooperation with the antitrust authority increases the chance that the victims will result in a successful lawsuit. This conflict requires an intense debate on how antitrust authorities should act regarding damage liability, disclosure of information to victims and the enforcement for encouraging lawsuits.

There is no consensus among countries yet. According to Cauffman (2011), in USA the Antitrust Criminal Penalty Enhancement and Reform Act of 2004 limits the civil liability for leniency applicants to single damages attributable to the applicant's own sales, meanwhile the other cartelists are required to cover the additional damages. Without leniency firms are liable for treble damages and are also jointly and severally liable for the entire cartel damage. On top of that, plaintiffs are able to request any relevant information they deem necessary from every wrongdoer, including the leniency applicant. In EU, Buccirossi, Marvão and Spagnolo (2015) highlight that a recent EU Directive states: "*an immunity recipient is jointly and severally liable to: a) its direct or indirect purchasers or providers; b) to other injured parties only where full compensation cannot be obtained from the other undertakings that were involved in the same infringement of*

competition law.[2] In addition, *"national courts cannot at any time order a party or a third party to disclose any of the following categories of evidence (a) leniency statement; and (b) settlement submissions"*[3]. Cauffman (2011) cites the Hungary case as an interesting one: a leniency applicant that has been granted immunity from fines may refuse to reimburse the damages as long as the claim can be collected from other undertakings being held liable for the same infringement, that is, cartel victims are only able to enforce their claims against the immunity recipient to the extent that it cannot obtain compensation from other cartelists.

The debate in Brazil is also recent and relevant[4]. According to Martinez (2015), cartel members in Brazil are jointly and severally liable for the illegal activity, with no exception to the leniency applicant. In addition, the Brazilian Constitution of 1988 states the disclosure of administrative processes as a general rule. Recent resolutions and recommendations are in course in order to improve the attractiveness of self-report policies, as the ones included in the Brazilian Senate legislative bill Nº 283/2016. It proposes that harmed parties have the right of being refunded in double by the damage caused by cartel members, except the leniency applicant, that will be liable only for the direct damage (single and not jointly and severally liable). However, these proposals are

[2] The full EU Directive is presented in European Commission (2014) and this quote represents the Article 11, paragraph 4.

[3] Article 6, paragraph 6 of EU Directive.

[4] There is no information about the exact number of damage claim lawsuits in Brazil. This is a hard task due the size of the country, the number of jurisdictions (cities, states and federal government), confidential lawsuits, etc. Nevertheless, the Brazilian technical note CADE (2016a) states that, despite small, the number of private lawsuits related to anticompetitive conducts have been increasing through the years. Until the year of 2011 they were around twenty cases, while from 2012 to 2014 there were twenty-two decisions.

sparse and do not constitute a legal system for the Brazilian Leniency Program yet, as clarified by CADE (2016b), a public document updated in the year of 2020 that lists the main guidelines for CADE's Antitrust Leniency Program. To sum up, regarding the damage liability there is no specific policy for leniency applicants yet[5].

The lack of a well-established set of rules regarding damage claims may be harming the effectiveness of the Brazilian Leniency Program, either by discouraging the wrongdoers from applying for leniency in already formed cartels or by not being threatening enough to deter the cartel formation. The fight against collusive agreements is a priority for Brazilian antitrust enforcement, therefore it is important to understand the consequences of self-reporting policies to increase the effectiveness of the Brazilian Leniency Program, already considered one of the best tools for fighting cartels.

The main objective of this paper is to analyze the best policies for leniency applicants regarding the damage liability and the consequences on the cartel behavior. Instead of considering a binary choice of colluding or not depending on the incentives (as most papers in this literature), we allow for the possibility of an endogenous decision on the collusive price. The theoretical framework is close as possible to the Brazilian situation regarding competition policies, antitrust authority acting and the market itself. We conclude that immunity from damage claims is the optimal policy in terms of deterrence, including in case of risk of betrayal, ex-post leniency and international cooperation, while in case of bankruptcy the recipient liability should be the minimum necessary to avoid the bankruptcy. It is also optimal to provide immunity regarding criminal sanctions.

[5]Since this paper deals with optimal policies, we can evaluate these proposals according to the main results later.

The remainder of the paper is organized as follows. Section 2 provides a literature review and Section 3 presents the main model and results. Section 4 works on five further extensions and Conclusions are presented in Section 5. The paper ends after the References.

2. Literature review

This paper is related to two important subjects in competition policy. The first one is the interplay between the public and private enforcement of law. Despite being complementary, if not designed cautiously one may be harmful to the other. Important contributions in this field from an economic and theoretical viewpoint include McAffee *et al.* (2008) and Bourjarde *et al.* (2009). More specific to our case, according to Cauffman (2011) two important actions may interfere in this interplay: the law can prevent disclosure of leniency applications; the law can decrease the risk or the amount of damages to be paid by leniency recipients.

The other important topic is the impact of leniency policies on collusive agreements from a theoretical perspective. Harrington (2008) differentiates two main effects: deterrence and desistance. Leniency programs can deter cartel formation either by making it unprofitable or making collusion unstable. On the other hand, leniency programs can cause collusion to desist by expanding the set of future states for which the cartel collapses. Since the seminal paper of Motta and Polo (2003) this is a vast literature that includes Brisset and Thomas (2004), Spagnolo (2005), Aubert *et al.* (2006) Harrington (2008), Lefouili and Roux (2012), Chen and Rey (2013), Emons (2020), among others.

Finally, two papers are closer to this one. Buccirossi, Marvão and Spagnolo (2015) is related to the two topics above, that is, they analyze theoretically the interplay between leniency policies and damage claims. They conclude that the private enforcement can improve the level of deterrence if the leniency applicant liability from damages is very low (immunity ideally), jointly with full disclosure of information to victims. Their proposal of immunity for the applicant is more effective than the current policy in US, EU and Hungary. The other paper is Houba, Motchenkova and Wen (2015). Inspired by Harrington (2005) and Harrington and Chen (2006), they analyze the impact of a leniency program on the collusive price, thus the decision of collude or not is not binary. Instead, there is a set of prices that sustains the cartel. They conclude that the *ex-ante* leniency is not effective in decreasing the maximal collusive price, while for *ex-post* leniency it is optimal to grant full immunity for the first one to report.

3. The model

The model is an infinitely repeated game where firms observe their expected values in each period to make their decisions. An industry consists of two symmetric firms[6] competing *à la* Bertrand *ad infinitum* in a context of any degree of heterogeneity among products, except for completely homogeneous goods (as explained later). We are interested in the Subgame Perfect Equilibrium (SPE hereafter), the profile of actions that induces Nash equilibrium in every subgame. It is well known that repeated games allow for the possibility of multiple SPE, including collusive and non-collusive ones. We analyze the most common and realistic one: the stationary SPE of collude and respect the collusive agreement in every period. Some papers like Motta and Polo (2003), Spagnolo

[6] The results are the same for $n > 2$. We assume $n = 2$ to facilitate the exposition.

(2005) and Houba, Motchenkova and Wen (2015) also consider the SPE in which firms "exploit" the leniency (since it reduces the costs of misbehavior) by colluding and reporting systematically. However, this is an unrealistic situation and not considered here.

The firm's profit is a function of the price set at the beginning of each period. A competitive duopoly results in both firms setting the Bertrand-Nash price, hereafter p_N, which generates the profit $\pi_N(p_N)$ (π_N from now on). As in Houba, Motchenkova and Wen (2012) and Houba, Motchenkova and Wen (2015), we normalize $\pi_N = 0$, which means that all other profits are seen as net values in relation to the Bertrand-Nash outcome. The collusive profit for each firm is $\pi_C(p)$, such that $p \in (p_N, p_M]$ is the collusive price fixed by the cartel and p_M is the monopoly price. Assuming $\pi_C(p)$ continuous and strictly increasing in $p \in (p_N, p_M]$, firms will always choose the maximal p as possible when colluding (given a set of prices that sustain the cartel and compensates all the risks, they will set the highest), we call it as the "maximum collusive price". Besides competing and colluding, firms can also agree to collude and then deviate, that is, agree to set the $p > p_N$ but instead of that set a lower price that maximize its profit given the maximum collusive price of the other firm. The profit obtained by unilateral deviation is denoted by $\pi_D(p)$[7], continuous and strictly increasing in $p \in (p_N, p_M]$. Lastly, we assume the same exogenous discount factor $\delta \in (0,1)$ for both firms.

The Antitrust Authority (AA) acts in two ways: independent investigation and leniency mechanism. Concerning the independent investigation, both firms are detected and prosecuted with probability α when they have done and respected the collusive agreement, such that $\alpha \in (0, 1)$. Once detected, each firm pays a fine $f\pi_C(p)$ in the same

[7] Note that $\pi_D(p)$ is the profit when the maximum collusive price established previously is p, and not the price when deviating.

period, where f represents the proportion of the collusive profit that is determined as the penalty for cartel members. The Brazilian's Law 12,529/2011 establishes the following criteria related to corporate fines: fine of 1% up to 20% of the company gross revenue in the last year preceding the establishment of the administrative procedure, concerning the business activity branch in which the offense occurred, which will never be lower than the advantage obtained when it is possible to calculate. Thus, considering the profit as a proxy for the revenue it is plausible to set the fine as a proportion of the total profit obtained in the beginning of each period[8].

With respect to the leniency mechanism, the Brazilian Leniency Program guarantees immunity from fines to the first eligible firm that applies for leniency, like in the USA[9]. Therefore, after a unilateral deviation it is not possible for the betrayed firm to obtain benefits from another leniency agreement. The immunity (total amnesty) may be obtained only when the AA is unaware of the collusive activity (*ex-ante* leniency). When the AA knows about the cartel but does not have enough proof to start a prosecution a leniency applicant can obtain only partial amnesty (from one-third up to two-thirds of the fine, as stated by the Brazilian Law 12,529/2011). This is known as *ex-post* leniency and will be considered later as a model extension.

Next, we define the private lawsuit enforcement, that is, the capacity of agents to sue the cartel for damages. The plaintiffs are allowed to sue the cartel as a whole, then

[8] In Houba, Motchenkova and Wen (2015), both α and f are non-decreasing functions of p. They assume that the higher the price charged by the cartel more distrusted is the AA about the infringement. In the same way, the degree of the infringement is a criterion for the penalty statement, thus higher maximum collusive prices induce higher fines. We consider these parameters as exogenous for three reasons: simplicity of the model, the focus is the damage liability and the results are not modified in either.

[9] This approach is considered also in Motta and Polo (1999) and Chen and Harrington (2007), despite most papers allow amnesty for more than one applicant (which represents the European Union case).

each firm is liable for their own damage when there is no leniency (different liabilities are proposed with leniency)[10]. We take an approach similar to Buccirossi, Marvão and Spagnolo (2015). When the cartel is detected and prosecuted by independent investigation, each firm pays a total amount of damages of $\beta d_{NL}\pi_C(p)$ in the same period, in which β is a parameter representing the AA enforcement for damage claims (mainly disclosure of evidence to plaintiffs, such that $\beta \in (0,1]$, while d_{NL} represents the court activity, that is, it is the proportion of the maximum damage request ($\beta\pi_C(p)$) set by the court when the firm is not a leniency applicant. Initially, when there is unilateral deviation and reporting the leniency applicant is liable for $\beta d_L\pi_D(p)$ (different liability rules are proposed later), in which d_L is the proportion of the maximum damage request ($\beta\pi_D(p)$) set by the court when the firm is in fact the leniency applicant. Note that β is an *ex-ante* policy and invariable with respect to being or not the recipient of leniency, while the terms d_{NL} and d_L are responsible for distinguish the damage liability of the leniency applicant. We assume $d_L \leq d_{NL}$, such that when $d_L = d_{NL}$ there is no AA policy of distinct liability, when $0 < d_L < d_{NL}$ there is a partial liability (the recipient receives a partial amnesty instead of immunity) and when $d_L = 0$ there is immunity for the leniency applicant.

As in Buccirossi, Marvão and Spagnolo (2015) and Emons (2020), we assume it is optimal to apply for leniency (report) when deviating. One possible interpretation for this assumption is that the expected damage liability when reporting is always lower than

[10] In theory, it is possible to claim the whole damage from one firm, since each wrongdoer is jointly and severally liable for damages caused by their illegal antitrust activity, that is, each cartel member may be held liable for the entire cartel-related damage, as highlighted by Martinez (2015). Nevertheless, Martinez (2015) gives an example of a damage claim against a leniency applicant of a cartel in Sao Paulo/Brazil where the judge required the government to amend the claim to also include the other cartel members.

the probability of getting caught and be required to pay the fine plus the collusive damage[11]. Another explanation is the following: α is the probability of detection and prosecution when both collude and respect the collusive agreement, but a deviation may destabilize the market and generate more suspicion, increasing α up to higher levels. In this framework, the probability of being caught may be very high, which induces the leniency application.

Lastly, firms are only liable for fines and damages regarding the current period activity, therefore they are not guilty for past infringements.

3.1. Optimal damage liability

Each firm chooses one of the two following actions: collude/respect the collusion (hereafter "collude") and collude/deviate/report ("report" from now on). We consider the grim-trigger strategy, that is, firms will keep colluding as long as no one "report". If any "report", the cartel dissolves and firms compete *à la* Bertrand forever. The same happens when a cartel is detected and punished by the AA: it will never be formed again, resulting

[11] Motta and Polo (2003) and Houba, Motchenkova and Wen (2015) consider the deviating firm immune to antitrust penalties, and in fact some papers like Spagnolo (2005) and Chen and Rey (2013) also argue that this is theoretically optimal in the sense of antitrust policy, since firms would be more encouraged to deviate when the cost of deviating is lower. However, the Brazilian's Law 12,529/2011 states that an antitrust infringement is any violation of economic order, regardless of fault, which achieved or not the objective. Thus, the intention itself is enough to induce guiltiness. This case is not even regardless of fault, as the deviating firm is benefitted from the agreement (despite not respecting it).

in competition from thereon. It seems appropriate because no cartel was discovered and punished twice in Brazil, even repeat offenders were members of different cartels[12].

In each period, the timing of the game is the following:

1) Firms agree on the maximum collusive price $p \in (p_N, p_M]$;

2) Each one decides to follow the agreement or not and realizes the profits. In other words, they choose between "collude" and "report".

3) When both "collude", the AA detects and prosecutes the cartel with probability α. If so, the AA sets the amount of fine and then the court sets the amount of damage for each firm (proportional to the collusive profit), the game ends for that period and firms compete from now on; if not, the game ends for that period and the same game is played next period. In case of unilateral "report", the deviating firm receives the benefits of leniency (immunity from fines) and initially pays the amount of damages proportional to

[12]Motta and Polo (2003) and Houba, Motchenkova and Wen (2015) consider the possibility recidivism, which is often in Europe. In practice, recidivism is likely if cartel members do not fear enough the antitrust enforcement, that is, if AA is not detecting enough, prosecuting enough and/or punishing enough the agreement remains profitable and stable even with α and f. It is also possible for punished firms to form a new collusive agreement, perhaps even more stable due the previous experience (new profits, parameters and variables). We presume recidivism in unusual in Brazil due the fight against cartels being recent, therefore punished firms remains on the radar of the AA and public opinion (increasing the probability of a new detection and punishment). Moreover, Brazilian's Antitrust Law 12,529/2011, Article 37 (I) determines that fines are in double in case of recidivism, which also discourages this practice. Despite the aforementioned, recidivism tends to compare again an expected value of "collude" and "report", thus the main conclusions of the paper remain valid: immunity regarding damage liability is the optimal policy.

the profit from deviation (different liability rules are proposed later), the game ends for that period and firms compete forever[13].

Now we define the expected values. The expected value of "collude" is:

$$V_C(p) = \pi_C(p) - \alpha[f\pi_C(p) + \beta d_{NL}\pi_C(p)] + \delta\left[\alpha\frac{\pi_N}{1-\delta} + (1-\ \alpha)V_C(p)\right] \quad (1)$$

In which the first part is the profit of colluding, the second part is the total amount of fines and damages when the cartel is detected and the third part is what occurs in the future: firms compete forever or maintain the same expected value. After some manipulation and considering $\pi_N = 0$ we have:

$$V_C(p) = \pi_C(p)\frac{(1-\alpha f-\alpha\beta d_{NL})}{(1-\delta+\delta\alpha)} \quad (2)$$

We assume $1 - \alpha f - \alpha\beta d_{NL} \geq 0$, therefore $V_C(p) \geq 0$. Also, $V_C(p)$ is strictly increasing in $p \in (p_N, p_M]$ due the fact that $\pi_C(p)$ is strictly increasing in $p \in (p_N, p_M]$. Next, we define the expected value of unilateral "report":

$$V_R(p) = \pi_D(p) - 0 - \beta d_L\pi_D(p) + \delta\frac{\pi_N}{1-\delta} \quad (3)$$

[13] Note that we are analyzing the cartel behavior regarding one specific stationary SPE: collude and respect the collusive agreement. The pay-off when both "report" plays no role here (it will be important later in the model extension "bankruptcy").

The first part is the profit of unilateral deviation, the second part is the immunity from fines guaranteed by the Brazilian Leniency Program when the AA is unaware about the infringement, the third part is the amount of damages to be paid and the last one is the competitive outcome forever. Again, we assume $1 - \beta d_L \geq 0$, therefore $V_R(p) \geq 0$ and strictly increasing in $p \in (p_N, p_M]$ due $\pi_D(p)$ strictly increasing in $p \in (p_N, p_M]$.

The incentive compatibility constraint (ICC) is given by $V_C(p) \geq V_R(p)$. This condition states "collude" as a SPE and sets the maximal collusive price when the equality holds [14]. Considering $\pi_N = 0$, the ICC be expressed as:

$$\frac{\pi_C(p)}{\pi_D(p)} \geq \frac{(1-\delta+\delta\alpha)(1-\beta d_L)}{(1-\alpha f-\alpha\beta d_{NL})} \quad (4)$$

As in Houba, Motchenkova and Wen (2015), the term $\pi_C(p)/\pi_D(p)$ is the relative gain of collusion in comparison to the gain of unilateral deviation[15]. We assume that an increase in p increases the profit of unilateral deviation at a higher rate than the collusive profit, thus the fraction is strictly decreasing in p. The right-hand side of (4) is denoted by ω and the following proposition formalizes the first result:

[14] This is the same as considering a firm's maximization problem of p on the form of: $Max\, p \in (p_N, p_M]\ subject\ to\ (4)$.

[15] For completely homogeneous goods the profit of deviation would be twice the collusive profit, so this fraction becomes constant. For this case, the model would keep working in the same way by setting α and f as functions of p, turning the right-hand side of (4) an increasing function of p, as in Houba, Motchenkova and Wen (2015).

Proposition 1*: Assuming* $\pi_C(p)/\pi_D(p)$ *strictly decreasing in* $p \in (p_N, p_M]$*, either the price is* p_N *or there exists a maximal collusive price* $p \in (p_N, p_M]$ *satisfying* $V_C(p) \geq V_R(p)$.

Proof: Consider that $\pi_C(p)/\pi_D(p)$ is left-bounded by $\pi_C(p_N)/\pi_D(p_N)$, while ω is exogenous. We have three possible cases:

1) If $\pi_C(p_N)/\pi_D(p_N) \leq \omega$, the price is p_N and $V_R(p) > V_C(p) \ \forall \ p \in (p_N, p_M]$ (total deterrence);

2) If $\pi_C(p_M)/\pi_D(p_M) \leq \omega < \pi_C(p_N)/\pi_D(p_N)$, there is an interior solution constraining the collusive price, such that $V_C(p) = V_R(p)$ for some $p \in (p_N, p_M]$, say p_I (partial deterrence if $p_I < p_M$ and no deterrence if $p_I = p_M$);

3) If $\pi_C(p_M)/\pi_D(p_M) > \omega \ \forall \ p \in (p_N, p_M]$, the maximum collusive price is p_M and $V_C(p) > V_R(p) \ \forall \ p \in (p_N, p_M]$ (no deterrence). □

The first case of the proof above represents a combination of a small δ, a big α and high values of f and βd_{NL}. The third one is the opposite: firms are patient (high δ), the independent investigation is small (low α) and f and βd_{NL} are also small. We are more interested in the second case (intermediate cases), that is, when the combination of parameters that compose ω provides an interior solution. This is the most realistic framework: firms have incentives to collude and set $p_I > p_N$, but they are not able to act freely and the ICC binds the endogenous decision such that $p_I \leq p_M$.

Now we analyze the AA activity. Assuming the cartel will form anyway when $p = p_I \in (p_N, p_M]$, the objective is to decrease the maximum collusive price as much as possible. The closer is p_I to p_N the lower is the profit and the deadweight loss (and higher

is the consumer surplus). From a simple comparative statics analysis, it is clear from (4) that an increase in α strengthens the ICC (as shown in the appendix), thus it is optimal to increase the AA independent investigation as much as possible. With respect to the AA enforcement for damage claims the situation is the following: ω is either decreasing or increasing in β depending on the parameters (as shown in the appendix). This is because when the leniency applicant is liable for damages we have an adverse effect: while an increase in β reduces $V_C(p)$ by the term $(\alpha\beta d_{NL})/(1-\delta+\delta\alpha)$, it also decreases $V_R(p)$ by the term βd_L, thus the consequences might be both in the sense of discouraging the report and in the sense of reducing the gains of collusion. The following proposition states the optimal antitrust policy regarding the damage liability:

Proposition 2*: From the AA perspective of decreasing the maximum collusive price, it is optimal to set* $d_L = 0$. *After that, the impact of* β *in reducing the maximum collusive price is maximized.*

Proof: The ICC is strengthened when $d_L = 0$. It shifts ω upward in (4) up to $\omega_* = [1-\delta+\delta\alpha]/[1-\alpha f-\alpha\beta d_{NL}]$ and decreases the maximum collusive price to some $p_* \in (p_N, p_M]$, such that $p_* < p_I$. Any other policy that reduces the damage liability for the leniency applicant but does not provide immunity is sub-optimal, since the maximum collusive price obtained lies between p_* and p_I. At the same time, the comparative statics in the appendix shows that a decrease in d_L turns the impact of β on ω more positive/less negative. The maximal positive impact of β on ω is obtained when $d_L = 0$. It occurs because with any other policy that reduces the damage liability for the leniency applicant, but does not provide immunity, the adverse effect of discouraging the report remains. □

Lastly, the AA policies of setting $d_L = 0$ and increasing β maintains "collude" as a SPE for all $p \in (p_N, p_M]$. Consider the maximum collusive prices p_* and p_I defined previously. Furthermore, denote the value of unilateral "report" after the immunity as $V_{R*}(p) = \pi_D(p)$. In the absent of the immunity, the maximum collusive price is set when $V_C(p_I) = V_R(p_I)$, but since $V_{R*}(p) > V_R(p) \ \forall \ p \in (p_N, p_M]$ we have $V_C(p_I) < V_{R*}(p_I)$, thus this policy strengthens the ICC up to $V_C(p_*) = V_{R*}(p_*)$, "collude" remains a SPE and since $p_* < p_I$ the amount of damage is lower and the consumer surplus is higher than before[16]. The same occurs with an increase in β after $d_L = 0$: it will reduce $V_C(p)$, generating a new ICC equilibrium and a new maximum collusive price strictly lower than before[17].

4. Further extensions

4.1. The risk of betrayal affecting the maximum collusive price

We are considering the sustainability of the stationary SPE in which firms collude and respect the collusive agreement in every period ("collude"). Before, the ICC was set by comparing the expected value of "collude" to the expected value of unilateral "report", which determines the maximum collusive price and turns "collude" into a SPE. Nevertheless, as pointed out by Spagnolo (2005) and Buccirossi, Marvão and Spagnolo

[16] If $p_* = p_N$, this policy results in complete cartel deterrence.

[17] Another policy that strengthens the ICC is increasing d_{NL}, that is, to incentive the damage claims from non-applicant, as the treble damages in USA and the propose of double damages of Brazilian Senate legislative bill Nº 283/2016. In terms of deterrence it is optimal to enhance d_{NL}, but it may lead to a problem that is discussed later at the model extensions: bankruptcy.

(2015), the risk of betrayal is an important channel of deterrence. It is related to the uncertainty on the other player's decision, that is, no firm is sure about the other's decision, resulting in each firm assigning a probability for each action of the other member and comparing the expected pay-off when playing "collude" to the expected pay-off when playing "report".

Following Spagnolo (2005) and Buccirossi, Marvão and Spagnolo (2015), to consider the fear of betrayal we apply an important concept developed by Harsanyi and Selten (1988): the equilibrium selection criterion of *risk dominance*[18]. It points at the less risky equilibrium, that is, when the consequences of the opponent not playing the equilibrium strategy are less negative. The interest is on the scenario that turns "collude" into a SPE in the presence of the risk of betrayal. The stage game[19] is represented in Table 1:

Table 1. The payoff matrix of the infinitely repeated game

	C	R

[18] Harsanyi and Selten (1988) argue that in games with multiple equilibria it is possible to use an equilibrium selection criterion to define which one is most likely. Besides the *risk dominance*, they also propose the *pay-off dominance*, in which the idea is that an equilibrium that provides higher pay-offs for all players dominates the others. We neglect this one because it would not bring any new element to the paper, we would only check if $V_C(p)$ dominates $V_{BR}(p)$ and how this dominance is affected by the damage liability of the leniency applicant. On the opposite, the *risk dominance* is theoretically important, and the paper is benefited from relevant insights when considered.

[19] If (R, R) is the unique Nash equilibrium of the one-shot game, it becomes a prisoner's dilemma. If (C, C) is also a Nash equilibrium, which is our main interest, the one-shot game presents two Nash equilibria.

	C	R
C	$V_C(p), V_C(p)$	$V_{OR}(p), V_R(p)$
R	$V_R(p), V_{OR}(p)$	$V_{BR}(p), V_{BR}(p)$

In which $V_C(p)$ and $V_R(p)$ were already defined, while $V_{OR}(p)$ and $V_{BR}(p)$ are the expected values when the other "report" and when both "report", respectively. We state the following:

$$V_{OR}(p) = \pi_{OD}(p) - f\pi_{OD}(p) - \beta d_{NL}\pi_{OD}(p) + \delta\frac{\pi_N}{1-\delta} \quad (5)$$

$$V_{BR}(p) = \pi_{BD}(p) - \frac{1}{2}[0 + \beta d_L\pi_{BD}(p)] - \frac{1}{2}[f\pi_{BD}(p) + \beta d_{NL}\pi_{BD}(p)] + \delta\frac{\pi_N}{1-\delta} \quad (6)$$

In (5), the firm is betrayed by the other deviating from the maximum collusive price[20], obtains the profit $\pi_{OD}(p)$ (other deviates) and pays the fine and damage with sure (we consider d_{NL} because the firm is not the leniency applicant, the other is). In (6), the term $\pi_{BD}(p)$ is the profit obtained when both deviate from the maximum collusive price, and since only the first one to report is able for leniency, we consider it a random event. When both "report" each one has a probability of ½ of being immune from fines (first brackets) and a probability of ½ of paying the whole fine (second brackets). We state $\pi_{BD}(p)$ and $\pi_{OD}(p)$ strictly increasing in $p \in (p_N, p_M]$ and $\pi_D(p) > \pi_C(p) > \pi_{BD}(p) > \pi_{OD}(p)$.

[20] Remember that the firm automatically applies for leniency when deviating.

We follow the procedure developed by Harsanyi and Selten (1988)[21]. The matrix in Table 1 is transformed into an equivalent one that represents the net gains of each equilibrium. This matrix can be expressed as in Table 2 below:

Table 2. The equivalent matrix of the infinitely repeated game

	C	R
C	$V_C(p) - V_R(p), V_C(p) - V_R(p)$	0,0
R	0,0	$V_{BR}(p) - V_{OR}(p), V_{BR}(p) - V_{OR}(p)$

Note that an increase in $V_R(\cdot)$ reduces the gains of "collude", making it less attractive. At the same time, a decrease in $V_{OR}(\cdot)$ makes "report" more attractive for both. It is possible to measure this relative risk by the *riskiness index* (γ), defined by:

$$\gamma(p) = [V_{BR}(p) - V_{OR}(p)]^2 - [V_C(p) - V_R(p)]^2 \quad (7)$$

When $\gamma(p) < 0$ we say that "report" is risk dominated by "collude", while $\gamma(p) > 0$ means the opposite and $\gamma(p) = 0$ represents the equivalence. Comparing to the Proposition 1, if $\gamma(p) < 0 \ \forall \ p \in (p_N, p_M]$ there is no deterrence, while if $\gamma(p) > 0 \ \forall \ p \in (p_N, p_M]$ there is total deterrence. As we are interested in the scenario that (C, C) is a SPE, only the case when $\gamma(p) \leq 0$ matters, that is, an interior solution given by the equality is the new ICC is the interest here. The new ICC can be expressed by:

[21] Check Harsanyi and Selten (1988) and Buccirossi, Marvão and Spagnolo (2015) for further details.

$$V_C(p) - V_R(p) \geq V_{BR}(p) - V_{OR}(p) \quad (8)$$

Replacing (2), (3), (5) and (6) in (8), considering $\pi_N = 0$ and after some manipulation we reach the new ICC that ensures (C, C) a SPE and sets the maximum collusive price:

$$\frac{\pi_C(p)}{\pi_D(p)} \geq \frac{(1-\delta+\delta\alpha)}{(1-\alpha f-\alpha\beta d_{NL})}\left\{(1-\beta d_L) + \frac{\pi_{BD}(p)}{\pi_D(p)}\left[1-\frac{f}{2}-\frac{\beta(d_L+d_{NL})}{2}\right] - \frac{\pi_{OD}(p)}{\pi_D(p)}(1-f-\beta d_{NL})\right\} \quad (9)$$

We denote the right-hand side of (9) as $\omega^{risk}(p)$. Maintaining the same assumptions of *Proposition 1*, this new ICC is more restrictive than (4) when:

$$\frac{\pi_{BD}(p)}{\pi_D(p)}\left[1-\frac{f}{2}-\frac{\beta(d_L+d_{NL})}{2}\right] > \frac{\pi_{OD}(p)}{\pi_D(p)}(1-f-\beta d_{NL}) \;\forall\; p \in (p_N, p_M] \quad (10)$$

This is true because $\pi_{BD}(p) > \pi_{OD}(p) \;\forall\; p \in (p_N, p_M]$ and $[1 - f/2 - \beta(d_L + d_{NL})/2] > (1 - f - \beta d_{NL})$. Therefore, the maximum collusive price obtained in (9) is strictly smaller than p_I in (4), which would be expected because the risk of betrayal reduces the gains of collusion and restrict any collusive equilibrium. We denote this new maximum collusive price as p^{risk}.

Now we focus on the immunity from damage claims. Note that it generates $V_{R*}(p) = \pi_D(p)$ as defined previously, but it also changes $V_{OR}(p)$ and $V_{BR}(p)$ because the betrayed firm is liable for the entire cartel damage (his own and the other's). We denote these new values as:

$$V_{OR*}(p) = \pi_{OD}(p) - f\pi_{OD}(p) - \beta d_{NL}\pi_{OD}(p) - \beta d_{NL}\pi_D(p) + \delta\frac{\pi_N}{1-\delta} \quad (11)$$

$$V_{BR*}(p) = \pi_{BD}(p) - \frac{1}{2}[f\pi_{BD}(p) + \beta d_{NL}\pi_{BD}(p) + \beta d_{NL}\pi_{BD}(p)] + \delta\frac{\pi_N}{1-\delta} \quad (12)$$

The ICC after the immunity is $V_C(p) - V_{R*}(p) \geq V_{BR*}(p) - V_{OR*}(p)$, which gives us the following:

$$\frac{\pi_C(p)}{\pi_D(p)} \geq \frac{(1-\delta+\delta\alpha)}{(1-\alpha f-\alpha\beta d_{NL})}\left[(1+\beta d_{NL}) + \frac{\pi_{BD}(p)}{\pi_D(p)}\left(1-\frac{f}{2}-\beta d_{NL}\right) - \frac{\pi_{OD}(p)}{\pi_D(p)}(1-f-\beta d_{NL})\right] \quad (13)$$

Note that the immunity strengthens the ICC at a higher degree than without considering the risk of betrayal. The right-hand side of (4) was already denoted by ω, now consider that the immunity shifts ω upwards up to $\omega_* = [1-\delta+\delta\alpha]/[1-\alpha f-\alpha\beta d_{NL}]$ in (4). At the same time, the immunity shifts $\omega^{risk}(p)$ in (9) up to $\omega_*^{risk}(p)$, the right-hand side of (13). We can state the following:

$$\omega_* - \omega = \beta d_L \frac{(1-\delta+\delta\alpha)}{(1-\alpha f-\alpha\beta d_{NL})} \quad (14)$$

$$\omega_*^{risk}(p) - \omega^{risk}(p) = \left\{\beta d_{NL}\left[1-\frac{\pi_{BD}(p)}{2\pi_D(p)}\right] + \beta d_L\left[1+\frac{\pi_{BD}(p)}{2\pi_D(p)}\right]\right\}\frac{(1-\delta+\delta\alpha)}{(1-\alpha f-\alpha\beta d_{NL})} \quad (15)$$

Since $0 < \pi_{BD}(p)/2\pi_D(p) < 1 \; \forall \; p \in [p_N, p_M]$ due to $\pi_{BD}(p) < \pi_D(p) \forall \; p \in [p_N, p_M]$, the right-hand side in (15) is strictly higher than the right-hand side in (14). It occurs because besides increasing $V_R(p)$ up to $V_{R*}(p)$ by pulling out $\beta d_L \pi_D(p)$, the immunity also decreases $V_{OR}(p)$ up to $V_{OR*}(p)$ by adding $\beta d_{NL}\pi_D(p)$ to the penalty. Denoting this new price as p_*^{risk}, we see that $p_*^{risk} < p_*$ because $\omega_*^{risk}(p) > \omega_* \; \forall \; p \in (p_N, p_M]$, thus it is possible to conclude that the immunity from damage claims for the leniency applicant

is even more effective in reducing the maximum collusive price when the risk of betrayal is considered.

4.2.Ex-post leniency

We have been assuming that firms decide between "collude" and "report" before any investigation, that is, the AA is unaware about the cartel activity and starts to investigate/prosecute only after their decision. It is possible to call this case as *ex-ante* leniency. However, in many cases firms choose their actions when the AA is already investigating the cartel, which can possibly change the collusive SPE. This situation is denoted by Houba, Motchenkova and Wen (2015) as *ex-post* leniency.

As mentioned in the introduction, an important difference here is that when the AA knows about the cartel activity the leniency applicant can only obtain partial amnesty, from one-third up to two-thirds of the estimated fine (stated by the Brazilian's Law 12,529/2011). We denote the amount of fine that the applicant is liable by $\vartheta\pi_D(p)$, such that $\vartheta \in (0, f)$, that is, the applicant is never granted full immunity ($\vartheta > 0$), but he always receives partial amnesty ($\vartheta < f$).

In the main model, we stated α as the probability of independent investigation and prosecution by the AA. It is possible to think of it as two distinct activities: the AA may launch an investigation on the market and may detect the cartel with probability $\rho \in (0,1)$; then, after the cartel detection, the AA may successfully prosecute it with a probability $\mu \in (0,1)$. As both are probabilities (restricted between zero and one) we have $\rho > \alpha$ and $\mu > \alpha$. Before, we were considering both launched together (α), but now the timing of the game is the following:

1) Firms agree on the maximum collusive price $p \in (p_N, p_M]$ simultaneously;

2) The AA launches the investigation on the market and detects the cartel with probability ρ;

3) Each firm chooses between "collude" and "report" and realizes the profits.

4) When both "collude":

i) If detected, the AA successfully prosecutes the cartel with probability μ, each firm pays the fines and damages, the game ends for that period and they compete from now on.

ii) If detected but not successfully prosecuted no one is penalized, the game ends for that period and both play the same game in the next period.

iii) If not detected, each one earns the collusive profit and both play the same game in the next period.

With respect to the unilateral "report":

i) Like in Motta and Polo (2003), we assume that it occurs only when the cartel is detected. In this case, the applicant pays the reduced fine and the amount of damage (different liability rules are proposed later), the game ends for that period and firms compete forever.

ii) If the cartel is not detected, the deviating firm earns the profit of unilateral deviation, the game ends for that period and both compete from now on.

Now we define the values of "collude" and "report"[22] under *ex-post leniency*, respectively (already considering $\pi_N = 0$):

$$V_C^{ex-post}(p) = \rho\{\pi_C(p) - \mu[f\pi_C(p) + \beta d_{NL}\pi_C(p)] + [1 - \mu]\delta V_C^{ex-post}(p)\} + (1-\rho)[\pi_C(p) + \delta V_C^{ex-post}(p)] \quad (16)$$

$$V_R^{ex-post}(p) = \rho[\pi_D(p) - \vartheta\pi_D(p) - \beta d_L\pi_D(p)] + (1-\rho)\pi_D(p) \quad (17)$$

We assume $V_C^{ex-post}(p) \geq 0 \ \in \forall\, p \in (p_N, p_M]$ and $V_R^{ex-post}(p) \geq 0 \ \in \forall\, p \in (p_N, p_M]$. The new maximum collusive price is set by $V_C^{ex-post}(p) \geq V_R^{ex-post}(p)$, therefore:

$$\frac{\pi_C(p)}{\pi_D(p)} \geq \frac{(1-\delta+\rho\delta\mu)(1-\rho\vartheta-\rho\beta d_L)}{(1-\rho\mu f-\rho\mu\beta d_{NL})} \quad (18)$$

Denote the right-hand side of (18) as $\omega^{ex-post}$ and the new maximum collusive price as $p^{ex-post}$. An increase in μ enhances $\omega^{ex-post}$, thus it is optimal to increase the capacity of prosecution as much as possible, but the same problem of increasing β without immunity in the main model occurs with ρ now: an increase in ρ reduces $V_C^{ex-post}(p)$ by the term $(\rho\mu f - \rho\mu\beta d_{NL})/(1-\delta+\delta\alpha)$, but it also decreases $V_R^{ex-post}(p)$ by the term $(\rho\vartheta - \rho\beta d_L)$, thus besides the impact of reducing the gain from collusion it also discourages the report. The fact is that setting $d_L = 0$ is the optimal policy in this framework as well: it shifts $\omega^{ex-post}$ upward up to $\omega_*^{ex-post} = (1-\delta+\rho\delta\mu)(1-\rho\vartheta)/(1-\rho\mu f-\rho\mu\beta d_{NL})$ and removes the adverse effect of ρ in

[22] As in the main model, we assume is always optimal to report when deviating.

$V_R^{ex-post}(p)$ regarding the damages. Consequently, the maximum collusive price is decreased from $p^{ex-post}$ to $p_*^{ex-post}$.

Finally, what about the relation between the maximum collusive prices in *ex-ante* and *ex-post* frameworks? The fact of existing ϑ (the leniency applicant receives partial amnesty and not full immunity) means that the adverse effect of ρ with respect to ϑ remains after $d_L = 0$. Since $\omega_* = (1 - \delta + \delta\alpha)/(1 - \alpha f - \alpha\beta d_{NL})$ and $\omega_*^{ex-post} = (1 - \delta + \rho\delta\mu)(1 - \rho\vartheta)/(1 - \rho\mu f - \rho\mu\beta d_{NL})$, there are three possible cases:

1) If $\alpha = \rho\mu$, we have $\omega_*^{ex-post} \leq \omega_*$, or $1 \leq 1/(1 - \rho\vartheta)$. In case of full immunity for ex-post leniency ($\vartheta = 0$) the effect on the maximum collusive price would be the same, but due Brazilian Leniency Program rules the ex-ante leniency is strictly more restrictive in this case ($\omega_*^{ex-post} < \omega_*$)[23].

2) If $\alpha > \rho\mu$, the value of ω_* would be even greater than $\omega_*^{ex-post}$, thus the maximal collusive price is even more restricted in case of ex-ante leniency in comparison to ex-post leniency. In other words, if the probability of punishing the cartel by setting the investigation and prosecution simultaneously is higher than the product of probabilities of investigating first and then prosecuting, the maximum collusive price is more restricted by *ex-ante* leniency (even if $\vartheta = 0$)[24].

[23] This is the case where ρ and μ are the same in ex-ante and ex-post leniency (and $\alpha = \rho\mu$), or ρ and μ are distinct but their product is the same. This is the case, for example, for a fixed budget constraint for the AA and cartel members indifferent from being investigated or not

[24] For a realistic example of $\alpha > \rho\mu$, suppose that the AA starts to investigate the cartel with probability ρ, but after knowing this fact cartel members start to destroy evidence of the infringement. It would reduce the probability of successful prosecution, therefore $\alpha > \rho\mu$.

3) If $\alpha < \rho\mu$, the relation between ω_* and $\omega_*^{ex-post}$ will depend on α, $\rho\mu$ and ϑ. If $\rho\mu$ is higher enough to compensate ϑ it is possible for the ex-post leniency to be more restrictive than ex-ante leniency[25].

This analysis is related to Emons (2020), where the author finds that post-investigation leniency provides better deterrence than pre-investigation leniency if firms are sufficiently impatient. In our case, for a constant discount factor, this comparison depends on α, $\rho\mu$ and ϑ. Despite the three cases above, the main result in this subsection is that $d_L = 0$ is also the optimal policy for ex-post leniency.

4.3.Bankruptcy

In the previous sections, we assumed that when one firm applies for leniency (and receives immunity from damages) the other one can afford the total amount of damages claimed. Depending on the fine set by the AA, plus the damage payment, perhaps the betrayed firm is unable to pay this entire amount and goes bankrupt, resulting in a market concentration for the future periods.

We assume the bankruptcy only occurs when one firm chooses "report", that is, if the cartel is discovered by independent investigation both firms can afford the damages. Thereafter, the expected value of "collude" is the same as (1). Now we define the new expected value for the one who "report". After the bankruptcy, the leniency applicant

[25] Suppose that the fact of first investigating and then prosecuting optimizes the antitrust enforcement, thus for the same budget constraint we have higher probabilities for both if compared to the case where both happen simultaneously. This is a example of $\alpha < \rho\mu$.

becomes a monopolist and is able to set p_M from thereon. The expected value of "report" becomes:

$$V_R^B(p) = \pi_D(p) + \delta \frac{\pi(p_M)}{1-\delta} \tag{19}$$

In which $\pi(p_M)$ is the monopolist profit at the monopoly price. Note that $V_R^B(p) > V_R(p) \; \forall \; p \in (p_N, p_M]$, thus the ICC is strengthened with the bankruptcy and, by consequence, the new maximum collusive price p_B is strictly lower than p_I.

Apparently, the immunity for the recipient is even more effective in a bankruptcy scenario. However, there are two points we need to address. The first one is that if the AA commits to the immunity and to a high enforcement of damage claims, the betrayed firm may goes bankrupt and maybe some plaintiffs will not be able to receive the refund (once it cannot be charged from the recipient). We consider that the proven claim is a right of the plaintiff set by the civil justice, thus someone needs to pay for it, even more in jurisdictions where each firm is jointly and severally liable for the entire cartel damage (as Brazil). Secondly, it is hard to believe that the AA will be directly responsible for bankruptcy and market concentration (except for authorized mergers) [26]. Since d_L and β are *ex-ante* policies, if the betrayed firm informs and proves that $d_L = 0$ will lead them to bankruptcy, the AA will be directly responsible for this. Thereby, we determine a new expected value of "report":

[26] The fines defined by the law have a preventive and punitive purpose. The Brazilian's Antitrust Law 12,529/2011 defines the economic situation of the offender as a criterium for the fine, precisely to not be responsible for bankruptcy and market concentration.

$$V_{R*}^{B}(p) = \pi_D(p) - \beta d_L^B \pi_D(p) + \delta \frac{\pi_N}{1-\delta} \quad (20)$$

The term d_L^B represents the AA policy regarding the damage liability for the leniency applicant with the risk of bankruptcy. From this perspective, the optimal d_L^B should be zero in the case of no bankruptcy or the minimum necessary to avoid bankruptcy otherwise. In other words, to guarantee the refund for those who claimed, it may be is necessary to charge a certain amount from the leniency applicant. It may weak the ICC up to a maximum collusive price higher than p_B, but is necessary to guarantee the right of refund and the integrity of firms.

This point was considered in Buccirossi, Marvão and Spagnolo (2015). They argue that the immunity is optimal even in case of bankruptcy in terms of deterrence[27]. We agree with that, but considering the plaintiff's right to restitution and the possibility of market concentration, we argue that the policy in Brazil should be: immunity for the leniency applicant and maximum enforcement of damages as a rule; the recipient will be

[27] They ICC results in a "minimum discount factor" that sustains the cartel, that is, there is a population of collusive agreements with discount factors uniformly distributed in the interval $(\frac{1}{2}, 1)$, while the ones below this "minimum discount factor" cannot sustain the agreement. The immunity from damage claims increases the "minimum discount factor", consequently a group of cartels that would form in the absence of this policy will not form anymore. In case of bankruptcy there is a trade-off: if the AA commits to the immunity for the leniency applicant and the other is charged for the entire amount of damage and goes bankruptcy, some plaintiffs will not be refunded; if the leniency applicant is charged for the minimum necessary to avoid the bankruptcy, the ICC is weakened. The authors affirm that the immunity is optimal even in this case, since increasing the "minimum discount factor" will prevent the cartel formation, which tends to be better than leaving some plaintiffs without refund.

liable only if the amount of damages cannot be charged from the others due bankruptcy[28]. As informed by Cauffman (2011) and Buccirossi, Marvão and Spagnolo (2015), these policies recommendations are close to the Hungary framework, in which the leniency applicant is only required to pay damages if the plaintiff cannot obtain compensation from other cartelists.

4.4. Criminalization

An important feature of the Brazilian competition law is that individuals participating in a collusive agreement can also be convicted in the criminal sphere, that is, a collusive behavior is an illicit under the administrative law[29] (under CADE jurisdiction), under the criminal law[30] (under criminal justice jurisdiction) and are subjected to damage claims by private and public agents[31] (under civil justice jurisdiction). It is presumable that the fear of criminal sanctions reduces the incentives to collude, but it also decreases the incentives to apply for leniency in case of no protection. For this reason, as informed by CADE (2016b), the Brazilian Leniency Program guarantee the suspension of the limitation periods and prevents the criminal prosecution of the leniency recipient (individuals) with respect to the antitrust offenses set forth in the Economic Crimes Act (Law nº 8.137/1990), and other crimes directly related cartel

[28] One would think that the AA could increase the enforcement of damage claims (increase β), but in the case of bankruptcy they could reduce this enforcement to guarantee the immunity for the leniency applicant (maybe denying proofs and information). Nevertheless, we assume β as an *ex-ante* and general policy, therefore it cannot change according to the circumstances.

[29] Article 36, paragraph 3, I, of Law nº 12.529/2011.

[30] Article 4, II, of Law nº 8.137/1990.

[31] Article 47 of Law nº 12.529/2011.

activity. To sum up, there is criminal immunity for individuals involved at the leniency application[32].

From now on in this subsection we check if criminal immunity is in fact the best policy in terms of cartel deterrence. Suppose that the possibility of criminal sanction for who chooses "collude" is represented by the term θC_{NL}, such that θ is the probability of being criminally convicted and C_{NL} is the size of the criminal penalty for non-leniency applicants[33]. For the leniency applicant the term is θC_L, where C_L is the same as before but for the one who report.

Based on (1) and (3), the new expected values of "collude" and "report" are the following:

$$V_C^{Crime}(p) = \pi_C(p) - \alpha[f\pi_C(p) + \beta d_{NL}\pi_C(p) + \theta C_{NL}\,] + \delta\left[\alpha\frac{\pi_N}{1-\delta} + (1-\ \alpha)V_C(p)\right] \quad (21)$$

$$V_R^{Crime}(p) = \pi_D(p) - 0 - \beta d_L\pi_D(p) - \theta C_L\ + \delta\frac{\pi_N}{1-\delta} \quad (22)$$

Note the additional terms above: in (21), when the cartel is discovered and punished by the AA with probability α, it may also be punished criminally by the term θC_{NL}; in (22), if the firm deviates and applies for leniency, it will be exposed for criminal

[32] In Brazil, according to CADE (2016b), if the leniency applicant is a company, the benefits of the agreement can be extended to its current and former directors, managers, and employees, as well as to companies of the same economic group, involved in the violation, as long as they cooperate with the investigations and sign the instrument together with the company. If the leniency applicant is an individual and the agreement is signed without the participation of the legal entity, the benefits will not be extended to the company with which the individual is or was associated.

[33] The penalty defined by article 4 of Law nº 8.137/1990 is from two up to five years of imprisonment, plus fines. Simply speaking, this parameter represents the costs of imprisonment (explicit and opportunity costs), costs related to a criminal defense, the fine set by the court, among other possible costs.

sanctions by the term θC_L. Considering the new ICC of $V_C^{Crime}(p) \geq V_R^{Crime}(p)$, providing criminal immunity to the leniency applicant ($C_L = 0$) is clearly the optimal policy in terms of strengthening the ICC and restricting the maximum collusive price. Furthermore, now we have the same situation as the AA enforcement for damage claims (β) analyzed in the main model, i.e., setting $C_L = 0$ removes the effect of criminal punishment on the incentives to report, which means that θ can be incentivized with no undesirable effects. In other words, if the recipient is protected from criminal sanctions, increasing the probability θ and the level of punishment C_{NL} by courts only results in desirable effects.

4.5. International cooperation

A recent discussion is the international cooperation among AAs in fighting cartels. International cartels tend to be highly harmful, since they demand a rigorous structure of working and monitoring and operate in a wide geographic area. According to Connor (2016), around 1300 international cartels were discovered worldwide in the period of 1990-2016, being responsible for more than $50 trillion in nominal affected sales. Many of these cases were punished in Brazil, as the lysine cartel, the vitamins cartel and the recent Optical Disk Drives cartel, which included a leniency agreement.

It is presumable that a synergy among distinct AAs improves the deterrence of cartels. Choi and Gerlach (2012a) shows that when local markets are linked by demand due to international trade and arbitrage constraints, antitrust prosecution in one jurisdiction can reduce internal cartel stability and lead to the demise of the cartel in the adjacent market. Regarding the information sharing of leniency agreements, Choi and

Gerlach (2012b) finds the conditions for which it improves or decreases the effectiveness of leniency policies.

We focus on the international cooperation regarding the incentives to report the collusive agreement in more than one jurisdiction. Suppose the cartel operates in k countries with leniency programs similar to Brazil, that is, immunity for the first applicant and the possibility of amnesty regarding damage liability. Based on expression (2), the expected value of "collude" in all jurisdiction is the following:

$$\sum_{i=1}^{k} V_{C_i}(p_i) = \sum_{i=1}^{k} \left[\pi_{C_i}(p_i) \frac{\left(1-\alpha_i f_i - \alpha_i \beta_i d_{NL_i}\right)}{(1-\delta_i+\delta_i \alpha_i)} \right] \tag{23}$$

Observe that the model parameters and variables are not necessary the same among countries.

It was assumed in the main model that it is optimal to apply for leniency (report) when deviating from the maximum collusive price, and this is exactly what generates the action "report". A relevant argument is that a deviation from the agreement may destabilize the market and more suspicion is created, which may increase the probability of detection and prosecution by the AA. A similar assumption is made here: if the cartel is reported in one country, it is optimal to report in all of them. If the cartel is international and a member decides to sign an agreement in one jurisdiction, it will probably call the attention of the other AAs, which reduces the expected value of "collude" by increasing drastically the probabilities of detection and prosecution. As a result, it is better to report.

The expected value of report in all jurisdictions is the following:

$$\sum_{i=1}^{k} V_{R_i}(p_i) = \sum_{i=1}^{k} \left[\pi_{D_i}(p_i) - 0 - \beta_i d_{L_i} \pi_{D_i}\left(p_i\right) + \delta_i \frac{\pi_{N_i}}{1-\delta_i} \right] \tag{24}$$

Normalizing $\pi_{N_i} = 0$, the ICC for a sustainable international agreement is given by $\sum_{i=1}^{k} V_{C_i}(p_i) \geq \sum_{i=1}^{k} V_{R_i}(p_i)$. Now the ICC constrains the group of maximum collusive prices in all countries, that is, we can not say the exact price values and what will happen in each country if the ICC is strengthened, but we know how the restriction affects the sum of expected values.

Focusing on the damage liability, note that if a specific country i provides immunity for the leniency applicant ($d_{L_i} = 0$) the right-hand side will be decreased, which strengthens the ICC. The difference is that now the effect is on the group of countries, thus it is possible for the cartel to reduce the maximum collusive price in the same country i, in another country or any other possible combination, as long as the ICC is respected. In other words, the immunity may not have any effect on the maximum collusive price of the country where the policy was originated. From the moment that other jurisdictions provide immunity the ICC is even more constrained, and if all countries k take this decision the decrease of maximum collusive prices is guaranteed everywhere.

To sum up, the optimal policy in terms of deterrence is a combination of immunity regarding damage liability in all jurisdictions. Single immunities help to constrain the international cartel activity, but there is no certainty of reduction of the maximum collusive price in the respective country, which is a not a desirable effect.

5. Conclusions

The interplay between private and public antitrust enforcement is an important issue nowadays. Regarding the leniency policies there are two main points to discuss: the damage liability for the leniency applicant; the AA enforcement for damage claims. The

situation in Brazil is not different and these topics are calling the attention of researchers, policy makers, economists, lawyers, and people from law and economics in general.

The main objective of this paper was to analyze the best policy for leniency applicants related to the damage liability in Brazil. We considered that cartel members can set a maximum collusive price and adapt themselves according to distinct policies and situations. In the main model, we concluded that, in terms of deterrence, it is optimal to grant immunity to the leniency applicant, as well as increase as much as possible the AA enforcement of damage claims. The extensions confirmed the following: the immunity is even more effective when there is risk of betrayal; the immunity is the best policy in the case of *ex-post* leniency; the immunity is the optimal policy when there is no bankruptcy, otherwise the applicant liability should be the minimum necessary to avoid the bankruptcy and to guarantee the refund to plaintiffs; in case of criminalization, immunity regarding criminal sanctions is the optimal policy; the optimal policy for international cartels is a combination of immunity regarding damage liability in all jurisdictions.

The trend in Brazil is the encourage of damage claim lawsuits, including the Brazilian Senate legislative bill Nº 283/2016 that proposes double refund for harmed parties and limited liability for leniency applicants (direct purchasers, single and not jointly and severally liable). However, we showed that stimulating the damage claims without providing immunity for the recipient is not optimal in terms of deterrence, as it reduces the incentives to report. Based on extensions, it is possible to obtain the following conclusions for CADE: providing immunity instead of partial amnesty would help to improve deterrence in ex-post leniency; immunity from criminal sanctions is in fact optimal; international cooperation in providing leniency to international cartel members is desirable.

Despite that the model has been developed based on the Brazilian structure of antitrust law, the results may be helpful to other jurisdictions as well. The private enforcement of damage claims is a powerful channel of deterrence, but in a context of leniency it may discourage the applicant if there is a fear of being sued for damages. The leniency applicant should to be protected from that, and maybe the partial liability as in US is not the best policy. Our approach is closer to the one adopted in Hungary.

In the model, we assumed that profits, fines and damages do not accumulate over time. It means that in each period there is a new independent value for these terms, so the firm is liable only for the damage done in the current period. It is possible to consider the cartel behavior in a dynamic context. We leave this suggestion for future works.

APPENDIX

Comparative statics on ω:

$$\frac{\partial \omega}{\partial \alpha} = \frac{\delta(1-\beta d_L)(1-\alpha f-\alpha\beta d_{NL})+(f+\beta d_{NL})(1-\delta+\delta\alpha)(1-\beta d_L)}{(1-\alpha f-\alpha\beta d_{NL})^2} \quad \text{(A.1)}$$

Since all terms inside the parentheses are positive the derivative is positive.

$$\frac{\partial \omega}{\partial \beta} = \frac{-(1-\delta+\delta\alpha)[d_L(1-\alpha f-\alpha\beta d_{NL})-\alpha d_{NL}(1-\beta d_L)]}{(1-\alpha f-\alpha\beta d_{NL})^2} \quad \text{(A.2)}$$

We see that the derivative is zero when $d_L(1-\alpha f) = \alpha d_{NL}$, is negative when $d_L(1-\alpha f) > \alpha d_{NL}$ and positive when $d_L(1-\alpha f) < \alpha d_{NL}$.

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