
# Debarment Legislation:

## Its Potential as an Anti-Cartel Enforcement Tool

### Master Thesis


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**Abstract**

Following the recent developments of an increasing importance of debarment in public procurement in the battle against corruption, an interest was sparked to analyse the potential of debarment as an anti-cartel enforcement tool. This paper explores the effect of debarment on cartel deterrence and the sustainability of collusive behaviour while allowing for interaction with other antitrust instruments, namely leniency programs and private damages. This paper analyses these effects with the help of three economic models based on the analytical framework of Auriol & Soreide (2017): (i) a benchmark model in which debarment is absent, (ii) a model including simple debarment legislation, and (iii) a model with debarment legislation extended by the introduction of self-cleaning.

Found is that the implementation of debarment legislation leads to both a higher deterrence level as well as a decreased sustainability of collusive agreements that do emerge. To enhance the effectiveness of debarment, governments could choose to make the mechanism interact with leniency programs by exempting reporting firms from debarment. Contrarily, this study shows that introducing self-cleaning initiatives impairs the effectiveness of debarment as an anti-cartel enforcement tool. Lastly, a surprising result was that debarment seems to have a double-edged nature. When a legal debarment regime was implemented too lenient, it had an anti-competitive effect in the market by becoming a facilitator of collusion.

"We must not tolerate oppressive government or industrial oligarchy in the form of monopolies and cartels."

~ Henry A. Wallace

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## 1. Introduction

In 2010, five major Development Banks (the African Development Bank Group, the Asian Development Bank, the European Bank for Reconstruction and Development, the Inter-American Development Bank Group and the World Bank Group) signed the "Agreement for the mutual enforcement of debarment decisions"[1]. This agreement formally stated that the participating institutions would enforce debarment on firms found guilty of participating in a cartel. Debarment entails that a potential supplying firm that has been found guilty of an offence or corruption in the public or private sector, specifically in this case involvement in a cartel, is excluded from taking part in future tenders for procurement auctions for a prespecified period of time (Auriol, Hjelmeng & Soreide, 2017).

Debarment is not a completely new instrument. In 1884, debarment was first introduced as an element of public procurement in the United States (US). The US Congress passed a law that enforced the executive branch to offer projects to the lowest bidding private firms that were deemed "responsible and honest". The main objective of debarment was to enhance the integrity of the government. In the early stages after implementation of debarment, contractors were rarely excluded based on this law. Even if they were, it was often due to previous criminal convictions. In the mid-1990s, the sentiment with respect to debarment changed. There was a rising concern about corruption and its consequences causing debarment to be resurrected as a deterrent against fraudulent companies. The European Union (EU) introduced its own debarment mandate in the Public Procurement Directive of 2004. Other countries followed, among which Egypt, China, and Mongolia introduced their own debarment legislation in the early 2000s (Auriol & Soreide, 2017).

Admittedly, debarment legislation is often aimed at combatting corruption and enhancing government integrity rather than tackling collusive practices directly (Auriol, Hjelmeng & Soreide, 2017). The fact that debarment has gained such significant terrain in the battle against corruption has been one of the motivations behind this paper to analyse its potential as an anti-cartel enforcement tool.

Governments from around the world have a direct interest in ensuring funds are being used appropriately given that they are the world's largest buyers of goods and services. To prevent improper dissipation of public funds it is key that governments only do business with responsible contractors. By excluding firms that have partaken in collusive practices from auctions, they reduce the overall risk of harm to the procurement system and wasting financial resources of the public (Dubois, 2012).

Moreover, it is an important public policy issue to optimise antitrust and specifically anti-cartel enforcement given that collusive practices cause great harm to society (Levenstein & Suslow, 2012). Despite the consensus reached two decades ago by the European Commission, the Department of Justice in the US and other competition authorities around the world that under no circumstances hard core

[1] Available at https://www.adb.org. Accessed April 22, 2019.

collusive practices were tolerated, cartels still continue to form. Between 1992 and 2010, the Department of Justice in the US reported roughly 700 cartel convictions[2]. This number excludes the cartels that were not caught and those with insufficient evidence to be successfully prosecuted. In the current fight against collusive practices, competition authorities can rely on a diverse array of sanctions and tools to detect and, more importantly, deter cartels. However, the incentive to work together for firms in order to increase profits is incredibly pervasive even in the face of extensive antitrust legislation. Disqualification for future procurement is often not among the penalties used by competition authorities (Auriol, Hjelmeng & Soreide, 2017). Yet, debarment could have an important role to play in achieving the objective to deter collusive agreements from forming.

To date there only have been very few papers about debarment as a potential anti-cartel enforcement tool. In addition, most of the existing literature is from a legal perspective. These papers mainly focus on the procedural dilemmas related to the act and process of debarring, and the legal status of those debarred (Williams, 2007; Youngman, 2013). There has been very little economic analysis. Auriol & Soreide (2017) tried to satisfy the need for economic insight by answering the question: "Under what circumstances will debarment of corrupt suppliers reduce the risk of corruption in public procurement?". In their paper, they also paid some attention to the effect of debarment on collusion. They investigated the debarment rules in a stylised, ceteris paribus, setting where debarment was the only anti-cartel enforcement tool available to competition authorities. Cerrone, Hermstruwer & Robalo (2018) analysed the deterrent effect of debarment on explicit and tacit collusion in a repeated first-price sealed-bid procurement auction with the help of an experiment. They compared debarment with the benchmark case of no sanctions, and with fines. They also looked at how the deterrent effect varies with the length of exclusion.

In my paper, I want to further fill this gap in the literature with respect to economic insight. I will extend the economic model of Auriol & Soreide (2017) by including private damages and leniency programs to analyse the effect of debarment in a more realistic setting. Leniency programs are relied heavily upon by competition authorities, at least in advanced economies. In the EU most of the recent detected cartels were revealed by a member applying for leniency[3]. Under a leniency program, a participant is granted a fine reduction, that could go up to immunity, in exchange for the initial reporting of a cartel or cooperation with the competition authority during an investigation (Marvao, 2016). On the other hand suing for private damages is a popular private action among cartel victims (Marvao, Buccirossi & Spagnolo, 2015). Due to the importance of these anti-cartel enforcement tools in today's antitrust legislation, I believe it is important to analyse debarment while allowing for interaction. Thus, this paper will try to answer the following research question: can a higher level of deterrence of

[2] Calculated by Levenstein & Suslow (2012) based on individual listed cases on the US Department of Justice website.

[3] 83% in 2008, 86% in 2009 and 100% in 2010-2013, see Marvao (2016).

anticompetitive conducts be achieved by implementing debarment as an additional anti-cartel enforcement tool next to leniency programs and private damages?

The analysis conducted in this paper shows that the implementation of debarment legislation leads to both a higher deterrence level as well as a decreased sustainability of collusive agreements that do emerge. To enhance the effectiveness of debarment, governments could choose to make the mechanism interact with leniency programs by exempting reporting firms from debarment. Contrarily, this study shows that introducing self-cleaning initiatives impairs the effectiveness of debarment as an anti-cartel enforcement tool. In the stylised analytical framework under review, debarment seems to have a double-edged nature. Debarment legislation was only shown to be effective in terms of reducing sustainability of cartel agreements when specific conditions with respect to how stringent the program is were met. In contexts where these conditions were violated, debarment had an anti-competitive effect in the market by becoming a facilitator of collusion.

The remainder of this paper will be structured as follows: Section 2 will discuss different possible legal regimes with respect to how debarment can be implemented and also an overview of the legislation concerning private damages and leniency programs. Next, Section 3 presents the analytical framework and assumption used to construct the theoretical models. Section 4 evaluates the different scenarios and discusses the effects on deterrence and sustainability in terms of collusive agreements. Section 5 looks at the interaction between the three antitrust instruments. Finally, Section 6 summarises the conclusions, addresses possible policy implications and provides recommendations for further research. All derivations can be found in the Appendix.

## 2. Anti-cartel enforcement legislation

The aim of this section is to gain a better insight into antitrust legislation, specifically the legal regimes concerning debarment, private damages and leniency program. I will begin in this section with taking an extensive look at debarment legislation. Next, an insight will be given into the legislation with leniency programs and private damages and its interaction with debarment legislation.

### 2.1 Debarment

When it comes to how an efficient and optimal legal regime with debarment looks like, there is no international consensus. Debarment could include disqualification based on three kinds of behaviour: (i) debarment could be directed at past violations of law, ethics or anti-corruption norms that are unrelated to public procurement, (ii) a supplier may be debarred from a particular procurement for a breach of the rules of that process without any consequences beyond the particular contract, or (iii) the supplier could be excluded from future contracts for past procurement violations (Williams, 2007). One can find significant variation in what behaviour is accepted and what is not and the exact consequences of undesirable behaviour across jurisdictions as well as international organisations (Hjelmeng &

Soreide, 2014). A brief overview of the most common rules for debarment specifically focusing on grounds for debarment, discretionary power, length of debarment and self-cleaning initiatives will be presented.

### 2.1.1 Grounds for debarment

In only a few legal regimes partaking in collusive practices is a stand-alone, clear-cut ground for mandatory debarment. For example, among the core principles in the agreement for the mutual enforcement of debarment decisions signed by, among others, the World Bank Group one can find the following:

"*Adoption of the harmonized definition of sanctionable (also known as prohibited) practices that include (i) Fraudulent Practice, (ii) Corrupt Practice, (iii) Coercive Practice, and (iv) Collusive Practice, as defined in the Uniform Framework*[4]*"*

Meanwhile in many other debarment regimes collusive practices are not a direct premise for debarment. Most often debarment is primarily used an anti-corruption policy. The definition that is widely used for corruption in anti-corruption discourse is: "*abuse of public office for private gain"*. This simple definition is broad enough to cover nepotism, fraud, theft of state assets, misallocation of benefits, and also collusive practices (Williams, 2007). Cartel behaviour is thereby often captured indirectly by more generally specified grounds for debarment. For instance, in the US the causes for debarment are grouped into the following three categories, namely (i) conviction of a crime or civil fraud, (ii) poor contract performance, or (iii) other serious misconduct showing the contractor is not responsible. The last category is often deemed to be the "catch-all" category which could potentially also capture cartel behaviour (Dubois, 2012). In the EU cartel members could be debarred based on the ground of having benefitted from corruption or alternatively from having unduly influenced the decision-making process leading to the award of a contract (Auriol & Soreide, 2017). Notwithstanding that more generally specified guidelines are able to capture collusive practices as a ground for debarment, it also leaves more room for interpretation and discussion.

Another major difference in debarment regimes can be observed with respect to whether decisions imposed on the supplier by another country or international organisation are respected. The Organisation for Economic and Co-operation and Development (OECD) and the World Bank have both emphasised the importance of operating with universal debarment rules in the global fight against corruption. They state that the geographical location or the exact market in which the crime was committed should be irrelevant in the decisions whether or not to disqualify a supplier (Auriol & Soreide, 2017).

[4] Available at https://www.adb.org. Accessed April 22, 2019.

Some institutions and countries have chosen to adopt such a more multilateral initiative. In the agreement for the mutual enforcement of debarment decisions signed by the Development Banks, it is stated that the banks in question agree to share information with respect to corrupt practices and investigations. Further, they ensure that enforcement action taken by one institution is supported by the others. The European Parliament is also making efforts towards a more internationally centralised system of debarment. Recently, a resolution proposing the establishment of an international system of blacklisting was passed. Also, the European Anti-Fraud Office is examining whether a mechanism for the exchange of debarment information between Member States, international financial institutions and EU institutions is viable (Williams, 2007).

However, compliance with multilateral regulations has proven to be challenging. A court case from Norway shows the practical difficulty of debarring a supplier from procurement auctions when the local risk of corruption is considered low[5]. The firm Norconsult was found guilty of bribery in Tanzania by a lower court in Norway. This exposed the supplier to debarment in Norway on top of a debarment period imposed by the World Bank. The case was brought up for an appeal court and the judges deemed the consequences unreasonable for the offence and subsequently found the supplier not criminally liable. The judges of the appeal court let the risk of debarment in public procurement affect their verdict on corporate criminal liability. As a result, the enforcement of an international harmonised debarment regime was undermined (Auriol & Soreide, 2017).

Moreover, many governments have a strong inclination to ignore cartel collaboration among firms if the consequences are strictly kept abroad (Martyniszyn, 2012). Consequently, many authorities stipulate in their debarment rules that where or in which branch the offence is committed matters.

### 2.1.2 Discretionary Power

In addition to different grounds for debarment, one can also observe significant difference across countries in who is responsible for enforcing the rulebook. Auriol & Soreide (2017) recommend to separate the authorities that exclude and re-include bidders and place them with different law enforcement institutions. These institutions will be the main targets for suppliers that seek to secure contracts through bribery. By separating the discretionary power of re-inclusion and exclusion, the system is less vulnerable for corruption and allows for stricter enforcement.

Admittedly, in current debarment legislation this separation of powers is not commonly implemented. In the EU, procurement agencies are responsible for deciding whether a firm is allowed to participate in a procurement auction. Considerations of exclusion and re-entry of a supplier are rarely regulated at the national level in any of the Member States of the EU. In most situations, the decision is left to an individual procurement official. This agent will judge whether a supplier is eligible for participation in an auction or whether there is enough “evidence” to support the suspicion of criminal

[5] Norwegian Supreme Court Judgement of June 28, 2013 in case 2012/2114

activity and consequently exclude the firm from participating. As long as corruption is reliably confirmed based on the judgement of the official, a supplier is supposed to be debarred (Auriol, Hjelmeng & Soreide, 2017).

A similar situation can be observed in the US. The only significant difference is that there is no agency making decisions on behalf of the federal government. All debarment decisions are made by a federal branch department. Within this department, suspension and debarment officials (SDOs) are responsible for determining whether debarment of a contractor is granted. They do so on a case-to-case basis (Dubois, 2012). Their decision is founded on a common regulatory framework that is set out in the Federal Acquisition Regulation (FAR). One would expect this potentially could alleviate some of the subjective bias that the debarment decisions might be subject to in Europe. However, the mere fact that an offence is listed in the FAR as a ground for debarment, does not automatically mean the supplier is debarred. Also, in the US the decision who is allowed to participate in a procurement auction is ultimately left with the federal agency (Youngman, 2013).

Under current legislation in the EU and the US, there are few reasons to believe that decisions are made in an unbiased and predictable way. Debarment legislation often suffers from inconsistency and weak oversight of enforcement practices. According to a report by the OECD (2014) just 2 out of 427 bribery cases in the OECD area resulted in actual debarment. In 2014 Transparency International noted that the European Union only blacklisted 6 companies so far (Auriol & Soreide, 2017). Also, the US Department of Justice (2012) found that due to the rules being enforced at state level too much room was left for discretion and as a result weak enforcement in practice.

Furthermore, in countries in which debarment is actually enforced governments rarely keep registers of debarred suppliers. It is up to procurement agents to check whether a supplier is ineligible for tender participation, or competitors to raise the issue and complain. If none of these actions take place, a debarred supplier may well take part in public tenders (Auriol & Soreide, 2017).

### 2.1.3 Debarment period

There are three systems that could be used with respect to determining the debarment period. A supplier can be declared ineligible to be awarded a procurement auction contract indefinitely or for a stated period of time, either fixed or proportional to the crime (Williams, 2007). When a supplier is disqualified indefinitely, a firm is never allowed to participate in a procurement auction again. In practice, very few, if any, governments and international organisations have implemented such a harsh penalty. When it comes to suspension for a stated period of time, a firm will eventually be allowed to re-enter and once again compete for procurement contracts. The length of this stated period of time can be fixed or proportional to the crime. When the debarment period is fixed, the length of time a firm is not allowed to compete is a set number of years regardless of the damages caused and the pay-off of the crime. An example of such a system is the Canadian debarment regime after its reformation in 2014. In Canada,

any company found guilty for the listed offences is deemed ineligible for government procurement auctions for 10 years irrespective of what the consequences of their actions were (PWGSC, 2014). An alternative system is a proportional debarment regime. This means that the length of debarment varies on a case-to-case basis and increases proportionately with the severity of the act. An example of a legal regime with a proportional debarment period is the FAR in the US. The regulations provide that the length of debarment should commensurate the seriousness of the situation. Moreover, the FAR states that debarment should not be allowed to exceed three years but longer periods may be imposed when the circumstances warrant to do so (Gordon, 1993).

### 2.1.4 Self-cleaning initiatives

In some jurisdictions, self-cleaning principles have been included in debarment legislation, for example the EU Public Procurement Directive of 2014. Self-cleaning entails that the length of debarment depends not only on the severity of the initial act but also on the efforts of a firm to become more trustworthy. Debarred firms can decrease their debarment period by, for example, offering compensation for damages caused, collaborating with investigators by participating in leniency programs, implementing internal organisational measures to prevent similar offences from happening in the future, etc. By introducing such an option, firms are encouraged to improve their business behaviour. The incentive to comply with self-cleaning initiatives is especially strong when the initial debarment period is very long and the climb down of the debarred firm with the help of self-cleaning is steep. By reducing the debarment period due to credible self-cleaning, the sanction doesn't only keep out those who are dishonest and took part in a cartel, but also incentivises towards honest business strategies (Hjelmeng & Soreide, 2014).

## 2.2 Leniency program legislation

Leniency programs were first introduced 1978 and are said to be one of the most important developments in cartel detection and deterrence of antitrust policy. Current literature has identified two main effects of leniency, namely (i) the effect on sustainability of collusion, and (ii) the effect on profitability. Regarding profitability, a generous leniency program can be exploited by broadening the range of collusive strategies for suppliers (Chen & Rey, 2013). Motta & Polo (2003) found that leniency programs could have a perverse effect. By allowing colluding firms to pay a reduced fine, as a result leniency programs could be pro-collusive ex-ante. By the same token, Spagnolo (2004) argued that leniency programs that were sufficiently generous, could change the value of collusion in the sense that colluding firms could find it profitable to consensually report their behaviour and avoid detection and the measures that are subsequently taken. Firms could even adopt a collude-and-report-systematically strategy. Regarding sustainability, leniency can exacerbate the temptation to deviate since it gives participants amnesty in return for coming forward and denouncing the cartel. A deviant firm can protect itself from antitrust sanctions by applying for leniency.

When it comes to the effectiveness of leniency, Motta & Polo (2003) found that antitrust agencies perform strictly better under postinvestigation leniency when they conduct investigations with a low probability of success in the absence of cooperation from the firms. Moreover, Chen & Rey (2013) added that preinvestigation leniency is always optimal to implement. Leniency programs can be made more effective by restricting the granted immunity only to the first informant.

Common beliefs are that the implementation of debarment will clash with leniency programs (Cerrone, Hermstruwer & Robalo, 2018; Auriol & Soreide, 2017). Debarment rules often do not stipulate special treatment with respect to debarment for leniency applicants. This means that a firm that has applied for leniency can still be debarred for their involvement in a cartel. Consequently, the incentive stemming from being able to avoid a fine is partly counterbalanced by the risk of losing future revenues due to being excluded from future procurement auctions. By participating in a leniency program, the firm in question voluntarily hands over all the evidence necessary to warrant debarment. Hence, firms are less likely to apply for leniency (Auriol & Soreide, 2017).

However, in a recent case in Germany a supplier involved in bid rigging was exempted from debarment after cooperating in an investigation by the competition authority[6]. The case concerns an inquiry into collusive practices and bid rigging from Vossloh Laeis with other firms on the supply of rails by the Bundeskartellamt, the German competition authorities. The aim of the cartel agreement was to divide tenders and projects among the members. For its involvement Vossloh Laeis was impositioned with a fine of just under 3.5 million euros. Moreover, the potential buyer Stadwerke Munchen sought to exclude Vossloh Laeis from its qualification system on the grounds of having been involved in anticompetitive conducts. The relevance of this cartel was very direct since Stadwerke Munchen also had been a victim of the collusive practices of Vossloh Laeis. However, Vossloh Laeis resisted the exclusion on the basis that they had engaged in self-cleaning measures and had compensated for the damages and should therefore be reinstalled. Also, Vossloh Laeis had cooperated with the competition authorities, in other words applied for leniency, during the investigation. The supreme court eventually judged that Vossloh Laeis had provided enough proof to re-establish its reliability and should be re-included in the qualifications.

This judgement is relevant for the interpretation of the Procurement Directive 2014 in Europe with respect to debarment, self-cleaning and leniency programs. It sets a precedent that by cooperating with the CA and applying for leniency, a firm has engaged in enough self-cleaning to be exempted from debarment. This case could also be used as the foundation to build a case contesting debarment decisions in other countries or jurisdictions.

[6] C-124/17 Vossloh Laeis, ECLI:EU:C:2018:316

### 2.3 Private damages legislation

An important private antitrust enforcement tool is the possibility for victims to sue for damages. In this case, the buyer or client of a seller can recover the damages suffered by proving seller collusion (Baker, 1988). This paper will specifically focus on two different legal regimes for damage claims namely the European as well as the current US regime. The major difference between the two regimes is that in the US members of a cartel are liable for triple damages whereas in Europe victims can only for single damages (Buccirossi, Marvao & Spagnolo, 2018).

Regarding the interaction with debarment legislation, the legal regimes of private damages often are fully independent with absolutely no interplay. There is no special treatment for debarred firms when it comes to civil liability nor is there an exemption of debarment for firms that have had to pay damages.

On the other hand, the US as well as the European legal regime of private damages does interact with the laws of leniency programs. The expected pay out of damages for a cartelists depends on the level of liability as well as the amount of information available to make a successful case to the claimants. When a member of a cartel applies for leniency, they voluntarily hand over a huge amount of incriminating evidence to the antitrust authorities. In the US, judges can subpoena the reporting firm and obtain all evidence acquired by the competition authorities. As a result, victims are more likely to receive and advantageous outcome in their lawsuit for private damages. In return, the civil liability of the reporting firm is decreased from triple to single damages. Meanwhile, its co-conspirators remain liable for triple damages. In the Public Procurement Directive of 2014 of the EU, reporting firms are not granted a reduction in civil liability but information in leniency statements is specially protected. Member States are required to ensure that national court can't order the disclosure of leniency statements for the purpose of actions for damages (Buccirossi, Marvao & Spagnolo, 2018).

## 3. Assumptions and framework for analysis

In this section, the analytical framework and the assumption used to analyse the function of debarment rules will be discussed. The base of my analytical framework will come from the economic model constructed by Auriol & Soreide (2017). Auriol & Soreide (2017) investigated the debarment rules in a stylised, ceteris paribus, setting. In their framework for analysis they consider a society where the government oversees public spending. Various procurement agencies are responsible for the contract allocation based on a given set of procurement rules. The procurement agencies are not assumed to be completely honest to allow for the possibility of corruption. The rules the agencies have to follow are set by the government and assumed to function as intended after they have been implemented. This means that with a certain probability corruption is detected and the involved suppliers are truly debarred. To keep the exposition simple, they rule out all other forms of corruption and corporate crimes and focus solely on cases where collusion can occur. Further, they consider that the number of firms in the market is at most $N$. With corruption and debarment in place, this number will decrease over time. There is no

new entry to replace the debarred firms nor can debarred firms re-enter the procurement auctions. In their paper, Auriol & Soreide (2017) assumed that competition authorities could only rely on debarment in the battle against cartels. I want to extend their model by allowing for interaction between debarment as an anti-cartel enforcement tool and other existing antitrust instruments, leniency programs and private damages.

### 3.1 The economic environment

Let us consider a society where the government oversees public spending and conducts all contract allocations. The aim of the government is to maximise a utilitarian social welfare function by being able to commit to a certain set of policy parameters. Debarment is introduced as a strategy to promote this objective. In combination with debarment, the government also uses fines, the possibility to sue for private damages and leniency programs in the fight against cartels. Regardless of the reviewed problems with debarment in practice, I assume that the rules will function as intended in this setting. This means that if collusion is detected and the cartelists involved did not apply for leniency, they will subsequently be debarred from future auctions.

As mentioned, in practice, many governments choose to let public procurement agencies conduct the contract allocations. Often these agencies also have the discretionary power of exclusion and re-entry (Auriol, Hjelmeng & Soreide, 2017). This would indicate a three tier hierarchy, where the principal (government) wants to acquire a service or good, the delegate (public procurement agency) has the responsibility of acquisition and lastly the agent (firms) supplies the procured good or service. The delegate has to follow a set of procurement rules provided by the principal during acquisition. Given that I assume that the rules are executed to a tee, debarment decisions by procurement agencies will not be dependent on subjective or biased considerations of procurement agents. As a result, the actions of procurement agencies will be fully rational and predictable. This allows us to simplify the hierarchy to a two tier structure.

I will consider an infinitely repeated purchase game between the government acting as public purchaser and $N > 1$ potential suppliers. The size of the market varies from one period to the next to account for random shocks to public demand:

$$Q_t = \underline{Q} + \varepsilon_t \qquad (1)$$

where $\underline{Q} > 0$ denotes the lower possible quantity and where $\varepsilon_t$ is identically, independently distributed over $[0, \bar{\varepsilon}]$. This means that market size is $Q_t \in \left[\underline{Q}, \bar{Q}\right]$. The firms have full information about the distribution and the minimum market size. The expected value of $Q_t$ will be denoted by $\mathbb{E}Q$. I assume

that the gross surplus of procuring $Q_t$ is large enough for all $t$ such that producing the commodity is always worth it for the government.

The government can choose to allocate the contract through multiple mechanisms, like single sourcing or competitive bidding. In case of single sourcing, the government negotiates the market with one specifically chosen firm. As a result, the acquisition costs will, given that all firms are full rational, be equal to the monopoly price. When the government chooses to allocate the contract through a competitive bidding procedure, all firms compete for becoming the supplier. Consequently, the costs for the procured goods will be lower. On the other hand, there also both monetary as well as non-monetary costs associated with running an open tender like advertisement, reviewing and evaluating of offers, and time delay. The optimal acquisition strategy therefore depends on the relative benefits of fostering competition in comparison to the costs. I assume the government will choose competitive bidding as its acquisition strategy to allow for the possibility of collusion. Admittedly, if the procedural costs of competitive bidding outweigh the social benefits of introducing competition the superior acquisition strategy would have been single sourcing.

Further, I assume that the type of auction held by the government for the competitive bidding procedure is a Vickrey auction. A Vickrey auction is a type of sealed-bid auction. All bidders are asked to submit written bids, which means that they do not have any knowledge about the bids of other players in the auction. The lowest bidder will win the auction, but will be paid the price of the second-lowest bid. This will provide firms with an incentive to reveal their cost parameters and bid their true valuation of supplying the procured good or service. Therefore, this type of auction is optimal under asymmetric information (Vickrey, 1961; Myerson, 1998). In case of multiple winning bids, the government will randomly choose a supplier from those firms who have won. The price the supplier will receive is then equal to the value they bid since the second lowest bid is equal in value to their own.

Next, as mentioned, there are $N$ firms in the procurement auction that can produce the service or good. For simplicity, I assume that the procured goods and/or services are homogenous. This implies that the firms face some common costs which will be set to zero. This simplification can be done without loss of generality (Auriol & Laffont, 1992). Further, I assume that all suppliers have identical marginal costs. Firm $i = 1,2, \dots, N$ is confronted with costs

$$C(q) = c \cdot q \qquad (2)$$

to produce a quantity of $q \geq 0$. Here, $c$ represent the marginal costs and is drawn from the independent, uniform distribution $[0, 1]$.

### 3.2 Stage game

In each auction, firms have a possibility to reach a collusive agreement. If so, they could decide to bid the monopoly price and the winning firm subsequently equally compensates the losing firms. However, firms might be against such a construction due to concern for detection. In that case, the best collusive mechanism would be to alternate the winning bid among the members of the cartel (Athey & Bagwell, 2001). Nonetheless, for a cartel to be established, firms will need to communicate. Once all firms in the auction have decided to enter into the collusive agreement, this communication will become hard and compromising evidence which could be found by the competition authorities (CA). The probability that the CA investigate, find the evidence and successfully prosecute the cartelists is $\rho$, with $0 < \rho < 1$.

If a firm is convicted as a result of an independent investigation by the CA, all cartelists will receive a fine of $F$. The fines are assumed to be determined exogenously. In addition, claimants can sue all members of the cartel for private damages. The expected pay out for damage of a single firm equals $D^{NR}$. Here the superscript $NR$ denotes a situation in which no firm reports the cartel to the CA.

There is also a leniency program in place to encourage cartelists to self-report themselves by exposing evidence. If the firms in a collusive agreement can be convicted due to one of the firms applying for leniency, the reporting firm is granted immunity with respect to the fine ($F = 0$) while the others still have to pay the full fine. The leniency applicant does still face potential lawsuits by the victims for private damages. The expected pay-out of damages is $D^R$ where $R$ denotes the situation in which the firm applies for leniency while the other members of the cartel do not. The remaining cartelists face an expected pay-out of private damages of $D^{OR}$. The superscript $OR$ denotes when another firm has applied for leniency and reported the cartel (Buccirossi, Marvao & Spagnolo, 2018). Further details about the legal regime concerning private damages will be provided in Section 3.3.

In each auction, the timing of the game is as follows:

- *Stage 0:* Each firm chooses whether they want to enter into a collusive agreement. If at least one firm decides to not collude, then competition takes places. The game ends after this period and all firms obtain their Nash equilibrium expected profit of:

$$\pi_{Nash} = 0 \quad \forall \quad i = 1, \dots, N \tag{3}$$

  In a competitive Vickrey auction without collusion all firms will have an incentive to bid their true valuation of supplying the procured good. Given that all firms have an identical costs structure, this means that they will all bid the exact same value. The government will then randomly choose a supplier and pay a price equal to the second lowest bid, which is equal in value to the winning bid. If the firms all decide to collude, the game moves to the next stage.

*Stage 1:* Each firm decides whether they respect the agreement or deviate from the agreed upon strategy by undercutting the bid. If all firms decide to respect the agreement, they will together earn monopoly profits and share them equally (See Appendix 1):

$$\pi_{Collude}(N) = \frac{1}{N} \cdot 0.5\mathbb{E}Q \quad \forall \quad i = 1, \dots, N \tag{4}$$

If a firm decides to deviate from the agreement by placing a bid below monopoly price, the firm will earn a profit of :

$$\pi_{Deviate} = 0.5\mathbb{E}Q \tag{5}$$

All other firms in the auction will earn a profit of zero. During this stage firms can also choose to apply to the leniency program. If at least one firm reports the cartel to the competition authorities, the game ends. Otherwise, the competition authorities open an investigation with probability $\rho$ and will penalise the firms found guilty.

### 3.3 Framework for private damages

As mentioned, this paper will consider two different legal regimes for damage claims namely the European as well as the current US regime. The construction used in the economic model to include private damages is based on the paper of Buccirossi, Marvao & Spagnolo (2018). The expected pay out of damages for a cartelists depends on the level of liability as well as the amount of information available to the claimants. The information availability will be denoted by $\alpha \in [0,1]$. The maximum amount of estimated damages for an individual firms will be denoted by $D$.

In the US, victims of cartels are liable for triple damages (so $3D$). If a firm has applied to a leniency program, its liability is reduced to single damages (thus $D$). Its co-conspirators, on the other hand, are still facing triple damages. Moreover, judges can subpoena all information acquired from a reporting firm by the competition authorities. The values of $D^{NR}$, $D^{R}$ and $D^{OR}$ can therefore be specified as follows:

$$D_{US}^{NR} = \alpha_{US}^{NR} \cdot 3D \tag{6}$$

$$D_{US}^{R} = \alpha_{US}^{R} \cdot D \tag{7}$$

$$D_{US}^{OR} = \alpha_{US}^{R} \cdot 3D \tag{8}$$

Here, the subscript $US$ represent the US legal regime. I assume that the US judges indeed use the right to subpoena firms and that they obtain all evidence that a leniency applicant provided to the Department of Justice in order to make their decision regarding private damages. Therefore, $\alpha_{US}^{R} > \alpha_{US}^{NR}$.

In the European legal regime, firms are liable for single damages $D$. The civil liability of a reporting firm is not reduced. However, in the EU, national courts have to ensure that there is no disclosure of leniency statements for the purpose of actions for damages (Buccirossi, Marvao & Spagnolo, 2018). This means that $\alpha_{EU} = \alpha_{EU}^{R} = \alpha_{EU}^{NR}$. The values of $D^{NR}$, $D^{R}$ and $D^{OR}$ can therefore be specified as follows:

$$D_{EU}^{NR} = D_{EU}^{OR} = D_{EU}^{R} = \alpha_{EU} \cdot D \tag{9}$$

The subscript $EU$ denotes the European legal regime regarding private damages.

For simplicity, I assume that the maximum amount of private damages are exogenously given. Moreover, under the assumption that the information availability in the absence of a leniency applicant in the US and the EU are identical, I have $D_{EU}^{NR} < D_{US}^{NR}$, $D_{EU}^{R} < D_{US}^{R}$ and $D_{EU}^{OR} < D_{US}^{OR}$.

## 4. Analysis

In this section I will analyse the effect of the different debarment legal regimes on deterrence of collusive behaviour. I will follow the standard approach of Stigler (1964) that focuses on the temptation to defect. A cartel is deterred from forming when the no-deviation incentive compatibility constraint for the collusive agreement being an equilibrium is violated.

Admittedly, there are some limitations to this approach. When firms decide whether or not to take part in a collusive agreement, they most often also take into account the possibility and consequences of being betrayed by other cartelists. In that sense, the incentive compatibility constraint is a necessary but not a sufficient condition for a collusive agreement. For a cartel to be sustainable in equilibrium, there must also be some sort of trust among the members. A firm will need to have sufficient confidence in its co-conspirators and their ability to hold up their end of the bargain (Spagnolo, 2004).

I will start by constructing a benchmark model in which debarment is absent. Next, I will introduce debarment into the model and add additional extensions from there on to allow for varying legal regimes with respect to debarment.

### 4.2 Benchmark model

To sustain a collusive agreement, firms rely on a grim trigger punishment strategy. This means that in case of deviation, there is a permanent reversion to the Nash equilibrium. Moreover, I assume that when no deviation takes place, firms will keep on colluding even after they have been convicted by the CA and their debarment period ends. Assuming that collusion would stop permanently or temporarily after detection and a successful conviction linked to a random investigation would yield the same results (Chen & Rey, 2013).

For the benchmark model, I further assume that the government has not implemented a debarment regime yet. This means that if a firm chooses to adhere to the collusive agreement, it will earn in each period a net profit of (4) minus the expected penalty ($F + D^{NR}$). A firm that deviates in the second stage from the collusive agreement will also find it optimal to apply for leniency by the CA. Given the others comply, it will then earn profits of (5) in combination with fine immunity. The firm will still face the possibility of having to pay private damages $D^R$. In future auctions, the reporting firm will earn Nash equilibrium profits of (3). This means that the expected discounted value of colluding and not reporting ($NR$) and deviating and reporting ($R$) are respectively:

$$V_B^{NR} = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho(F + D^{NR})}{1-\delta} \tag{10}$$

$$V_B^R = 0.5\mathbb{E}Q - D^R \tag{11}$$

Where subscript $B$ denotes the benchmark model. Collusive agreements can only arise if the expected value of colluding exceeds the net present value of competing. Therefore, I also computed the expected pay-off of a firm $i = 1, \dots, N$ when it participates in an infinite sequence of competitive auctions (See Appendix 2.1):

$$V^{Nash} = 0 \tag{12}$$

Superscript $Nash$ represents the Nash equilibrium outcome, the expected pay-off in a competitive environment. Being a member of a cartel is profitable for firm $i = 1, \dots, N$ if and only if $V_B^{NR} > V^{Nash}$ which is equivalent to

$$N \leq \overline{N_B} \equiv \frac{0.5\mathbb{E}Q}{\rho(F + D^{NR})} \tag{13}$$

If this condition on the number of suppliers in the auction is satisfied then collusive agreements can emerge. The incentive compatibility constraint for these agreements to be sustainable in equilibrium is satisfied when the discount factor of the firms in the procurement auction are higher or at least equal to the minimum discount factor $\underline{\delta_B}$ (See Appendix 2.1):

$$\delta \geq \underline{\delta_B} \equiv 1 - \frac{0.5\mathbb{E}Q}{N(0.5\mathbb{E}Q - D^R)} + \frac{\rho(F + D^{NR})}{0.5\mathbb{E}Q - D^R} \tag{14}$$

So collusion occurs and is sustainable if, and only if, firms are sufficiently patient. If the discount factor is below the critical level, each firm would find it more profitable to deviate since the present value of the short term gains exceed the long term losses. I will use the thresholds $\underline{\delta}$ and $\overline{N}$ as a characterisation of the effectiveness of antitrust policy. The more stringent the condition is on the number of potential suppliers, the more cartels are deterred from forming in the first place. The higher the discount factor has to be, thus the more patient firms have to be, the more successful anti-cartel enforcement legislation is in breaking up collusive agreements that did emerge.

Most often the discount factor, $\delta$, is said to represent the level of patience of a firm, but as discussed in Auriol, Hjelmeng & Soreide (2017), in this setting, it could also represent the extent to which a firm is dependent on procurement contracts. In others words, how important is it for the firm to obtain the next or any other future contracts in the procurement auction. If firms are not heavily relying on procurement contracts, then debarment will have no impact on the market and it will most likely also not have an effect on collusion. Regardless of what the discount factor exactly represents, the interpretation deducted on the sustainability of anticompetitive conducts remains the same.

By examining the critical discount factor more closely in the benchmark model, see Appendix 2.2, one can make several observations. For all interpretations I work under the assumption that the net present value of collusion is strictly positive. As mentioned, if this condition is violated, it would be best for firms to simply compete in procurement auctions rather than to collude.

First of all, a higher level of patience is required to sustain a collusive agreement when there are more players in the auction, see analytical expression (28). More potential suppliers means that the monopoly profits have to be divided among more cartel members thereby decreasing the individual share. Deviating from the collusive agreement and the short term gains that can subsequently be accumulated become relatively more attractive. Hence, collusion becomes less likely in equilibrium when there are more players (Wils, 2006).

Moreover, one can see that an increase in the expected penalty (i.e. due to a higher level of fines and private damages in case of no leniency applicant or a higher probability of detection) also causes collusive agreements to become less sustainable in equilibrium, see analytical expressions (26) and (27) respectively. An increase in the expected penalty causes the net present value of colluding to decrease making defection more probable (Hamaguchi, Kawagoe & Shibata, 2009). In similar fashion, an increase in the expected penalty of a leniency applicant, thus $D^R$, will lead to a lower critical discount factor, see (30). A higher expected pay-out of private damages for a leniency applicant will lead to a reduction of the net present value of deviating. Consequently, collusion becomes more profitable relative to deviating and therefore more sustainable in equilibrium.

Based on this observation, one can compare the US private damages legal regime with that in Europe. Both the expected private damages for a leniency applicant, $D^R$, as well as those for firms in case of no reporting, $D^{NR}$, are higher in the US. Whether a higher level of deterrence is reached by the US depends on which effect is dominant. If the higher expected damages for a leniency applicant cause the dominant effect, then the critical discount factor will be lower in comparison to that in the EU. Thus the likeliness of cartels in equilibrium would be higher in the US than in Europe. The opposite holds when the effect of higher private damages in case of no leniency applicant is dominant. In short, it is not possible to draw set conclusions on whether the European or the US legal regime result in a higher level of sustainable anticompetitive practices.

Lastly, I look at the effect of demand fluctuations on collusion, see $(29)$. An increase in demand has two subordinated effects, namely (i) higher demand increases the profit that can be obtained by deviating, and (ii) an increase in collusive profits. The effect of demand fluctuations on collusion depends on which of these two subordinated effects is dominant. If $N > \frac{1}{1-\delta}$, effect (ii) is superior and therefore one can observe a decrease in the critical discount factor. This entails that collusion is more probable and easier to sustain in auctions with high demand in comparison to periods with falling demand. This is also consistent with findings in current literature. During recessions, the foregone long-term profits from deviation are relatively low compared to current gains which makes defection more tempting (Haltiwanger & Harrington Jr., 1991). If $N < \frac{1}{1-\delta}$, then effect (i) is dominant over (ii), and defection becomes more tempting. In that scenario, an increase in demand will lead to a higher critical discount factor.

### 4.3 The dynamics of debarment

I now introduce debarment legislation, which allows competition authorities to temporarily exclude suppliers that have engaged in collusive practices from future procurement auctions. For simplicity, I assume that once a cartel is detected, the government debars the cartelists for one period.[7]

If a cartel is discovered through a leniency applicant, the government could consider to exempt the reporting firm as a reward. If so, a reporting firm will not only be granted immunity for the fine but it will also be allowed to continue to participate in all future auctions. Variable $\psi$ will represents whether a leniency applicant is granted immunity from debarment. In case of exemption $\psi = 1$, otherwise $\psi = 0$. Meanwhile, the reporting firm's co-conspirators will be debarred either way. This would imply that when a reporting firm is exempted, it will become the sole supplier left in the auction until its competitors

[7] The debarment period could have been made contingent on the severity of the crime and have been allowed to fluctuate. Cerrone, Hermstruwer & Robalo (2018) already found that by increasing the length of inclusion, the frequency of collusive behaviour decreases. An extension could have made from this analysis. However, this was considered to be beyond the scope of this research paper.

are allowed to re-enter. I assume that during this period the leniency applicant can act as a monopolist and obtain a profit of $(5)$.

If a cartel is detected or reported and no special treatment is provided to the reporting firm, all players will be debarred. This would imply that all firms are forced to leave the auction and the government is left without a private supplier. Consequently, the credibility of debarment as an anti-cartel enforcement tool could be threatened. The government wants to acquire the commodity each period since it yields a positive gross surplus. This seemingly becomes impossible when there are no players left in the auction that could supply the procured good. Consequently, firms might start to believe that they will be exempted from debarment. To enhance credibility, I assume that the government is able to produce the product or service themselves but at higher costs than the private sector could, even when charged with monopoly price. Further, I assume that the value they place on honest business conduct outweighs the additional costs of self-production in the short run.

To compute the critical discount factor after implementation of debarment, I start by obtaining the expected present values from which we can deduct the incentive compatibility constraint. A firm that chooses to adhere to the collusive agreement will now earn a net expected profit of $(4)$ minus the expected penalty $(F + D^{NR} + \delta\frac{\mathbb{E}Q}{2N})$. Here, the term $\delta\frac{\mathbb{E}Q}{2N}$ represents that firms now also face the possibility of one-period debarment when they are detected. During this period they are unable to engage in the market and thus have to forego collusive profits. A firm that deviates from the collusive agreement will also find it optimal to apply for leniency by the CA. Given the others comply, it will then earn profits of $(5)$ in combination with fine immunity. It remains liable for private damages of $D^R$. Moreover, they could be exempted from debarment. In that case, they would earn a profit of $(5)$ in the first period after reporting as well. If leniency is not granted with respect to debarment, the reporting firm is not allowed to participate in the auction in period $t = 1$, given they applied for leniency in period $t = 0$. As a result, they will obtain a net profit of zero at $t = 1$. Once all firms are allowed to re-enter, the reporting firm and all its competitors will earn Nash equilibrium profits of $(3)$.

This means that the expected discounted value of colluding and not reporting $(NR)$ and deviating and reporting $(R)$ are respectively:

$$V_D^{NR} = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta\frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta} \tag{15}$$

$$V_D^R = \mathbb{E}Q(1 + \psi\delta) - D^R \tag{16}$$

Where subscript $D$ denotes a simple debarment model. Being a member of a cartel is only profitable for firm $i = 1, \dots, N$ if $V_D^{NR} > V^{Nash}$ which is equivalent to

$$N \leq \overline{N_D} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho\delta)}{\rho(F+D^{NR})} \tag{17}$$

Since $\delta \in [0,1]$ and $\rho \in [0,1]$, it is given that $\rho\delta \leq 1$. This means that the condition for collusion to be profitable is more stringent in the presence of debarment in comparison to in the absence of debarment, see (13). Debarment causes a decrease in the net present value of colluding, regardless of its interaction with leniency programs, thereby increasing the deterrence level of antitrust legislation. If collaborative agreements do emerge the incentive compatibility constraint for them to be sustainable in equilibrium is satisfied when:

$$\frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F+D^{NR}+\delta\frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta} - 0.5\mathbb{E}Q(1+\psi\delta) + D^{R} \geq 0 \tag{18}$$

Under the assumption that collusion is profitable, it will only be sustainable if the net present value of deviating is lower than that of working together. As we know, debarment reduces the expected value of colluding. Moreover, the impact of debarment on the expected value of defection is non-existent in case of no exemption for a reporting firm whereas it causes an increase in case of immunity from exclusion in future auctions. This entails that by implementing debarment legislation deviating has become relatively more attractive. Thus, in addition to reaching a higher deterrence level, debarment legislation also makes the collusive agreements that arise less sustainable.

For an extensive analysis of the effects of debarment legislation on the critical discount factor, I used implicit differentiation. The implicit derivatives were taken from (18) with respect to parameters that were influenced by debarment, see Appendix 3. They were then compared with those obtained from the benchmark model, see Appendix 2.2.

First I look at the effect of more competitors in the auctions, higher $N$, on the critical discount factor, see (32). In the benchmark model an increase in the number of firms would solely cause the individual collusive profit to decrease, see (28). As a result, collusion became less sustainable and the critical discount factor increased. After the implementation of debarment, there is additional effect when the number of suppliers increases. Given that the penalty associated with debarment equals the foregone collusive profits, an increase in firms also results in a decrease of the expected penalty. A lower penalty makes collusion more profitable which means there is reduction in the critical discount factor. However, the effect of a decrease in collusive profits remains dominant and therefore the total effect of more potential suppliers still leads to a higher critical discount factor but to a lesser extent.

In the absence of debarment, an increase in demand had two subordinated effects, see (29), namely (i) higher demand increases the profit that can be obtained by deviating, and (ii) an increase in

collusive profits. Which of the two effects was dominant relied on the number of potential suppliers in the market. After implementation of debarment, there are two additional effects of an increase in demand, see (33), namely (iii) a leniency applicant that has been exempted from debarment is able to earn higher monopoly profits during the debarment period of its co-conspirators, and (iv) the penalty of debarment which is given by foregone collusive profits also increases. The first of the two additional effects mentioned further increases the expected value of deviating where the last mentioned causes a decrease in the net present value of collusion. The result is that the total effect causes a reduction in the critical discount factor, if $N > \frac{1-\delta\rho}{(1-\delta)(1+\delta\psi)}$. This condition is satisfied with a lower number of potential suppliers than in the benchmark model. This means that higher demand is more likely to lead to more sustainable collusive agreements after the implementation of debarment legislation.

The effect of an increase in the detection rate is enforced by implementing debarment, see (27) and (34). In the absence of debarment legislation, a higher probability of detection would lead to a higher critical discount factor and thus to collusion to be less sustainable in equilibrium. After the implementation of debarment, the increase in the discount factor caused by higher detection rate is more significant. By including debarment, cartelists face a larger penalty when detected. If the likelihood of being detected increases then, due to the expected penalty being higher, firms will be more hesitant to enter into a collaborative agreement.

Lastly, I look at the effect of including exemption of debarment in the legal regime for reporting firms, see (31). By exempting the leniency applicant from being excluded from the auction, they are able to compete in all future auctions. Given all its co-conspirators will be debarred as a consequence of the cartel being reported, the reporting firm is able to act as a monopolist during their debarment period. This increases the expected value of deviating. Adding leniency to debarment legislation, therefore, causes an increase in the critical discount factor which means anticompetitive conducts will be less sustainable in equilibrium.

The interpretations of the implicit derivates are all made under the assumption that the following condition holds:

$$N > N_{D,E} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho)}{\rho(F+D^{NR}) + 0.5\mathbb{E}Q \cdot \psi \cdot (1-\delta)^2} \tag{19}$$

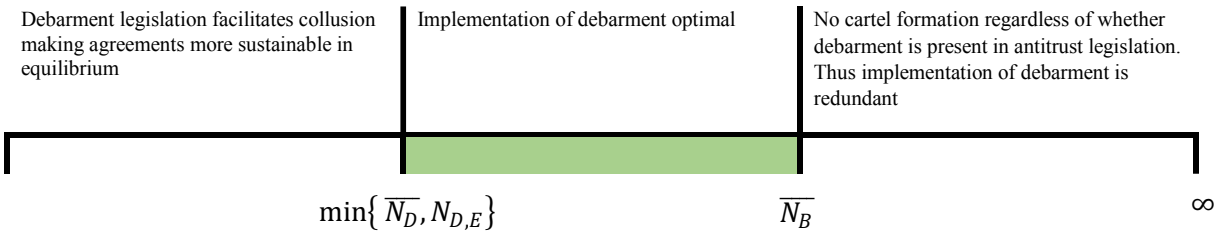
Where subscript $E$ stands for effectiveness of debarment. If the condition is violated, all effects of the parameters influenced by debarment will be reversed. An increase in the number of potential firms will then make collusion more likely, a higher detection rate will yield a lower critical discount factor, and the exemption of reporting firms from debarment will also make collusion more sustainable. These results are very counterintuitive. A possible explanation for this surprising observation could be the dual

nature of debarment. Debarment as an anti-cartel enforcement instrument is a double edged sword. In the perfect setting it can successfully be used as a sanction to discourage collusive behaviour. However, when implemented too lenient it could also be a facilitator of collusion (Auriol & Soreide, 2017; Cerrone, Hermstruwer & Robalo, 2018). This is also what we observe if we analyse condition (19).

The implementation of debarment is optimal, when $N_{D,E} < N \leq \overline{N_B}$ given that $N_{D,E} < \overline{N_D}$. If $N > \overline{N_B}$, there is no need to implement additional legislation in the form of debarment since there is no incentive to work together regardless. If $N < N_{D,E}$, then debarment has an adverse effect and becomes a facilitator of collusion by reducing competition. It thereby triggers the exact behaviour it tries to deter. It such a situation debarment regulation only entails a cost, in terms of reducing competition, without generating any benefit. How severely competition is affected and the exact damages caused depends on whether all firms involved in the conspiracy, or only the ringleader or specific beneficiary of the cartel is debarred upon discovery. (Auriol & Soreide, 2017; Cerrone, Hermstruwer & Robalo, 2018).

If exemption for a reporting firm is added to the legal regime of debarment ($\psi = 1$), in other words the legislation is made more lenient, a higher number of firms in the market is needed for debarment to be an effective tool. This makes the condition for the implementation to be optimal more stringent. It could even lead to the number of firms required for debarment to be effective, $N_{D,E}$, to lie above $\overline{N_D}$. If so, the condition for the implementation of debarment to be optimal changes to $\overline{N_D} < N \leq \overline{N_B}$. The effectiveness of debarment is impaired in the subset interval $\overline{N_D} < N < N_{D,E}$. This means that in this interval the sustainability of cartel agreements that emerge increases. However, in that same interval, there is no incentive to form collusive agreements due to the increase in cartel deterrence as a result of the implementation of debarment. Thus the debarment program itself will actually not be used and the effect on sustainability is irrelevant. The forward guidance from the government as a result of implementing debarment program itself is enough to scare off any firms that thought about forming a cartel. A graphical representation of the optimality condition for the introduction of debarment can be found in Figure 1. The green highlighted interval represents for which number of suppliers in the auction it is optimal to introduce debarment.

**Figure 1: The optimality condition for the introduction of debarment in the Simple Debarment Model in terms of *N***



### 4.4 Self-cleaning initiatives

In this subsection, I follow recent developments in debarment legislation by also taking into account self-cleaning initiatives. As mentioned in Section 2.1.4, firms are able to reduce their debarment period by engaging in self-cleaning initiatives by for example the removal of employees from the given area of responsibility or the implementation of internal administrative or organisational measures to prevent future offences. I will denote the probability whether a debarred firm engages in self-cleaning by $1-\lambda$, where $\lambda \in [0,1]$. Self-cleaning is optimal for an individual firm if, and only if, the marginal costs of self-cleaning practices are equal to or below the marginal benefits of an early re-entry. Firms that engage in self-cleaning are exempted from one-period debarment and thus allowed to participate in the next auction. If early re-entry of debarred firms occurs, a leniency applicant that had been exempted from debarment can no longer obtain monopoly profits. This changes the expected discounted value of colluding and not reporting ($NR$) and deviating and reporting ($R$) to:

$$V_S^{NR} = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta\left[\lambda\frac{0.5\mathbb{E}Q}{N}\right]\right)}{1-\delta} \tag{20}$$

$$V_S^{R} = 0.5\mathbb{E}Q(1+\psi\delta\cdot\lambda) - D^{R} \tag{21}$$

Where subscript $S$ denotes a debarment model with self-cleaning initiatives. Being a member of a cartel is only profitable for firm $i = 1, \dots, N$ if $V_S^{NR} > V^{Nash}$ which is equivalent to

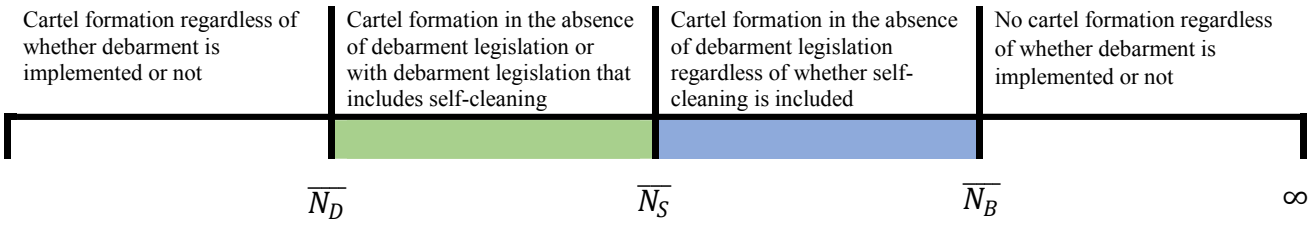
$$N \leq \overline{N_S} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho\delta\lambda)}{\rho(F + D^{NR})} \tag{22}$$

Since $\delta \in [0,1]$, $\lambda \in [0,1]$ and $\rho \in [0,1]$, it is given that $\rho\delta \leq \lambda\rho\delta \leq 1$. The condition for collusion to be profitable has become less stringent compared to the debarment regime in which self-cleaning initiatives were absent, see (17). This means that by including self-cleaning, cartel deterrence is lower. On the other hand, the condition is more stringent in comparison to the benchmark model, see (13). This tells us that the increase in effectiveness in terms of cartel deterrence of debarment is not fully impaired due to allowing firms to engage in self-cleaning. Admittedly, if a government decides to make self-cleaning extremely attractive such that the probability of a firm engaging in these activities is one, then the increase in cartel deterrence as a result of debarment will be entirely counterbalanced by the self-cleaning initiatives. In conclusion, $\overline{N_D} \leq \overline{N_S} \leq \overline{N_B}$.

A graphical representation of the effect on cartel deterrence of the different legal regimes can be found in Figure 2. The blue highlighted interval shows the increase in cartel deterrence due to the introduction of debarment legislation with self-cleaning. The green and blue highlighted intervals

combined represent the increase in cartel deterrence due to simple debarment legislation in which self-cleaning initiatives are absent.

**Figure 2: Cartel deterrence under different debarment legal regimes**




If a collaborative agreement does emerge the incentive compatibility constraint for them to be sustainable in equilibrium is satisfied when:

$$\frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta \cdot \lambda \frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta} - 0.5\mathbb{E}Q(1 + \psi\delta \cdot \lambda) + D^{R} \geq 0 \tag{23}$$

To evaluate the effect of introducing self-cleaning initiatives on the critical discount factor, I again used implicit differentiation. The implicit derivatives were taken from (23) with respect to parameters that were influenced by debarment, see Appendix 4. They were then compared with those obtained from the benchmark model and the debarment legal regime in which self-cleaning is absence, see Appendix 2.2 and Appendix 3.

First I again look at the effect of more competitors in the auction, higher $N$, on the critical discount factor, see (36). As mentioned above, in the benchmark model a higher number of firms would solely cause the individual collusive profit to decrease, see (28). This would result in less collusion in equilibrium. After the implementation of debarment, there was an additional effect caused by an increase in the number of suppliers, see (32), namely the expected penalty of a cartelists decreased. After allowing for self-cleaning initiatives this expected penalty is even further reduced. This will have an encouraging effect on collusive behaviour. Yet, the effect of a decrease in collusive profits remains dominant and therefore the total effect of more potential suppliers still leads to a higher critical discount factor but to a lesser extent than in the absence of self-cleaning.

In the absence of debarment, an increase in demand has two subordinated effects, see (29), namely (i) higher demand increases the profit that can be obtained by deviating, and (ii) an increase in collusive profits. Which of the two effects was dominant relied on the number of potential suppliers in the market. After implementation of debarment, there were two additional effects caused by an increase in demand, see (33), namely (iii) a leniency applicant that has been exempted from debarment is able to earn higher monopoly profits during the debarment period of its co-conspirators, and (iv) the penalty

of debarment which is given by foregone collusive profits increases. The first of the two mentioned additional effects further increases the expected value of deviating where the last mentioned causes a decrease in the net present value of collusion. The result is that the total effect causes a reduction in the critical discount factor, if $N > \frac{1-\lambda\delta\rho}{(1-\delta)(1+\lambda\delta\psi)}$. This condition is satisfied with a lower number of potential suppliers than in the benchmark model but a higher number of firms compared to debarment legislation without self-cleaning, see (37). This means that higher demand is more likely to lead to less sustainable collusive agreements after the introduction of debarment with self-cleaning is introduced. However, higher demand would have been even more likely to lead to less sustainable collusive agreements after the introduction of debarment legislation in which self-cleaning is absent.

The effect of an increase in the detection rate is enforced by implementing debarment but subsequently weakened by allowing for self-cleaning, see (27), (34) and (39). By including debarment, cartelists face a larger penalty when detected. This means that if there is a higher likelihood of being detected, due to the expected penalty being higher, firms will be more hesitant to enter into a collaborative agreement. However, by giving firms the possibility to engage in self-cleaning the expected penalty decreases. Thus, by introducing self-cleaning initiatives in debarment legislation, the enforced effect of a higher detection rate due to debarment is reduced.

Next, I analyse the effect of immunity of debarment for reporting firms. By exempting the leniency applicant from being excluded from the auction, they are able to compete in all future auctions. In the absence of self-cleaning initiatives, all co-conspirators would have been debarred and consequently the reporting firm would have been able to act as a monopolist during their one period debarment, see (31). However, due to the possibility of self-cleaning other co-conspirator could potentially have an early re-entry from debarment. If so, the reporting firm will not be able to act as a monopolist but will have to compete with other suppliers. This decreases the expected value of deviating in comparison to the model of debarment without self-cleaning. Adding leniency to debarment legislation, will still cause an increase in the critical discount factor in comparison to the benchmark model. However, the program will become less effective after the implementation of self-cleaning, see (35).

At last, I consider the direct effect of self-cleaning initiatives on the critical discount factor, see (38). If there is an increase in the probability of debarred firm engaging in self-cleaning, $1 - \lambda$ is higher and thus $\lambda$ is reduced. Based on the implicit derivative, one can then conclude that more self-cleaning results in a reduction of the critical discount factor. This entails that collusion is more likely to be sustained in equilibrium. A very intuitive explanation is that self-cleaning increases the value of collusion, by reducing the expected penalty, while having no impact or decreasing effect of the value of deviation, by lowering the profits a reporting firm can obtain if they are granted immunity from debarment.

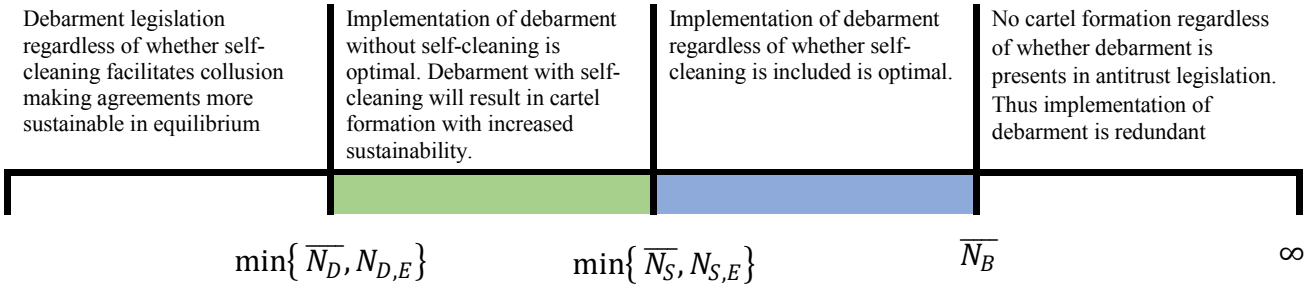
The interpretations of the implicit derivates are all made under the assumption that the following condition holds:

$$N > N_{S,E} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho\lambda)}{\rho(F+D^{NR})+0.5\mathbb{E}Q\cdot\psi\cdot\lambda\cdot(1-\delta)^2} \tag{24}$$

Where subscript $E$ stands for effectiveness of debarment. Once more, if the condition is violated, all effects of the parameters influenced by debarment will be reversed. This shows us again the dual edged nature of debarment legislation. Similar observation can be made with respect to the effectiveness of debarment as in the debarment regime without self-cleaning, see (19). Debarment with the possibility of self-cleaning is optimal to implement when $N_{S,E} < N \leq \overline{N_B}$ given that $N_{S,E} < \overline{N_S}$ and $\overline{N_S} < N \leq \overline{N_B}$ given that $\overline{N_S} < N_{S,E}$. The optimality condition for debarment is more stringent compared to a debarment regime without self-cleaning, given that $\lambda \in [0,1]$. This is very intuitive since self-cleaning initiatives make the antitrust legislation more lenient.

If exemption for a reporting firm is added to the legal regime of debarment, so the legislation is made even more lenient, we observe that even an higher number of firms in the market is needed for debarment to remain an effective tool. This makes the condition for the introduction of debarment with self-cleaning to be optimal increasingly stringent. A short graphical representation of the optimality condition with respect to the introduction of debarment with or without self-cleaning can be found in Figure 3.

**Figure 3: The optimality condition for the introduction of debarment with and without self-cleaning in terms of *N***




All in all, it seems that introducing self-cleaning initiatives might not be the best course of action for governments and international organisation. Self-cleaning initiatives reduce the deterrence levels of debarment as well as make collusion more sustainable equilibrium. Also, the condition that needs to be met for the implementation of debarment to be optimal becomes more stringent after the introduction of self-cleaning initiatives.

However, in practice, eliminating self-cleaning might be suboptimal. Self-cleaning initiatives are designed to make firms work on their trustworthiness. By not implementing the opportunity for self-cleaning, firms will not experience an incentive to engage in such activities. It decrease the effectiveness of debarment as an anti-cartel enforcement tool, but firms no longer put any effort or investments into changing towards a more honest business strategy in the long run. Furthermore, self-cleaning is said to reduce the short-term costs of leaving out convicted players and accelerates the process towards obtaining the benefits that motivated the government to implement debarment, namely a competitive market equilibrium (Hjelmeng & Soreide, 2014).

## 5. Extension: Interaction with leniency programs and private damages

Apart from solely focusing on the effect of debarment on cartel deterrence and sustainability while taking into account the presence of private damages and leniency programs, it also interesting to see the effect of debarment on the effectiveness of the other two antitrust instruments. In order to gain a better insight into the interaction between debarment and leniency programs and debarment and private damages, the implicit derivatives were taken from (18) and (23) with respect to the policy parameters $D^R$, $D^{NR}$ and $F$.

I will first focus on the interaction between the mechanisms of debarment and leniency programs, see Appendix 5.1. I assume that debarment is only implemented when the effectiveness constraint, (19) in the absence of self-cleaning and (24) debarment legislation including self-cleaning, is satisfied. Based on analytical expression (40) and (41), one can then see that the introduction of a leniency program with a fine still results in an increase of the critical discount factor. In other words, leniency programs lead to a lower sustainability of cartel agreements in equilibrium. Debarment actually exacerbate the effectiveness of leniency programs in terms of reducing cartel sustainability given that the denominator of (40) and (41) is lower compared to (26) while the nominator has remained identical. In case the government chooses to exempt the reporting firm from debarment, the effectiveness of leniency programs is further enhanced. Contrarily, implementing self-cleaning impairs the increase in effectiveness caused by the interaction between debarment and leniency programs.

A similar result is obtained for the interaction between private damages and leniency programs. Under the assumption that debarment is only implemented when the effectiveness constraint is satisfied, the impact of private damages remains the same. However, just as with leniency programs, debarment exacerbates this effect. By looking at (42) and (43), one can see that increasing the expected pay-out of private damages for a non-reporting firm reduces the sustainability of collusive agreements. This reduction in sustainability is higher compared to in the benchmark model, see (26). Including self-cleaning initiatives in debarment legislation, once again, does impair the increase in effectiveness of private damages of non-reporting firms in terms of sustainability. In contrast, including legislation concerning exemption for the reporting firm in debarment further reinforces the reduction in sustainability. Next, the expected pay-out for private damages for the leniency applicant was analysed.

In the benchmark model, see (30), a higher level of private damages for a reporting firm reduced the discount factor. This means that a lower level of patience is required from firms to sustain collusive agreements making them more likely. The same impact is found after implementation of debarment, see (44) and (45), but to a greater extent. The introduction of self-cleaning in debarment legislation would in this case mitigate the negative interaction between private damages for a reporting firm and debarment, while exempting a leniency applicant would further worsen the situation.

In short, this means that whether a government or organisation should implement debarment and what legal regime is preferred based on its interaction with leniency programs and private damages depends on how they structured their antitrust legislation. In a situation where CAs rely on high fines and a high expected pay-out of private damages for non-reporting firms while leniency applicants are granted immunity from civil liability ($D^R = 0$), it is best to implement debarment with special exemption for reporting firms minus self-cleaning initiatives. Given that the effectiveness constraint of debarment is not violated. In contrast, this course of action might be the worst decision possible in an economy where the fines are low and the expected pay-out of damages for a leniency applicant are equal in value to those for non-reporting firms.

## 6. Conclusion

Debarment has been an important instrument to combat corruption and to enhance government integrity. In this paper, I tried to analyse debarment as an anti-cartel enforcement tool. I believe it is important for policy makers to obtain a better understanding of the mechanisms of debarment and its potential in the battle against cartels. The presented analysis shows that the implementation of debarment legislation leads to not only higher deterrence levels, but it also makes defection more attractive in the collusive agreements that emerge.

Further, to enhance the effectiveness of debarment, governments and international organisations could choose to make the mechanism interact with leniency programs by providing exemption for reporting firms. Notwithstanding, that granting immunity to leniency applicants will not lead to higher deterrence levels, it will cause the collusive agreements that arise to become less sustainable. It also addresses the common believes that debarment will negatively impact the performance of leniency programs. The incentive stemming from being able to avoid a fine is no longer partly counterbalanced by the risk of losing future revenues due to being excluded from future procurement auctions.

Another potential supplement to debarment legislation are self-cleaning initiatives. This analysis shows that the introduction of self-cleaning initiatives cause the effectiveness of debarment to be reduced. The possibility of self-cleaning decreases the deterrence levels of cartel forming. However, the deterrence levels are still higher compared to the benchmark model in which debarment was absent. In addition, self-cleaning makes collusive agreements more sustainable in equilibrium. Thus, based on a solely technical point of view with respect to anti-cartel enforcement, it would be best to not include

self-cleaning initiatives. On the other hand, self-cleaning could potentially change future behaviour of companies rather than solely punish the perpetrators. Therefore, whether or not to include such initiatives in legislation depends on the preferences of governments and international organisations.

Admittedly, debarment is only effective when specific conditions with respect to how stringent the program is are met. In contexts where these conditions are violated, debarment as a strategy against collusion is hard to defend. Debarment is a double edged sword and when implemented too lenient, it could become a facilitator of collusion. Further research will need to be conducted to gain a better insight into the two-faced nature of debarment. This could lead to more information about how debarment can be implemented optimally.

One could propose to make the length of debarment longer to avoid the debarment legal regime from being too lenient. In this paper, the analysis was conducted under the assumption that the debarment period was one period regardless of the specific of the crime. But the length of debarment could be increased or made contingent on the nature and consequences of the crime. Prior research has shown that the severity in which debarment decreases the frequency of collusion is increasing the length of exclusion. However, a longer debarment will also mean longer-term harm to competition, which is counterintuitive to the objective of debarment. To minimise the costs to competition, firms should not be excluded from procurement auctions longer than what is deemed "necessary". Therefore, more research has to be conducted into the optimal length of debarment.

In addition, my technical analysis of debarment as an instrument of antitrust legislation is useful for understanding its potential effect. However, the effects in practice will depend on the government system that manages the tool and the exact way it is implemented. For the sake of securing the positive effects that debarment has on cartel deterrence, governments should introduce more internationally harmonised legislation and care for better enforcement and execution of debarment laws. For future research, it might interesting to focus more on practical difficulties that might occur with the introduction with specific anti-cartel enforcement debarment legislation.

## Appendix A

### A.1 Profits

In case of a monopoly, the government becomes the buyer in a second-bid auction with one bidder. The government will clearly need to set a maximum price, otherwise the price offered by the supplying firm will go to infinity. In the optimal maximum price is equal to the monopoly price. The government is assumed to be risk neutral. Moreover, the government is assumed to be aware of the distribution from which the marginal costs, $c$, of the potential supplier are drawn. They don't know the exact value of the marginal costs. From the paper of Laffont & Maskin (1980), we then know that the maximisation problem of the government can be presented as:

$$\min_{m}\big(1 - F(m)\big)m \cdot \mathbb{E}Q$$

Where $m$ denotes the maximum price and $F(\cdot)$ the distribution function. The first order condition then becomes:

$$m^* = \frac{1 - F(m^*)}{f(m^*)}$$

Where $f(\cdot)$ denotes the density function. Given that the firms marginal cost value $c$ is drawn from an independent, uniform distribution $[0, 1]$, we know that $m^* = 0.5$. This means that the government will set a maximum price of $0.5$. Under the assumption that the potential supplier is aware of this maximum price, they will bid exactly the reservation price. As a result, they will obtain a profit of $\pi_{Monopoly} = p \cdot q = 0.5 \cdot \mathbb{E}Q$.

### A.2 Benchmark model

#### A.2.1 Construction of the model

We first start by computing the expected payoff of a firm $i = 1, \dots, N$ when it participates in an infinite sequence of competitive auctions:

$$V^{Nash} = 0 \cdot \sum_{t=0}^{\infty} \delta^t = \frac{0}{(1 - \delta)} = 0$$

Superscript $Nash$ represents the Nash equilibrium outcome, the expected pay-off in a competitive environment. Next, we compute the expected pay-off in case of a collusive agreement:

$$V_B^{Collusion} = \left[\frac{1}{N} \cdot 0.5\mathbb{E}Q - \rho(F + D^{NR})\right] \sum_{t=0}^{\infty} \delta^t = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho(F + D^{NR})}{1-\delta}$$

Superscript $Collusion$ represents the expected pay-off in a collusive setting and subscript $B$ denotes the benchmark model. Being a member of a cartel is profitable for firm $i = 1, \dots, N$ if and only if $V_B^{Collusion} > V^{Nash}$ which is equivalent to

$$N \leq N_B \equiv \frac{0.5\mathbb{E}Q}{\rho(F + D^{NR})}$$

In words, the expected monopoly profit that can be obtained in the auction relative to the expected penalty of colluding must be larger than the number of members in the cartel for collusion to be profitable. A cartel is stable if deviating at any period $t \geq 0$ from the collusive agreement is not profitable. Given that $D_{US}^{NR} > D_{EU}^{NR}$, the number of players must be smaller for collusion to be sustainable in the US in comparison to the EU. A firm that deviates in the second stage from the collusive agreement will also find it optimal to apply for leniency by the CA. Given the others comply, it will then earn profits of $(5)$ in combination with fine immunity. It remains liable for private damages of $D^R$. In future auctions, given all firms utilise the grim trigger Nash reversion punishment strategy, the reporting firm will earn profits of $(3)$. The expected pay-off of deviating is therefore:

$$V_B^{Deviate} = 0.5\mathbb{E}Q - D^R + 0 \cdot \sum_{t=1}^{\infty} \delta^t = 0.5\mathbb{E}Q + \frac{0}{1-\delta} - 0 = 0.5\mathbb{E}Q - D^R$$

Superscript $Deviate$ represents that the analytical expression denotes the expected pay-off in a collusive setting. From here I can deduce that at date $t \geq 0$ deviation is ex-ante unprofitable if:

$$ICC_B = V_B^{Collusion} - V_B^{Deviate} = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho(F + D^{NR})}{1-\delta} - 0.5\mathbb{E}Q + D^R \geq 0$$

Equivalently

$$0.5\mathbb{E}Q - D^R \leq \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho(F + D^{NR})}{1-\delta}$$

This yields

$$\delta \geq \underline{\delta}_B \equiv 1 - \frac{0.5\mathbb{E}Q}{N(0.5\mathbb{E}Q - D^R)} + \frac{\rho(F + D^{NR})}{0.5\mathbb{E}Q - D^R}$$

### A.2.2 Extensive analysis of the benchmark critical discount factor

To examine the influence of the size of the fine, the value of private damages in case of no reporting, the expected pay-out for private damages for the leniency applicant, the expected demand of goods from the government, the probability of detection and numbers of players in the market on the critical discount factor, I have computed the implicit derivatives of the $ICC$ in Appendix 2.1. To interpret the derivatives and the effect of the parameters on the critical discount factor, the assumption is made that the net present value of collusion is strictly positive.

$$\frac{\partial \underline{\delta}_B}{\partial F} = \frac{\partial \underline{\delta}_B}{\partial D^{NR}} = -\frac{\frac{\partial ICC_B}{\partial D^{NR}}}{\frac{\partial ICC_B}{\partial \delta}} = -\frac{\frac{\partial ICC_B}{\partial F}}{\frac{\partial ICC_B}{\partial \delta}} = \frac{\frac{\rho}{1-\delta}}{\frac{1}{1-\delta} \cdot V_B^{Collusion}} > 0 \tag{26}$$

Which simplifies to

$$\frac{\partial \underline{\delta}_B}{\partial F} = \frac{\partial \underline{\delta}_B}{\partial D^{NR}} = \frac{\rho}{0.5\mathbb{E}Q - D^R} > 0$$

An increase in fines or the value of private damages in case of no leniency applicant, increases the critical discount factor. Thus, firms have to be more patient for collusion to be sustainable in equilibrium.

$$\frac{\partial \underline{\delta}_B}{\partial \rho} = -\frac{\frac{\partial ICC_B}{\partial \rho}}{\frac{\partial ICC_B}{\partial \delta}} = \frac{\frac{F + D^{NR}}{1-\delta}}{\frac{1}{1-\delta} \cdot V_B^{Collusion}} > 0 \tag{27}$$

Which simplifies to

$$\frac{\partial \underline{\delta}_B}{\partial \rho} = \frac{F + D^{NR}}{0.5\mathbb{E}Q - D^R} > 0$$

An increase in the probability of detection, also increases the critical discount factor. Thus, firms have to be more patient for collusion to be sustainable in equilibrium.

$$\frac{\partial \underline{\delta}_B}{\partial N} = -\frac{\frac{\partial ICC_B}{\partial N}}{\frac{\partial ICC_B}{\partial \delta}} = \frac{\frac{0.5\mathbb{E}Q}{N^2(1-\delta)}}{\frac{1}{1-\delta} \cdot V_B^{Collusion}} > 0 \tag{28}$$

Which simplifies to

$$\frac{\partial \underline{\delta}_B}{\partial N} = \frac{0.5\mathbb{E}Q}{N^2(0.5\mathbb{E}Q - D^R)} > 0$$

An increase in the number of potential suppliers in the auction makes collusive behaviour less sustainable. It results in a higher discount factor. The effect on the critical discount factor is diminishing as $N$ further increases.

$$\frac{\partial \underline{\delta}_B}{\partial \mathbb{E}Q} = -\frac{\frac{\partial ICC_B}{\partial \mathbb{E}Q}}{\frac{\partial ICC_B}{\partial \delta}} = \frac{0.5\left(1 - \frac{1}{N(1-\delta)}\right)}{\frac{1}{1-\delta} \cdot V_B^{Collusion}} \tag{29}$$

Which simplifies to

$$\frac{\partial \underline{\delta}_B}{\partial \mathbb{E}Q} = \frac{\frac{1}{N} \cdot 0.5\mathbb{E}Q - \rho(F + D^{NR}) - \frac{1}{N}(0.5\mathbb{E}Q - D^R)}{2(0.5\mathbb{E}Q - D^R)^2}$$

If $N(1-\delta) > 1$, collusion becomes more sustainable when the demand of goods asked by the public purchaser increases. An increase in demand results in a decrease of the critical discount factor. In contrast, if $N(1-\delta) < 1$, anticompetitive conducts are sustainable and the critical discount factor increases due to higher demand.

$$\frac{\partial \underline{\delta}_B}{\partial D^R} = -\frac{\frac{\partial ICC_B}{\partial D^R}}{\frac{\partial ICC_B}{\partial \delta}} = \frac{-1}{\frac{1}{1-\delta} \cdot V_B^{Collusion}} < 0 \tag{30}$$

Which simplifies to

$$\frac{\partial \underline{\delta}_B}{\partial D^R} = \frac{\rho(F + D^{NR}) - 0.5\mathbb{E}Q \cdot \frac{1}{N}}{(0.5\mathbb{E}Q - D^R)^2} < 0$$

An increase in the expected pay-out of private damages for a leniency applicant result in a decrease of the critical discount factor, so anticompetitive conducts are more likely to be sustained in equilibrium.

**A.3 Dynamics of debarment**

I start by computing the expected pay-off in case of a collusive agreement:

$$V_D^{Collusion} = \left[\frac{0.5\mathbb{E}Q}{N} - \rho\left(F + D^{NR} + \delta\frac{0.5\mathbb{E}Q}{N}\right)\right]\sum_{t=0}^{\infty}\delta^t$$

$$= \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta\frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta}$$

Superscript $Collusion$ represents the expected pay-off in a collusive setting and subscript $D$ denotes the model with debarment legislation. Being a member of a cartel is profitable for firm $i = 1, \dots, N$ if and only if $V_D^{Collusion} > V^{Nash}$ which is equivalent to

$$N \leq \overline{N_D} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho\delta)}{\rho(F + D^{NR})}$$

A cartel is stable if deviating at any period $t \geq 0$ from the collusive agreement is not profitable. A firm that deviates in the second stage from the collusive agreement will also find it optimal to apply for leniency by the CA. Given the others comply, it will then earn profits of (5) in combination with fine immunity. It remains liable for private damages of $D^R$. Also, they will be debarred for their involvement in the cartel. During the debarment period, firms are unable to compete in auctions and therefore obtain a profit of zero. The reporting firm could be granted leniency and be exempted from debarment. If so, they are the sole competitor in the auction during the period that its co-conspirators are debarred. The reporting firm is then able to obtain a profit of (5). Once all firms are allowed to return, given all firms utilise the grim trigger Nash reversion punishment strategy, they will earn profits of (3) in future procurement auctions. The expected pay-off of deviating is therefore:

$$V_D^{Deviate} = 0.5\mathbb{E}Q - D^R + \psi\cdot\delta\cdot 0.5\mathbb{E}Q + 0\cdot\sum_{t=2}^{\infty}\delta^t = 0.5\mathbb{E}Q(1+\psi\delta) - D^R$$

Superscript $Deviate$ denotes the expected pay-off in a collusive setting. From here I can deduce that at date $t \geq 0$ deviation is ex-ante unprofitable if:

$$ICC_D = V_D^{Collusion} - V_D^{Deviate} = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta\frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta} - 0.5\mathbb{E}Q(1+\psi\delta) + D^R \geq 0$$

To analyse the impact of debarment on the critical discount, the implicit derivatives were obtained with respect to the debarment parameters (number of suppliers $(N)$, demand $(\mathbb{E}Q)$ and leniency $(\psi)$).

$$\frac{\partial \underline{\delta_D}}{\partial \psi} = -\frac{\frac{\partial ICC_D}{\partial \psi}}{\frac{\partial ICC_D}{\partial \delta}} = \frac{\delta 0.5\mathbb{E}Q}{\frac{1}{1-\delta}\cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{31}$$

$$\frac{\partial \underline{\delta_D}}{\partial N} = -\frac{\frac{\partial ICC_D}{\partial N}}{\frac{\partial ICC_D}{\partial \delta}} = \frac{\frac{0.5\mathbb{E}Q}{N^2(1-\delta)}(1-\rho\delta)}{\frac{1}{1-\delta}\cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{32}$$

$$\frac{\partial \underline{\delta_D}}{\partial \mathbb{E}Q} = -\frac{\frac{\partial ICC}{\partial \mathbb{E}Q}}{\frac{\partial ICC}{\partial \delta}} = \frac{0.5\left[1 + \psi\delta - \frac{1-\delta\rho}{N(1-\delta)}\right]}{\frac{1}{1-\delta}\cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{33}$$

$$\frac{\partial \underline{\delta_D}}{\partial \rho} = -\frac{\frac{\partial ICC}{\partial \rho}}{\frac{\partial ICC}{\partial \delta}} = \frac{\frac{F + D^{NR} + \delta\frac{0.5\mathbb{E}Q}{N}}{1-\delta}}{\frac{1}{1-\delta}\cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{34}$$

To interpret the implicit derivatives it is important to know whether the denominator is positive or negative. However, there is no clear answer to that question. Therefore the following condition was derived:

$$N > N_{D,E} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho)}{\rho(F + D^{NR}) + 0.5\mathbb{E}Q\cdot\psi\cdot(1-\delta)^2}$$

Here, subscript E denotes effectiveness of debarment. If the condition is satisfied, the denominator is positive. If the condition is violated, the denominator of the implicit derivatives is negative.

### A.4 Self-cleaning initiatives

We first start by computing the expected payoff of a firm $i = 1, \dots, N$ when it participates in an infinite sequence of competitive auctions:

$$V^{Nash} = 0 \cdot \sum_{t=0}^{\infty} \delta^t = \frac{0}{(1-\delta)} = 0$$

Superscript $Nash$ represents the Nash equilibrium outcome, the expected pay-off in a competitive environment. Next, we compute the expected pay-off in case of a collusive agreement in an economy with debarment and the possibility of self-cleaning:

$$V_S^{Collusion} = \left[\frac{0.5\mathbb{E}Q}{N} - \rho\left(F + D^{NR} + \delta\left[\lambda\frac{0.5\mathbb{E}Q}{N} + (1-\lambda)\cdot 0\right]\right)\right]\sum_{t=0}^{\infty}\delta^t =$$

$$\frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta\cdot\lambda\frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta}$$

Superscript $Collusion$ represents the expected pay-off in a collusive setting and subscript $S$ denotes the model including debarment legislation and self-cleaning initiatives. Being a member of a cartel is profitable for firm $i = 1, \dots, N$ if and only if $V_S^{Collusion} > V^{Nash}$ which is equivalent to

$$N \leq \overline{N_S} \equiv \frac{0.5\mathbb{E}Q\ (1-\rho\delta\lambda)}{\rho(F + D^{NR})}$$

A cartel is stable if deviating at any period $t \geq 0$ from the collusive agreement is not profitable. A firm that deviates in the second stage from the collusive agreement will also find it optimal to apply for leniency by the CA. Given the others comply, it will then earn profits of $(5)$ in combination with fine immunity. It remains liable for private damages of $D^R$. Also, they will be debarred for their involvement in the cartel. During the debarment period, firms are unable to compete in auctions and therefore obtain a profit of zero. However, they are allowed to re-enter early if they engage in self-cleaning initiatives which they do with probability $1-\lambda$. The reporting firm could be granted leniency and be exempted from debarment. If so, they are the sole competitor in the auction during the period that its co-conspirators are debarred. The reporting firm is then able to obtain a profit of $(5)$. A leniency applicant that had been exempted from debarment can no longer obtain monopoly profits if competitors are allowed to re-enter early. Once firms are allowed to return, given all firms utilise the grim trigger Nash reversion punishment strategy, they will earn profits of $(3)$ in future procurement auctions. The expected pay-off of deviating is therefore:

$$V_S^{Deviate} = 0.5\mathbb{E}Q + \delta[0.5\mathbb{E}Q \cdot \psi\lambda + 0 \cdot (1-\lambda)] - D^R = 0.5\mathbb{E}Q(1 + \psi\delta \cdot \lambda) - D^R$$

Superscript $Deviate$ denotes the expected pay-off in a collusive setting. From here I can deduce that at date $t \geq 0$ deviation is ex-ante unprofitable if:

$$ICC_S = V_S^{Collusion} - V_S^{Deviate} = \frac{0.5\mathbb{E}Q}{N(1-\delta)} - \frac{\rho\left(F + D^{NR} + \delta \cdot \lambda\frac{0.5\mathbb{E}Q}{N}\right)}{1-\delta} - 0.5\mathbb{E}Q(1 + \psi\delta \cdot \lambda) + D^R \geq 0$$

To analyse the impact of debarment on the critical discount, the implicit derivatives were obtained with respect to the debarment parameters (number of suppliers $(N)$, demand $(\mathbb{E}Q)$, leniency $(\psi)$, and self-cleaning initiatives $(\lambda)$).

$$\frac{\partial\underline{\delta}_S}{\partial\psi} = -\frac{\frac{\partial ICC_S}{\partial\psi}}{\frac{\partial ICC_S}{\partial\delta}} = \frac{\lambda\delta 0.5\mathbb{E}Q}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda + \frac{\rho\lambda}{N(1-\delta)}\right)} \tag{35}$$

$$\frac{\partial\underline{\delta}_S}{\partial N} = -\frac{\frac{\partial ICC_S}{\partial N}}{\frac{\partial ICC_S}{\partial\delta}} = \frac{\frac{0.5\mathbb{E}Q}{N^2(1-\delta)}(1-\rho\delta\lambda)}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda + \frac{\rho\lambda}{N(1-\delta)}\right)} \tag{36}$$

$$\frac{\partial\underline{\delta}_S}{\partial\mathbb{E}Q} = -\frac{\frac{\partial ICC_S}{\partial\mathbb{E}Q}}{\frac{\partial ICC_S}{\partial\delta}} = \frac{0.5\left[1 + \psi\delta\lambda - \frac{1-\delta\rho\lambda}{N(1-\delta)}\right]}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda + \frac{\rho\lambda}{N(1-\delta)}\right)} \tag{37}$$

$$\frac{\partial\underline{\delta}_S}{\partial\lambda} = -\frac{\frac{\partial ICC_S}{\partial\lambda}}{\frac{\partial ICC_S}{\partial\delta}} = \frac{0.5\mathbb{E}Q\left[\frac{\rho\delta}{N(1-\delta)} + \psi\delta\right]}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda + \frac{\rho\lambda}{N(1-\delta)}\right)} \tag{38}$$

$$\frac{\partial\underline{\delta}_S}{\partial\rho} = -\frac{\frac{\partial ICC_S}{\partial\rho}}{\frac{\partial ICC_S}{\partial\delta}} = \frac{\frac{F + D^{NR} + \lambda \cdot \delta\frac{\mathbb{E}Q}{2N}}{1-\delta}}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{39}$$

To interpret the implicit derivatives it is important to know whether the denominator is positive or negative. However, there is no clear answer to that question. Therefore the following condition was derived:

$$N > N_{S,E} \equiv \frac{0.5\mathbb{E}Q\ (1-\lambda\rho)}{\rho(F+D^{NR})+0.5\mathbb{E}Q\cdot\psi\cdot\lambda\cdot(1-\delta)^2}$$

Here, subscript E denotes effectiveness of debarment. If the condition is satisfied, the denominator is positive. If the condition is violated, the denominator of the implicit derivatives is negative.

### A.5 Interaction between antitrust instrument

To analyse the impact of debarment on the effect of private damages and leniency programs on the critical discount, the implicit derivatives were obtained from the incentive compatibility constraints (see (18) and (23) respectively) with respect to the policy parameters $D^{NR}$, $D^{R}$ and $F$.

#### A.5.1 Leniency programs and debarment

First, the interaction between the mechanisms of leniency programs and debarment is analysed by taking the implicit derivative from (18) and (23) with respect to the fine. The following results were obtained:

$$\frac{\partial \underline{\delta_D}}{\partial F} = -\frac{\frac{\partial ICC_D}{\partial F}}{\frac{\partial ICC_D}{\partial \delta}} = \frac{\frac{\rho}{1-\delta}}{\frac{1}{1-\delta}\cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi+\frac{\rho}{N(1-\delta)}\right)} \tag{40}$$

$$\frac{\partial \underline{\delta_S}}{\partial F} = -\frac{\frac{\partial ICC_S}{\partial F}}{\frac{\partial ICC_S}{\partial \delta}} = \frac{\frac{\rho}{1-\delta}}{\frac{1}{1-\delta}\cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda+\frac{\rho\lambda}{N(1-\delta)}\right)} \tag{41}$$

#### A.5.2 Private damages and debarment

Next, the interaction between private damages and debarment was analysed. There are two important parameters when it comes to the private damage legal regime, namely $D^{R}$ which denotes the expected pay-out of private damage for the reporting firm and $D^{NR}$ which represents the expected private damages for the non-reporting firms. The implicit derivatives of (18) and (23) with respect to these parameters are:

$$\frac{\partial \underline{\delta}_D}{\partial D^{NR}} = -\frac{\frac{\partial ICC_D}{\partial D^{NR}}}{\frac{\partial ICC_D}{\partial \delta}} = \frac{\frac{\rho}{1-\delta}}{\frac{1}{1-\delta} \cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{42}$$

$$\frac{\partial \underline{\delta}_S}{\partial D^{NR}} = -\frac{\frac{\partial ICC_S}{\partial D^{NR}}}{\frac{\partial ICC_S}{\partial \delta}} = \frac{\frac{\rho}{1-\delta}}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda + \frac{\rho\lambda}{N(1-\delta)}\right)} \tag{43}$$

$$\frac{\partial \underline{\delta}_D}{\partial D^{R}} = -\frac{\frac{\partial ICC_D}{\partial D^{R}}}{\frac{\partial ICC_D}{\partial \delta}} = \frac{-1}{\frac{1}{1-\delta} \cdot V_D^{Collusion} - 0.5\mathbb{E}Q\left(\psi + \frac{\rho}{N(1-\delta)}\right)} \tag{44}$$

$$\frac{\partial \underline{\delta}_S}{\partial D^{R}} = -\frac{\frac{\partial ICC_S}{\partial D^{R}}}{\frac{\partial ICC_S}{\partial \delta}} = \frac{-1}{\frac{1}{1-\delta} \cdot V_S^{Collusion} - 0.5\mathbb{E}Q\left(\psi\lambda + \frac{\rho\lambda}{N(1-\delta)}\right)} \tag{45}$$

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