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**ROUNDTABLE ON EX OFFICIO CARTEL INVESTIGATIONS AND THE USE OF SCREENS TO
DETECT CARTELS**

-- Background Note by the Secretariat --

The note by the Secretariat is submitted FOR DISCUSSION under item X of the forthcoming Competition Committee meeting to be held on 30-31 October 2013.

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EX OFFICIO CARTEL INVESTIGATIONS AND THE USE OF SCREENS TO DETECT CARTELS

Background paper by the Secretariat¹

1. Introduction

1. Investigating, prosecuting and bringing hard core cartels to an end, as well as deterring individuals and firms from taking part in such conspiracies remains a top priority for competition agencies. But because cartels are secret conspiracies and cartelists go to great lengths in concealing their illegal activities, evidence of direct communications and agreements between competitors is hard to uncover. In their efforts to overcome the inherent challenge of cartel detection, competition agencies tend to rely on “reactive detection” tools, i.e. on third parties coming forward with information on the existence and the functioning of the cartel, rather than pro-actively seeking out suspicious firms or markets to investigate *ex officio* (so called “pro-active detection”). Dissatisfied customers reporting suspicions of anti-competitive behaviour by sellers are an important source of information for competition agencies, just like disgruntled employees turned into whistle-blowers, or co-conspirators who choose to come forward and confess their illegal behaviour through amnesty or leniency programmes.² It is for this reason that most competition agencies around the world allocate most of their resources to pursuing the growing number of cases brought to them by such detection programmes, and devote less attention to pro-actively seeking out and detecting cartels. This policy choice has as a consequence that in some jurisdictions leniency programme cases have “crowded out” efforts to expose cartels by other means.

2. The question that this paper contributes to address is whether it is a good policy for competition agencies to rely exclusively, or almost exclusively, on amnesty/leniency programmes to detect cartels. There is a growing body of literature arguing against what is perceived a competition agencies’ bias towards reactive detection measures, and in particular amnesty/leniency programmes. In this regard, some commentators argue that neglecting pro-active detection measures may not only results in failure to capitalise on the stand-alone ability of these measures to trigger successful cartel investigations, but may also results in failure to benefit from their positive externalities in terms of improving the effectiveness of amnesty/leniency programmes. For example, a senior U.S. cartel enforcement official has recently stated that one of the three cornerstones of an effective amnesty/leniency programme is that “*organizations must perceive a high risk of detection by antitrust authorities if they do not self-report*”.³

¹ This paper was written by Antonio Capobianco of the OECD Competition Division and Yonatan Cwikel on secondment to the OECD Competition Division from the Israeli Antitrust Authority.

² According to the International Competition Network (ICN), complaints made by competitors, employees or consumers are the predominant method of cartel detection, but amnesty/leniency programmes seems to be more effective, mainly because they allow direct and speedy access to hard evidence of cartel behaviour, and because their implementation seems to require fewer resources in comparison to other detection measures. See ICN (2010).

³ See Hammond (2010).

3. It follows that competition agencies should consider complementing their reactive detection measures by pro-actively seeking out cartels and launching independent *ex officio* investigations against suspicious firms and individuals. It is in this context that this paper focuses on the role that empirical screens may play in pro-active cartel detection and in initiating *ex-officio* investigations. Screens are detection methodologies designed to help competition agencies decide which markets or industries are more likely to be prone to cartel behaviour, and in some cases they can also flag to them possible cartel behaviour that would deserve closer scrutiny.⁴

4. One approach, commonly referred to as “structural screening”, is based on what economic theory and empirical research tell us about the relationship between market characteristics and the likelihood of collusion occurring in markets, essentially by identifying certain structural features of products or market which facilitate collusion. This approach may enable a competition agency to screen any number of markets or industries in order to flag those markets where a cartel is more likely to occur.

5. The second approach, based on “behavioural screening”, is used for indicating whether a specific market was actually affected by collusion. Of course, direct evidence of cartelisation is not easily observable and is hard to uncover. However, economic theory and analysis of data on observed cartels has identified various types of observable traces that the creation, life, and break-up of a cartel are likely to leave behind. These trails are what behavioural screens are designed to detect.

6. These two approaches do not exclude each other. On the contrary, they are usually viewed as complementary, so that if the structural screening gives positive results, agencies can proceed with a more targeted review based on firms behaviour and their consistency with a competitive process.

7. At the outset, a note of caution on screens as an enforcement tool is necessary. The academic literature recognised that it is challenging to engage in a theoretical and empirical discussion on what sort of structures and/or behaviours are consistent with cartels. As this paper hopes to explain, there are market structures and market outcomes which *could* be consistent with collusion. Screens aim at detecting these structures and outcomes. However, screens do not answer a fundamental question that agencies face when screening gives a positive result: has the screen detected a cartel or “just” tacit collusion? This is most obviously a problem for structural screens, but it also relates to behavioural - do tacit and explicit collusion differ in what they imply for parallel pricing, variance of price etc.? It is important to say clearly at the outset that an effective screen should be able to distinguish competitive from non-competitive conduct, but whether the non-competitive conduct amounts to an infringement of competition law must be further ascertained through an in-depth antitrust investigation and the gathering of actual evidence of cartelisation.⁵

8. The purpose of this Background Note is first discusses the relationship between reactive and pro-active cartel detection tools, and makes a policy argument in favour of a mixed cartel detection policy where reactive and pro-active tools are used together and in support of each other. The second part of the paper explores the role that pro-active detection measures and screens in particular may play in effective cartel detection and deterrence. It describes the main features of structural and behavioural screens; it

⁴ Screens have multiple uses, but the focus of this paper is on their use in anti-cartel policies implemented by competition agencies and public procurement officials. For a review of additional uses of screens see the introductory remarks in Chapter 3 and Abrantes-Metz and Bajari (2012); Abrantes-Metz (2012); and Hüscherlath and Veith (2011).

⁵ If the purpose of screens is to detect collusive markets and outcomes for further investigation by the competition agency, and not to prove the existence of a cartel, in some (admittedly rare) cases they have also provided the agency with actual evidence of cartelisation that has been used in court to prove an actual cartel infringement. The Mexican case discussed in Annex 2 is a clear example of this.

provides an overview of the main theories on cartel screens developed in the literature; and it focuses on effective screen design and on the challenges associated with the implementation of screens. The paper includes two annexes: Annex 1 describes some of the cartel screens proposed by the economic literature, and Annex 2 discusses some of the experiences with the application of structural and behavioural screens by competition and other regulatory agencies to detecting cartels and other types of frauds and manipulations.

2. Balancing reactive and pro-active cartel detection tools

9. The adoption of an anti-cartel legislation in many OECD and non-OECD countries reflects the notion that cartels inflict considerable harm to society, and that society should take measures to protect itself against such practices and to punish the offenders. However, at least in jurisdictions where leniency or amnesty programmes are in place, deterrence (i.e. the decision of a firm not to engage in cartel activity) and desistance (i.e. the decision of a firm to break-up from an existing cartel), rather than retribution, is the anti-cartel enforcement policy's ultimate goal.⁶ After all, this is the reason why societies are willing to let the first cartel member to come forward and confess to being part of a cartel to go unpunished and this with the aim of intensifying the conflict of interests between cartel members, increasing cartel instability, and ultimately reducing the incentives to take part in cartels in the first place.

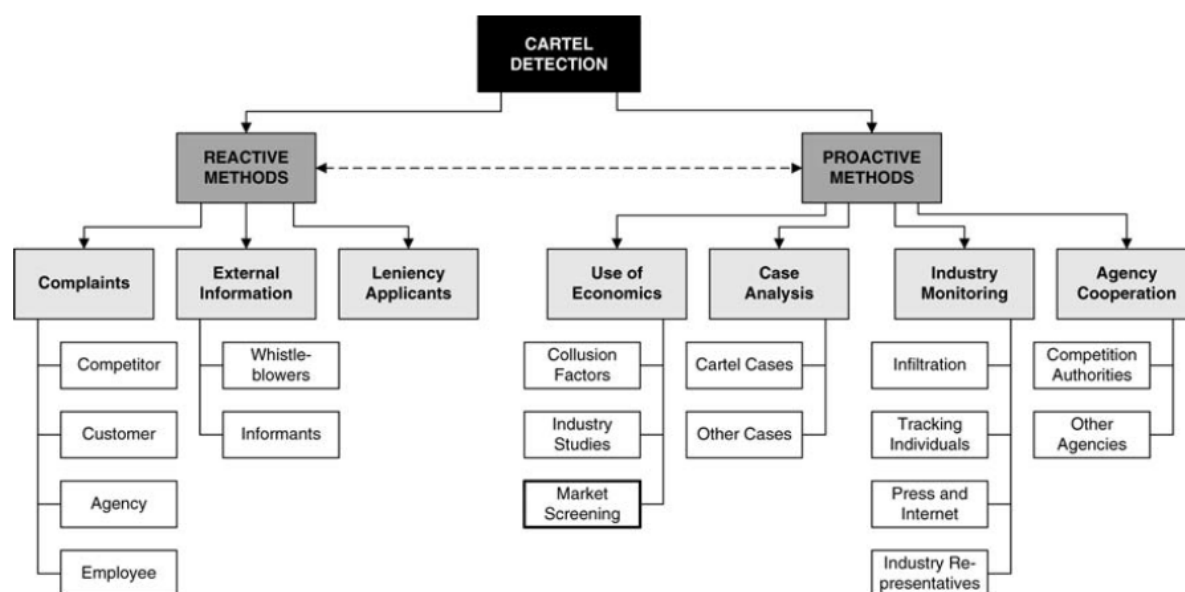
10. Effective cartel deterrence and desistance depend on the probability of the cartel being detected and their members being punished. But cartels secretive nature poses serious challenges for competition agencies, which in turn continue to consider a variety of measures to effectively detect cartels.⁷ Broadly speaking, competition agencies detect cartels through different means which include both pro-active and reactive measures (see Fig. 1 below).⁸

⁶ E.g. Friederiszick and Maier-Rigaud (2008); Spagnolo (2008); Harrington and Chang (2012), all highlighting deterrence as a primary goal for anti-cartel enforcement policy.

⁷ E.g. Schinkel (2008).

⁸ For a general review of various cartel detection measures, see ICN (2010).

Fig. 1 – Pro-active and reactive methods of cartel detection



Source: Hüschelrath (2010), based on ICN (2010).

11. *Reactive detection* methods are based on information or evidence brought before the competition agency by third parties. Leniency or amnesty programmes are considered the most effective reactive detection measure, especially because they provide the competition agency with direct evidence of a cartel. This in turn facilitates the investigation of the illegal conduct and the subsequent punishment of the perpetrators. In contrast, *pro-active detection* occurs when competition agencies engage in cartel detection on their own initiative, i.e. pro-active methods of cartel detection are initiated from within the agency and do not rely on an external triggering event.

12. There is little evidence on the relative importance of reactive cartel detection measures as opposed to pro-active methods. In a seminal paper, which pre-dates the adoption of the U.S. amnesty programme, Hay and Kelley⁹ identified at least twelve different detection methods in both categories actually used by the U.S. DOJ between 1963 and 1972 to detect overall 49 cartels. However, in 70% of the cases, one of the following four methods was actually applied: Grand Jury investigation in another case (24%), complaint by competitor (20%), complaint by customer (14%) and complaint by a local, State, or Federal agency (12%). More recently, the ICN concluded that most cartels are still discovered because of complaints by consumers and competitors.¹⁰

13. Competition agencies employ a variety of pro-active detection methods, such as the monitoring of media or trade press, monitoring of firms' participation to trade/business associations' activities and of their attendance at industry events, and of course – empirical economic analysis and screens. These and

⁹ Hay and Kelley (1974).

¹⁰ ICN (2010). This despite the fact that complaints are not considered a very effective detection measure because they often do not provide competition agencies with sufficient grounds for initiating investigations, and because they are costly to handle as the sheer number of complaints lodged with competition agencies can be significant. Whistle-blowers and informants can also lead to cartel detection; however, it is quite typical for the information provided by said sources to be outdated or biased.

other pro-active methods are usually more resource intensive and costly to implement, and their success rate, in terms of the number of cartel cases actually discovered through such methods, seems to be rather low.¹¹ Some authors argue that competition agencies should nevertheless invest more in pro-active detection and that this could be achieved by a wider implementation of empirical screens. In the following sections, we explore the arguments calling for a better balance between the main reactive detection measure – the amnesty/leniency programme – and pro-active detection measures.

2.1 *The success of leniency/amnesty programmes*

14. By offering amnesty to the first conspirator who fully cooperates with a competition agency, or a more lenient treatment to subsequent applicants, amnesty/leniency programmes are intended to induce cartel members to come forward and disclose the existence of a cartel, and to provide evidence of their involvement in the conspiracy.¹² Amnesty/leniency programmes have increased significantly the number of detected cartels in many jurisdictions.¹³ They seem to have also facilitated the successful prosecution of cartel cases by providing competition agencies with hard evidence of the competition law infringement.¹⁴ A few examples will illustrate this success story:

- In the United States, the first antitrust amnesty programme was adopted in 1973 but remained largely ineffective until it was reformed in 1993.¹⁵ Today, the programme allows corporations and individuals, who have engaged in anti-competitive cartel activity to receive amnesty from government penalties (fines and prison sentences). According to Werden and others, “[o]ver ninety percent of fines imposed for Sherman Act violations since 1996 can be traced to investigations assisted by leniency applicants, and prosecutions assisted by leniency applicants accounted for over ninety percent of the total commerce affected by all the cartels prosecuted by the Division since 1999.”¹⁶
- In the European Union, the first leniency programme was adopted by the European Commission in 1996, and was subsequently revised in 2002 and in 2006.¹⁷ As a consequence of the adoption of its leniency programme, the European Commission received many leniency applications

¹¹ As shall be further discussed, one should also consider detection measures’ effect on deterrence. In theory, implementation of very effective measures may increase deterrence to the extent that no cartels being detected.

¹² This general description of amnesty/leniency programmes is sufficient for the current discussion. Note, however, that while amnesty/leniency programmes are conceptually similar, their design and implementation may vary across jurisdictions (e.g. Spagnolo, 2008). For further details on different types of leniency programmes see OECD (2012).

¹³ E.g. Friederiszick and Maier-Rigaud (2008); Harrington and Chang (2012) and references there.

¹⁴ ICN (2010).

¹⁵ The 1993 revision made it possible for amnesty to be awarded even when an investigation had been started and made it a condition that the U.S. DOJ “has not received information about the illegal activity being reported from any other source.” This means that amnesty is limited to one firm per cartel. Relevant material and information on the U.S. Leniency Program are available at <http://www.justice.gov/atr/public/criminal/leniency.html>.

¹⁶ Werden, Hammond and Barnett (2012).

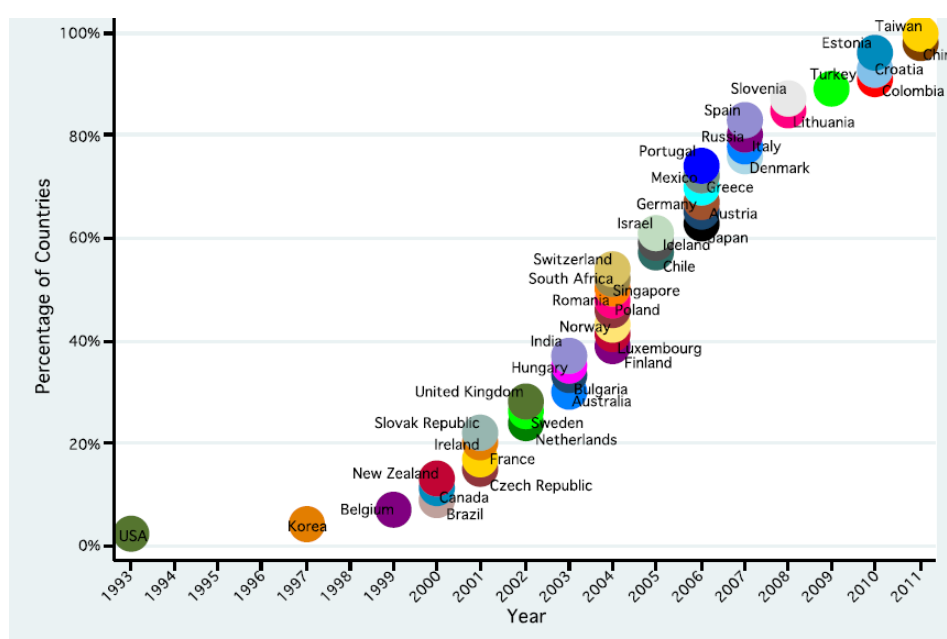
¹⁷ See European Commission, Commission Notice on the non-imposition or reduction of fines in cartel cases, in O.J. [1996] C 207/4; European Commission, Commission Notice on Immunity from fines and reduction of fines in cartel cases, in O.J. [2002] C 45/3; European Commission, Commission Notice on Immunity from fines and reduction of fines in cartel cases, in O.J. [2006] C 298/17.

(approximately 188 between 1996 and 2002) and 46 out of 52 cartel decisions (88%) from 2002 through 2008 were triggered by a leniency application.¹⁸

- Similar experiences can be traced in various jurisdictions around the world. By way of example, Harrington reports that the South African Competition Commission receives on average three leniency applications a month, which is more than the average monthly rate of amnesty applications in the U.S. Similarly, In Spain, the day its leniency programme was launched on February 28, 2008, seven applications were received.¹⁹

The figures and table below illustrate the fast pick up of leniency programmes in both OECD and non-OECD economies.²⁰

Fig. 2 – Pick up of leniency programmes around the world



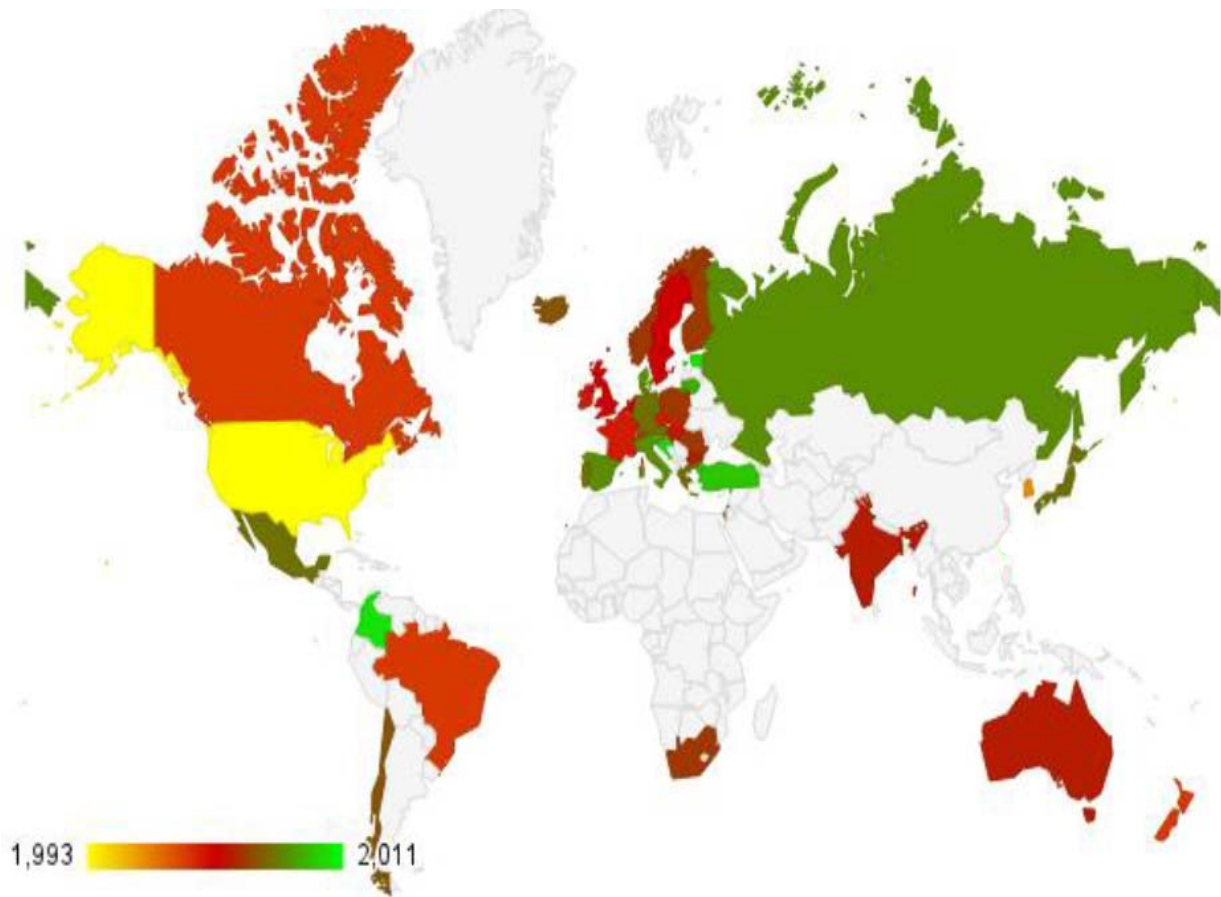
Source: Borrell, Jiménez and García (2012)

¹⁸ European Parliament, Parliamentary questions: Joint answer given by EU Commissioner Kroes on behalf of the European Commission to written questions: E-0890/09, E-0891/09, E-0892/09, 2 April 2009; and Riley (2010).

¹⁹ Harrington (2010).

²⁰ The figures and table from Borrell, Jiménez and García (2012) do not include the EU leniency programme, first adopted in 1999 and then revised in 2002 and 2006. The authors of this Background Paper also note that the German Bundeskartellamt established its leniency programme in 2000, and only revised it in 2006, which would make Germany an “early adopter” in Table 1.

Fig. 3 - Pick up of leniency programmes around the world (map)



Source: Borrell, Jiménez and García (2012)

Table 1 – Pick up of leniency programmes around the world

		Countries with leniency programme	% adopters
1998		2	3%
1999		2	3%
2000	Early adopters	3	5%
2001		5	8%
2002		9	15%
2003		12	20%
2004	Middle adopters	16	27%
2005		25	42%
2006		28	47%
2007		34	58%
2008	Latecomers	38	64%
2009		40	68%
2010		41	69%
2011		44	75%

Source: Borrell, Jiménez and García (2012) – Survey based on 54 jurisdictions, and on leniency information from competition authorities' web pages and from the ICN website

15. Because amnesty/leniency programmes are generally regarded as a very effective investigative tool,²¹ some competition agencies seem to have shifted most of their resources to the pursuit of amnesty/leniency cases.²² In addition, some studies suggest that leniency programmes have a positive effect on cartel desistence and deterrence levels, though this effect may be difficult to measure. For example, Borrell and others argue the implementation of leniency programmes has had an effect on managers' perceptions of competition agencies' detection capabilities.²³ Using data for 59 countries during a 14-year span, the authors find that leniency programmes increase the perception of effectiveness by an order of magnitude ranging from 10% to 21%. They conclude that leniency programmes have become "*weapons of mass dissuasion*" for competition agencies, especially against the more damaging forms of explicit collusion in the market place.

2.2 Limits of amnesty/leniency programmes

16. The uptake of amnesty/leniency programmes around the world has raised concerns that competition agencies may become victims of their own success. The argument is that competition agencies impressed or flooded by an increasing number of amnesty/leniency applications and of successful cases

²¹ ICN (2010); and Miller (2009), as far the US amnesty programme is concerned.

²² Friederiszick Maier-Rigaud (2008).

²³ Borrell, Jiménez and García (2012). See also Chen and Harrington (2007), who argue that overall, implementation of amnesty/leniency programmes has a negative effect on cartel formation. On the same point, see also Aubert, Kovacic, and Rey (2003), Motta and Polo (2003), Spagnolo (2003), Feess and Walzl (2004), Motchenkova (2004), and Harrington (2005). However, some authors have questioned the effectiveness of amnesty/leniency programmes to deter and desist cartel behaviour (see, for example, Brenner 2009 and De 2010, both on the EC leniency programme).

detected through such programmes²⁴ are not devoting enough attention and resources to pro-active, independent anti-cartel enforcement. This over-reliance on amnesty/leniency programmes in the long run may undermine the effectiveness of cartel enforcement itself. Amnesty/leniency programmes are designed to take advantage of cartel dynamics and play on cartel members' incentives, conflicting interests and fear of detection, in order to cause them to break away from the cartel, report their fellow conspirators and for that to benefit from a more lenient treatment. But if competition agencies rely *only* on amnesty/leniency programmes to detect cartels, then cartels may remain undetected where incentives to break away from the cartel are weak.²⁵ This may be for example the case in small economies where corporate links between competitors are more prominent, or where many businesses are still family-owned. In these particular circumstances, the incentives to deviate from a cartel agreement may not be as strong and reactive detection tools, such as amnesty/leniency programmes, may not as effective. Complementing them with a vibrant pro-active cartel detection programme may affect the incentives of firms to enter the amnesty/leniency programme and strengthen the effectiveness of the programme itself.

17. Despite the implementation and success of amnesty/leniency programmes, cartels continue to form and operate.²⁶ Some studies suggest that profitable cartels seem more likely to remain stable and endure for longer periods of time, while it is often the case that cartels detected through leniency applications have already become unstable, for example due to some external shock.²⁷ If spontaneous reporting of stable cartels through amnesty/leniency programmes rarely occurs, one might argue that the value of amnesty/leniency programmes as a detection measure may be rather limited.²⁸ From a consumer welfare standpoint, an enforcement policy biased towards pursuing "terminal" cartels, as opposed to actively seeking out cartels which remain operational, may be questionable.²⁹

18. To conclude, both theory and practical experience seem to suggest that reliance on amnesty/leniency programmes alone may produce a sub-optimal probability of cartel detection, which in turn may have a negative effect on deterrence. For these reasons, among others,³⁰ primary reliance on amnesty/leniency programmes may be a cause for concern, even when a jurisdiction has many amnesty/leniency cases. While it may be possible to remedy some of these issues through a better design

²⁴ Harrington and Chang are among those who argue that since competition policy's main goals are cartel desistance and deterrence, an amnesty/leniency programme's success cannot be measured only by counting the number of successful cartel cases initiated by amnesty/leniency applications. See Harrington and Chang (2012); Spagnolo (2003).

²⁵ Despite the recent successes in the fight against cartels around the world, a substantial fraction of cartels remain undetected. Combe, Monnier and Legal (2008) and Bryant and Eckard (1991), for example, estimates that the average annual probability of cartel detection in the EU and the US respective is rather low, i.e. somewhere between 12.9% and 15%.

²⁶ Levenstein and Suslow (2012); and Abarantes-Metz and Bajari (2012).

²⁷ Abrantes-Metz and Bajari (2012). Levenstein and Suslow (2012).

²⁸ Harrington (2008).

²⁹ Friederiszick and Maier-Rigaud (2008).

³⁰ One other concern worth mentioning is that conspirators may actually abuse amnesty/leniency programmes to maintain cartel stability, for example by threatening their fellow cartel members with a amnesty/leniency application. See Spagnolo (2003), Levenstein and Suslow (2012). In addition, amnesty/leniency programmes are sometimes questioned for other reasons, which are not necessarily directly linked to the probability of detection (for example, where amnesty/leniency is abused to raise former fellow conspirators' costs in post-cartel ensuing competition, or where applicants earn additional supra-competitive profits by undercutting the agreed cartel price and subsequently filing for amnesty/leniency, etc.; e.g. Schinkel, 2007). While various arguments along this line may support the case against over-reliance on amnesty/leniency programmes, they are beyond the scope of our current discussion.

and implementation of amnesty/leniency programmes,³¹ competition agencies should consider the beneficial role that pro-active detection measures may play in increasing cartel detection either directly or through stronger incentives to enter into the amnesty/leniency programme. As opposed to amnesty/leniency programmes, pro-active detection measures need not be based on cartel members' incentives and are not bound by cartel dynamics, but rather leave the initiative with the competition agency.

2.3 *The benefits from a mixed cartel detection policy*

19. Pro-active detection measures should be implemented not only because of their intrinsic detection capabilities, but also because they may produce positive externalities in terms of improving the efficacy of amnesty/leniency programmes.³² So if pro-active methods are properly designed and implemented,³³ they may allow the agency to detect and subsequently investigate cartels which would otherwise remain stable under a stand-alone amnesty/leniency regime.³⁴ It should be noted in this regard that the probability of detection plays an important part in the decision of amnesty/leniency applicants to cooperate with the competition agency. It follows that if competition agencies can somehow increase the probability of detecting cartels, they may be able to induce more amnesty/leniency applications. In other words, if competition agencies are able to strike fear of detection into cartelists' hearts, that may be another reason for conspirators to desist from their activities and to race for amnesty/leniency.³⁵ Thus, pro-active detection measures may in fact be implemented for the purpose of complementing and reinforcing amnesty/leniency programmes.

20. One apparent limitation with amnesty/leniency programmes, even in jurisdictions where they have been extremely successful, is that investigations initiated through amnesty/leniency seem to be concentrated in a relatively small number of industries.³⁶ In the United States for example, in the late 1990s, investigations were concentrated in the food and feed industry, the vitamins industry, and the chemical industry. Today, the concentration appears to be even more focused than it was in the 1990s. The "big three" industries over the past five years are the electronics/computer parts industry, the air cargo/passenger industry, and the automotive parts industry.³⁷ This can only be partly explained by the

³¹ It appears that some fundamental issues pertaining to the design and implementation of amnesty/leniency programmes are still subject to an on-going contentious debate (for example, the question of awarding leniency to several applicants, rather than only to the first applicant); see e.g. Spagnolo's review of differences between the amnesty/leniency programmes in place in the U.S and the E.U. (Spagnolo, 2003). The on-going search for the optimal amnesty/leniency programme may result in better programme design and implementation, thus alleviating some of the concerns raised by heavy reliance on amnesty/leniency programmes.

³² E.g. Harrington (2008).

³³ See discussion in the Section 3.2 of this paper.

³⁴ Friederiszick and Maier-Rigaud (2008).

³⁵ Friederiszick and Maier-Rigaud (2008). See also Schinkel (2008), and Harrington (2006) who argues that pro-active empirical screens may scare cartel members enough to induce them to apply for amnesty/leniency.

³⁶ Klawiter (2012); Klawiter (2011).

³⁷ Klawiter (2011).

U.S. Amnesty Plus programme.³⁸ Pro-active detection tools can help agencies who are in a similar situation to expand the effect of deterrence beyond the markets where leniency is effective to the whole economy.

21. Advocates of pro-active detection measures recognise amnesty/leniency programmes' success and contribution to cartel prosecution and deterrence, and are not arguing that amnesty/leniency programmes should be abandoned. They rather support the proposition that to maximise the effectiveness of amnesty/leniency programmes they should be complemented by pro-active enforcement and *ex officio* investigations. Striking a better balance between pursuing amnesty/leniency cases on the one hand and unearthing cartels through *ex officio* investigations on the other, could significantly contribute to a successful anti-cartel programme and to an increase of the overall deterrence and desistance levels. It is, however, important to note that the arguments against over-relying on amnesty/leniency programmes and neglecting pro-active detection measures may be invoked in general support of pro-active enforcement policy and other specific pro-active detection measures.³⁹

3. Empirical screens to detect cartels

22. There is no general definition of what is a cartel screen. Some academics focus on what screens do; for example, Abrantez-Metz defines screening as “[t]he ability to flag unlawful behavior through economic and statistical analyses.”⁴⁰ Other definitions focus on the methodology used; for example, according to Harrington “[s]creening refers to a process whereby industries are identified for which the existence of a cartel is likely. [...] Screening methods [are] designed to pick up the transition from non-collusion to collusion – looking for a radical change in firm behavior - or the stationary collusive phase – finding differences in behavior from when firms compete.”⁴¹

23. Cartel screens are economic tools designed to analyse observable economic data and information,⁴² such as information on various product and market characteristics, data on costs, prices, market shares, various aspects of firm behaviour, etc. and flag markets which may either have been affected by collusion, or which may be more susceptible to collusion. Where such analysis raises suspicions that a specific market may be affected by collusion, a competition agency may consider conducting further inquiries (“verification stage”) and, where appropriate, to conduct a full-blown, independent *ex officio* investigation to collect direct evidence of cartelisation through searches and seizures, witness interviews, etc. (“prosecution/investigation stage”). Results from screens are usually not intended to serve as proof that firms have engaged in illegal behaviour, but only as a measure of singling

³⁸ “Amnesty Plus” refers to the benefits that the U.S. DOJ can offer to a cartel member who discloses previously undetected antitrust offenses involving a cartel *different* from the one that first brought that cartel to the prosecutors’ attention. Amnesty Plus induces firms that are already under investigation to clean house and report violations in which it may be involved in other markets.

³⁹ In a recent article, Abrantes-Metz argues that an effective anti-cartel enforcement policy should include six proactive and reactive components: education of the business community on competition law issues; clear guidelines on horizontal exchange of information; leniency programmes; screening programmes; incentives for effective corporate governance; and rewards for whistle-blowers. See Abrantes-Metz (2013).

⁴⁰ Abrantez-Metz (2013).

⁴¹ Harrington (2006).

⁴² To clarify, for our purposes, the term “observable data and information” excludes any direct evidence of illegal cartel agreement of the type which is generally revealed to competition agencies only through amnesty/leniency applications, whistleblowing, seizure of documents in the framework of a dawn raid, or any other method designed to reveal direct evidence of illegal explicit agreement which would otherwise remain concealed.

out markets worthy of additional review, for prioritising complaints or for focusing investigations on particular markets, firms or individuals etc.⁴³

Box 1 - Multiple uses of screens beyond cartel detection by competition agencies

Beyond cartel detection by competition agencies,⁴⁴ screens may have multiple uses. The literature has identified the following areas where screen can prove useful:

- Screens as a means to strengthen compliance and audit programmes:⁴⁵ Just like cartel detection programmes by competition agencies, firms compliance programmes are designed to detect possible instances of law infringement so that the company can take the necessary actions to ensure compliance, including applying for amnesty or leniency. Screening can help companies identify high risk areas or parts of a company's business where a cartel could be in place.⁴⁶ Companies can then allocate compliance resources more effectively. The implementation of screens as part of compliance programmes can be especially effective because the screening exercise can rely on internal company data which is not necessarily always available to competition agencies.
- Screen as a tool for due diligence in M&A activities:⁴⁷ audits run by counsels before their clients engage in mergers or acquisitions can help detecting illegal conduct, manipulations, or frauds put in place by the target company. The acquirer can therefore better assess the antitrust and regulatory risks to which the target company is potentially exposed. This screening activity can also benefit from a rich data set, as counsel have access to all data and information on the target company during the pre-

⁴³ However, screens can also produce evidence which may serve, together with additional facts, as indirect proof of a conspiracy. See discussion on Mexico in Annex 2.

⁴⁴ Screens can also help antitrust enforcers better managing their scarce resources, for example by providing arguments for rejecting clearly unfounded complaints about alleged cartels and for focussing resources on cases which have a higher chance of success. See, for example, the discussion on Brazil in Annex 2.

⁴⁵ Abrantes-Metz (2012); Abrantes-Metz (2011); Abrantes-Metz, Bajari and Murphy (2010); Klawiter (2012); Hüschelrath and Veith (2011a and 2011b).

⁴⁶ Hüschelrath and Veith (2011.a and 2011.b), for example, reviewed a combined data set of publicly available data with private data on about 340,000 market transactions from 36 smaller and larger customers of German cement producers to study the pricing dynamics during and after the breakdown of a German cement cartel. They investigated to what extent gross prices and net prices differed both during and after the breakdown of the cartel and whether and to what extent the pricing dynamics of cartel members and non-cartel members diverged in the cartel and non-cartel periods. The analysis revealed that both gross prices and net prices were significantly higher in the cartel period than in the non-cartel period. Moreover, by comparing cartel members' and non-cartel members' gross prices, they found cartel members to keep gross prices significantly higher in the post-cartel period. As gross prices are not only reported to industry associations and statistical offices but might also be used by antitrust agencies as part of market monitoring procedures, cartel members had incentives to keep these prices high during but also after the breakdown of the cartel agreement. As for net prices, they found no difference between the cartel members and non-cartel members price behaviour after the breakdown of the cartel. From a policy perspective, they concluded that if price screens had been available, the larger cement customers could have detected the upstream cartel *before* the competition agency did. The ability of screens to detect cartels early on has therefore several important implications for the business strategy of these larger customers as they could have easily reduced the cost of a key input.

⁴⁷ Klawiter (2012).

merger due diligence period.

- Screens can be useful tools in government investigations or during litigation.⁴⁸ when companies are under a government investigation (e.g., after a dawn-raid) or are required to comply with an information request, screens can be very effective in helping the company focusing on the conduct, the timing, and the duration of the alleged infringement, and planning the internal investigation effectively. Similarly, in an on-going litigation, screens can provide defendants with valuable information to develop their defence strategy. In this case, screens can help limiting the scope of the alleged infringement, its duration or the affected customer groups. On the prosecution or plaintiff side, results of screening can be used to suggest to decision makers that collusion or other manipulations are a likely event.
- Screens can help the plaintiff quantifying damage claims in private actions: Quantifying the harm from a cartel is a very difficult exercise.⁴⁹ Usually, damages from anti-competitive conduct are calculated by multiplying the difference between the price charged by the cartel and the price that would have existed in the absence of the cartel (the so-called ‘but for’ price) with the respective sales volumes. Screens can be used to estimate the “but for” competitive price.⁵⁰

24. Market screens are based on a growing body of economic research and on the development of theoretical models of competition and collusion, as well as on the analysis of available data on markets in which robust competition prevails and markets known to have been affected by collusion. Such research has enabled economists to develop methods designed to analyse various aspects of firms and market performance against comparable competitive or non-competitive benchmarks, and to scan data for distinctive indicators (or markers) of collusion, suspicious patterns, anomalies etc., which may either be incompatible with competition or associated with collusion.

25. It is possible to distinguish between two general types of approaches to cartel screening.⁵¹ The first is the “structural” approach, which typically involves screening a series of industries or markets in the attempt to identify those which exhibit characteristics which make them more prone to collusion. The second, “behavioural” approach, is designed to flag firms behaviour or market outcomes which may raise suspicions that firms have in fact colluded. Some general frameworks proposed in the literature involve a combination of both approaches.

3.1 *Structural screens*

26. Structural market screening typically involves a cross-industry or cross-market search for those characteristics which are known to facilitate cartelisation, or which have been exhibited in cartelised industries in the past. As opposed to behavioural screens, the focus is not on firms behaviour or market outcomes, but rather on the structural (product and market) circumstances in which collusive arrangements are more likely to form and thrive. Structural screens may serve two main purposes in the context of anti-cartel enforcement. First, structural screens may be useful to create an initial list of industries that are worthy of further scrutiny.⁵² Various pro-active methods can then be used to follow up on this list,

⁴⁸ Klawiter (2012).

⁴⁹ OECD (2011).

⁵⁰ Harrington (2006).

⁵¹ Harrington (2008).

⁵² Structural screens may also be employed for uses other than systematic screening of industries. For example, structural screens may streamline the handling of complaints when the information provided to

including behavioural screening methods. Second, structural screens may complement reactive detection measures by allowing competition agencies to focus their resources on the most promising cases initially originated from complaints.

27. In most cases, structural screens are rather straightforward and relatively simple to implement. They do not involve complicated econometric analysis or extensive staff training on the screening process. In addition, structural screens usually require data which is readily available or rather simple to collect. Another advantage of structural screens is that they may be quite difficult or even impossible for cartelists to beat.⁵³ However, since structural screens only point at markets which exhibit a *propensity* for collusion, they do not provide competition agencies even with preliminary evidence of collusion.⁵⁴ Thus, one might argue that their contribution to cartel detection (and deterrence) is rather limited and that cartelists need not necessarily be very concerned about beating structural screens, which in the end may produce a rather long list of industries deserving a closer look by competition agencies.

the competition agency by the complainant is limited both in quantity and quality. By pointing both at markets which exhibit low or high propensity for collusion, competition agencies can use structural screens to efficiently prioritise the review of complaints based on the markets exposure to the risk of collusion.

⁵³ For example, it is unlikely that cartelists would ease entry just to increase the number of competitors and consequently reduce HHI levels, or to eliminate instruments that facilitate coordination such as trade associations.

⁵⁴ One just has to mention that cartels have formed and operated in industries which do not have necessarily been flagged by structural screens. Structural screens therefore can produce false negatives.

Box 2 - Structural analysis for co-ordinated effects in merger control

Competition agencies are well familiar with the methodology used by structural screens, as it is the same that underpins the analysis that agencies do when having to establish the risk of coordinated effects from a notified transaction. Merger guidelines and notices adopted by competition agencies include specific references to the structural characteristics of markets which make collusion more likely.

The Guidelines on the Assessment of Horizontal Mergers of the European Commission,⁵⁵ for example, state that in assessing the likelihood of coordinated effects, the European Commission should take into account all available relevant information on the characteristics of the markets concerned, including both structural features and the past behaviour of firms. As for the structural factors considered by the European Commission, the Horizontal Merger Guidelines state that *“it is easier to coordinate among a few players than among many. It is also easier to coordinate on a price for a single, homogeneous product, than on hundreds of prices in a market with many differentiated products. Similarly, it is easier to coordinate on a price when demand and supply conditions are relatively stable than when they are continuously changing. In this context volatile demand, substantial internal growth by some firms in the market or frequent entry by new firms may indicate that the current situation is not sufficiently stable to make coordination likely. In markets where innovation is important, coordination may be more difficult since innovations, particularly significant ones, may allow one firm to gain a major advantage over its rivals.”*⁵⁶

Similarly, the Horizontal Merger Guidelines adopted in 2010 by the United States Federal Trade Commission (U.S. FTC) and the Department of Justice (U.S. DOJ)⁵⁷ state that a market is more vulnerable to coordinated effects if *“the terms offered to customers are relatively transparent”* and add that *“[p]rice transparency can be greater for relatively homogeneous products”*. Coordinated conduct is also considered likely *“if there are few significant competitors [and] if products in the relevant market are relatively homogeneous.”* Other factors identified in the US Horizontal Merger Guidelines which can have a bearing on coordinated conduct are technological innovation, elasticity of demand, and buyer power.

In the United Kingdom, the Merger Assessment Guidelines jointly released by the Competition Commission and the Office of Fair Trading (OFT) in 2010⁵⁸ say that *“[w]hen assessing coordinated effects, the Authorities will analyse the characteristics of the market that could be conducive to coordination.”* The Guidelines also discuss the factors that the two agencies may consider when deciding if the merging firms would be able to reach an understanding on the terms of coordination. These include *“the number of firms in the market—the fewer firms, the easier it will be to reach an understanding; and the degree of complexity in the environment in which firms interact—the more complex this environment, the more difficult it will be for firms to reach a common understanding (in particular for tacit coordination).”*

28. Theoretical economic research has identified an ample number of factors that could influence the potential gains and costs -and therefore the rationality and stability- of cartels and collusion.⁵⁹ These factors can be grouped into structural, supply-related, and demand-related factors. Structural factors that ease collusion include a small number of competitors, high entry barriers, frequent interaction between firms (e.g. repeated bidding opportunities), and market transparency. Demand-related factors include stable demand conditions, low demand elasticity, buying power, and the absence of club and network effects.

⁵⁵ In [2004] O.J. C 31, p. 5.

⁵⁶ See paragraph 42.

⁵⁷ Available at <http://www.justice.gov/atr/public/division-update/2011/merger-guidelines.html>.

⁵⁸ Available at http://www.offt.gov.uk/shared_offt/mergers/642749/OFT1254.pdf.

⁵⁹ See among the vast literature on this point Rey (2006); Grout and Sonderegger (2005); Grout (2006); ABA (2010); and ICN 2010.

Finally, supply-related factors include the mature stage of an industry, the low pace of innovation, symmetry and commonality of costs, symmetric capacities, product homogeneity, multi-market contacts, structural links, and a history of anti-competitive conduct, as well as frequent contractual relationships between competitors (e.g. co-operation agreements).

3.1.1 *Structural factors*

29. The economic literature has identified a number of structural characteristics which make markets more prone to collusion. The concentrated nature of a market makes collusion more likely. The larger the number of competitors, the more difficult coordination becomes.⁶⁰ As the number of actual (and potential) competitors increases, the incentives to collude decrease and deviations from a collusive agreements are more likely (i.e. short-run gains from deviations increase, while the long-run benefit of maintained collusion is reduced).⁶¹

30. In markets where entry is made difficult or is more costly by high (economic or legal) entry barriers, any attempt to maintain supra-competitive prices is likely to be more successful. If market entry is relatively inexpensive and likely, supra-competitive cartel profits would represent a very high incentive to new entrants to enter the market (e.g., short-term or ‘hit-and-run’ entry strategies). This would erode the profitability of the cartel, and the prospect of future entry will likely reduce the scope for retaliation.

31. In markets with a high frequency of interaction between competitors, cartels will be more sustainable.⁶² Frequent firms interaction provides for an increased number of opportunities to cartelists to observe the behaviour of their competitors and to punish deviations from the cartel agreement (i.e. the time of reaction to deviations is shorter). This will make retaliation more swift and the thread of punishment more credible.

32. Market transparency makes collusion more likely.⁶³ Cartels can only operate if cartelists have access to information which allows them to monitor the implementation of the collusive arrangement and to retaliate promptly when one cartelist secretly undercuts the other cartel participants. This requires that deviations can be identified timely and that the other cartelists can react promptly. In markets where individual firms behaviour is not readily observable and cannot easily be inferred from available market data, strategic deviations will be more likely and collusion more difficult.

3.1.2 *Supply-side factors*

33. Mature industries with little innovation are more prone to stable cartels. Innovation limits the scope for collusion, as the incentives of firms to sell their new products will outweigh the incentives to collude and to share the market with competitors. Moreover, the prospect of innovation reduces the value of future collusion as well as the cost from possible retaliation.⁶⁴

⁶⁰ Tirole (1988); Bain (1956).

⁶¹ First, a small number of participants makes it easier to find a consensus over the modalities of the collusive agreement. Second, a small number of participants makes deviations from the collusive agreement easier to monitor. Third, as the number of firms increases, each firm gets a lower share of the market. This has the effect of increasing the appeal of deviations and of decreasing the fear of punishments hence making collusion harder to sustain. (See Grout, 2006)

⁶² Snyder (1996).

⁶³ Stigler (1964) and Green and Porter (1984).

⁶⁴ Ivaldi, Jullien, Rey, Seabright and Tirole (2003).

34. It is easier to collude when competitors have similar costs and/or similar cost structures. Rey identifies three reasons why cartels are more complex if cartelists have different costs.⁶⁵ First, costs asymmetry may make it difficult to agree on a common pricing policy, since firms with a lower marginal cost will insist on lower prices than those that high-cost firms would wish to sustain; more generally, different cost structures may rule out ‘focal points’ and consequently it exacerbates coordination problems. Second, technical efficiency would require allocating market shares to low-cost firms, which might be difficult to achieve in the absence of side-transfers. Third, lower-cost firms may be more tempted to deviate from a cartel agreement, both because they may gain more from undercutting rivals and because they may have less to fear from a possible retaliation by higher-cost firms.

35. Asymmetric distribution of production capacities is a factor which may hinder collusion as the firm with the largest production capacity will have greater incentives to undercut rivals, particularly if their production capacities limit their retaliatory power.⁶⁶

36. The nature of the product may also have an impact on the likelihood of collusion. It is far more easy for firms which supply homogeneous products to agree on a common price policy.⁶⁷ Product differentiation, on the contrary, may contribute to reducing market transparency and therefore makes collusion less sustainable over time.

37. If competitors meet on several markets (multi-market contacts) they will be able to sustain collusion more easily.⁶⁸ Multi-market contacts make firms interaction more frequent and increase the opportunities of retaliation in case of deviations. They also allow cartels to thrive in markets where industry characteristics would otherwise not permit it.

38. Structural links between competitors can facilitate collusion as they affect incentives to compete. Cross-shareholdings (even non-controlling, passive minority shareholdings) can reduce the gains derived from undercutting the other firm and therefore favour an alignment of price strategies.⁶⁹ For these reasons, collusion is more likely to emerge in markets where competitors are tied through structural links.

39. Even in the absence of structural links, the existence of co-operative agreements and/or other contractual relationships (such as financial loans) between competitors can affect the likelihood of collusion. Such contractual relationships can, for example, enlarge the scope for retaliation, thereby enhancing the ability to punish deviating partners. These agreements may also have a direct impact on the firms’ pricing strategies and on their overall incentives to compete.

3.1.3 *Demand-side factors*

40. A number of demand-side factors can affect the likelihood of collusion in a certain market.

⁶⁵ Rey (2006).

⁶⁶ The role played by capacity constraints on the feasibility of cartels is ambiguous. On one side, a capacity constrained firm has less to gain from undercutting its rivals, as it is able to accommodate only a fraction of the extra demand this would generate. On the other hand, capacity constraints limit firms’ retaliatory power. This is because the strongest penalty that firms can envisage is to produce at full capacity. See Brock and Scheinkman (1985); Compte, Jenny and Rey (2002).

⁶⁷ Chang (1991); Ross (1992).

⁶⁸ Edwards (1955); Bernheim and Whinston (1990).

⁶⁹ OECD (2008); Malueg (1992); Gilo and (2005).

41. Collusion is easier to sustain in markets with growing demand, where expected profits outweigh current profits. The threat of retaliation is more significant if demand is growing, as firms will not be willing to trade off short-term gains (from deviation) with the higher cost of future retaliation.

42. Similarly, collusion is more sustainable in markets that are not subject to significant demand fluctuations, since peak periods exacerbate short-term gains from a deviation, relative to the potential cost of later retaliation.⁷⁰

43. It is unclear in the literature if the elasticity of demand has an impact on the sustainability of collusive prices. However, collusion is more profitable when demand elasticity is low, which in turn can influence the firms' willingness to establish a cartel and facilitates its stability over time.

44. If consumers have a strong buying power, a cartel may find it difficult to impose high prices, and this makes the illegal activity less profitable. Buyer power will affect incentives of firms to enter into a collusive arrangement in the first place.⁷¹

3.2 Behavioural screens

45. Behavioural screens refer to a variety of methods designed to indicate whether or not collusive behaviour of firms has in fact affected a specific market. Behavioural screening involves painting a picture of what competition or collusion in a specific market would look like, based on the analysis of a variety of variables such as prices, quantities, market shares, bidding decisions, etc.. Under this "behavioural" or "outcomes" approach, economists look at the behaviour of markets and their participants and apply screens to assess whether the observed behaviour is more or less likely to be consistent with a collusion or competition. According to Harrington, behavioural assessment "*focuses on the market impact of [...] coordination; suspicions may emanate from the pattern of firms' prices or quantities or some other aspect of market behaviour.*"⁷²

3.2.1 Designing effective behavioural screens

46. The design of behavioural screens is the one factor that affects almost exclusively their ability to flag situations where possible manipulations or conspiracies have taken place. Abrantes-Metz suggests that screen design should rely on either of these two fundamental principles:⁷³

- Improbable or unusual events can be a sign of manipulation or of a cartel conspiracy if these events cannot be explained but for industry co-ordination.⁷⁴

⁷⁰ Demand fluctuations hinder collusion, particularly when fluctuations are *deterministic* (as in the case of seasonal cycles, where it is anticipated that the future will be less rosy) as opposed to random. On the vast literature on the demand fluctuation in collusion, see Rotemberg and Saloner (1986), Haltiwanger and Harrington (1991), Bagwell and Staiger (1997) and Staiger and Wolak (1992).

⁷¹ Snyder (1995); Compte (2000).

⁷² Harrington (2006).

⁷³ E.g. Abrantes-Metz, 2013.

⁷⁴ Some screens attempt to identify observations which are improbable under regular market conditions. Such observations may indicate an artificial interference in the natural occurrence of events, and may be used to flag a collusive scheme. For example, it is highly improbable for a number of competitors participating in an auction to submit the exact same bid. To illustrate this principle Abrantes-Metz uses the example of cheat detection in a casino. If the probability of a winning bet in a roulette is roughly 0.5 %, a croupier will be alerted if a roulette dealer wins 20 times in a row. Statistical chances that this would happen are almost

- Comparing behaviour of individuals or groups in similar situations may reveal that one group's behaviour is subject to manipulation or conspiracy.⁷⁵

47. Screen design should ensure that screens are as simple and as cheap to implement as possible, while at the same costly for cartels to evade them, preferably to the point where costs of evading detection are high enough to discourage collusion in the first place.⁷⁶ Designing effective and robust screens, however, is not a simple exercise. It requires a good knowledge of the market context and of the industry to which the screen is supposed to be applied. A screen developed for a market with certain features bears a high risk of failure to flag manipulations and conspiracies if applied to a market which has different features. Unfortunately, there is no “one size-fits-all” screen so it is important that screens are tailored to the market that they are meant to screen. To ensure that screens are correctly tailored, Abrantes-Metz identifies six factors which are key to developing and implementing a good behavioural screen.⁷⁷ These include:

1. an understanding of the market at hand, including the nature of competition and the potential incentives to cheat;
2. a view of the likely nature of cheating;
3. a view of how cheating will affect market outcomes;
4. a set of statistics that can capture both the implications of cheating as well as ordinary, natural relationships between key market variables;
5. empirical or theoretical support for the screen; and,
6. the identification of an appropriate non-tainted benchmark against which the evidence of cheating can be compared.

3.2.2 *Theoretical foundations of behavioural screens*

48. Any screens should be based on a solid economic theory and on its ability to distinguish between competition and collusion. When designing a screen, therefore, it is important to first understand how competition and collusion work and whether a particular screen would help distinguishing one from the other. Without a solid economic theoretical foundation, a screening programme is unlikely to be implemented as its credibility will be undermined.

zero (though not impossible). He may not be able to prove that cheating has occurred, but he could look into the gambler's behaviour more closely to avoid the casino losing more money. See Abrantes-Metz (2013).

⁷⁵ To illustrate this principle Abrantes-Metz uses the example of a bid rigging conspiracy in the New York cement market. During the 1980s, the price of concrete in New York was 70% higher than in other U.S. cities. While prices may differ between geographic areas, price differences of 70% are rare and anomalous. This may suggest a possible competition problem. See Abrantes-Metz (2013).

⁷⁶ According to Abrantes-Metz and Bajari, there are four desirable properties of a good screen: (i) it should minimize the number of false positives and negatives; (ii) it should be easy to implement; (iii) it should be costly for agents to disguise such behaviour; and (iv) the screen should have empirical support. These elements will be discussed in the course of this paper (Abrantes-Metz and Bajari, 2012).

⁷⁷ Abrantes-Metz, 2013, and Abrantes-Metz (2011).

Box 3 - The importance of empirical support for screens

Most screens benefit not only from a solid theoretical support but also from empirical testing. It is quite typical for academic papers on screens to outline the economic theory underlying the proposed screen and then to test the proposed screen in real situations.⁷⁸ To provide empirical support for the use of the proposed screen, some authors demonstrate its application using data from markets which have been affected by cartels, e.g. markets which were the subject of a formal decision by a competition agency or a court.⁷⁹ In a number of articles, the proposed screen is subsequently applied to yet another market, or to a different subset of firms, in order to test whether that market merits further competition scrutiny.⁸⁰

Such an approach was adopted, for example, by Abrantes-Metz and others when they proposed a “price-variance screen” to detect likely collusive strategies in a given market.⁸¹ Briefly, the authors based the proposed test on the theory that costs associated with the coordination of prices and the need to solve agency problems are likely to result in a lower price variance under collusion. They first referred to some theoretical and empirical studies pointing in that direction. They then test the screen with data on the supply of frozen perch to military installations, which was known to have been the subject of bid rigging. The main result was that under collusion, prices were much less varied than in periods before and after the cartel.⁸² Finally, the authors applied their price variance screen to the retail market for gasoline in Louisville, Kentucky, a market which had not been the subject of an antitrust investigation, and found that the screen results did not suggest collusive behaviour in that market.⁸³

49. The next paragraphs discuss some of the theoretical foundations which underpin behavioural screens developed in the economic literature.

50. Green and Porter proposed that periodic sharp price drops might indicate collusion.⁸⁴ Departing from the assumption that sharp price drops reflect the intrinsic instability of cartels, they developed a model where periodic price drops in colluding firms’ prices and profits may indicate that cartels are using price wars as a self-policing/self-enforcement device. They assumed that demand is uncertain, and that firms collude depending on whether or not the market price is above an agreed-upon “trigger” price. The alternative hypothesis of collusion is that output levels follow a switching process triggered by drops in the market price. Green and Porter applied their theory to the American rail freight industry in the 1880s and concluded that this was an industry that exhibited the kind of collusion that they modelled.

⁷⁸ E.g. Friederiszick and Maier-Rigaud (2008); Lorenz (2008). Summaries and reviews of some articles proposing specific screens appear in articles discussing the use of market screens generally. See e.g. Abrantes-Metz and Bajari (2012) and Harrington (2008).

⁷⁹ E.g., Lorenz (2008) and Conley and Decarolis (2013).

⁸⁰ E.g. Conley and Decarolis (2013).

⁸¹ Abrantes-Metz, Froeb, Geweke and Taylor (2006). For a more detailed discussion see further below in Annex 1, Section 1.

⁸² Abrantes-Metz, Froeb, Geweke and Taylor (2006).

⁸³ Similar exercises can be found in various academic papers. They are designed to provide both theoretical and empirical support for specific market screens. At the same time, this way of proceeding provides insights in other important issues concerning the use of screens by competition agencies, namely those touching on the ability to re-run the screen on a number of different markets, the human and data resources needed to implement the screen, and the costs and difficulties associated with evasion from detection. See, for example, Lorenz (2008). Conley and Decarolis (2013). Various papers on the on-going LIBOR case discussed below (see Annex 2, Section 3.3) also follow this general structure.

⁸⁴ Green and Porter (1984).

51. Rotemberg and Saloner studied pricing strategies of implicitly colluding firms facing fluctuating demand.⁸⁵ They concluded that a credible threat of future punishments provides the discipline that facilitates collusion. However, the temptation to unilaterally deviate from the collusive outcome is often greater when demand is high. To moderate this temptation in periods of high demand, colluding firms are likely to behave more competitively. This behaviour generates counter-cyclical price and margin movements, i.e. the collusive price and margin are lower when demand is high and higher when demand is low. Rotemberg and Saloner found that the railroads industry in the 1880's, the automobile industry in the 1950's were examples that supported their theory.

52. Athey, Bagwell, and Sanchirico suggested that prices that are rigid in the face of cost shocks could indicate collusion.⁸⁶ Their paper suggested that price rigidity can serve as a screen of collusive behaviour in an industry that satisfies certain structural assumptions. They considered an infinitely repeated Bertrand game, in which each firm is privately informed of its unit cost level in each period, where there is a continuum of possible costs, and cost levels are independently and identically distributed across firms. They showed that if firms are sufficiently patient and the distribution of firms' costs is log-concave, then optimal symmetric collusion in equilibrium is characterized both by price rigidity and the absence of price wars. They also showed that in competitive settings price varies more closely with cost. Their analysis suggests that cartels can be expected to lead to a reduction in the price variance as, for example, frequent adjustments of cartel agreements are costly and would complicate the detection of deviations from the cartel agreement. As a consequence, the transition from a competitive situation to a cartelised situation is characterized by a decrease in price variance (and vice versa).

53. Marshall, Marx, and Raiff analysed price announcements in the vitamins industry, with a view to detect collusion in the industry after 1985.⁸⁷ They found that price announcements during the cartel period, and the lead times before these prices took effect, were fundamentally different in character from price announcements when explicit collusion was less likely. Logit estimates showed that after 1985, the likelihood of a price announcement was largely driven by the length of time between announcements, rather than cost or demand factors, suggesting that price announcements after 1985 stemmed from cartel meetings. They modelled public price announcements in an industry with homogenous products and capacity constraints as a multi-period game and found that, relative to the pre-1985 period, announcements were made well in advance of effective dates in the collusive period. They also observed that the timing of price announcements in the collusive period was consistent with regularly scheduled cartel meetings. For these reasons, they concluded that the empirical implications of their model were largely consistent with the absence of explicit collusion in the vitamins industry prior to 1985, but consistent with the presence of explicit collusion after 1985.

54. Harrington and Chen studied a dynamic model of oligopoly with stochastic costs, in which a firm that forms a cartel is detected with some probability.⁸⁸ Their analysis characterizes collusive pricing patterns when buyers may detect the presence of a cartel. Buyers are assumed to become suspicious when they observe anomalous prices. They found that the cartel price path was comprised of two phases. During the transitional phase, price was generally rising and relatively unresponsive to cost shocks. During the stationary phase, prices responded to costs but were much less sensitive than under non-collusion or simple monopoly. In addition, compared to when firms do not collude, cost shocks take a longer time to pass-through to price. They concluded that a low price variance may be used as a collusive marker.

⁸⁵ Rotemberg and Saloner (1986).

⁸⁶ Athey, Bagwell, and Sanchirico (2004).

⁸⁷ Marshall, Marx, and Raiff (2008).

⁸⁸ Harrington and Chen (2006).

3.2.3 Collusive markers and structural breaks for designing screens

55. There are fundamentally two main steps to designing behavioural screens. First is to identify *collusive markers* which, according to theoretical and empirical literature, allow to distinguish behaviour which is consistent with competition from behaviour which can be explained by collusion. Second, is to look for *structural breaks* (e.g. a cartel price war) or *exogenous shocks* (e.g. a change in input costs) in the competitive process which can explain a change in firms' behaviour consistently with a collusive/competitive scheme.

3.2.4 Collusive markers – general remarks

56. Screens can be used to search for collusive patterns using pointers or indicia, often called 'markers', such as prices, quantities and market shares, or costs. Like doctors who are trying to diagnose a patient with an illness look for specific symptoms, cartel screens should be designed to detect symptoms of cartel behaviour. The Table below lists a number of price and non-price collusive markers that the literature has identified as relevant when designing behavioural screens.

Table 2 – Collusive markers for behavioural screens

Type of collusive marker	Description
Price	1 A higher list (or regular) price and reduced variation in prices across customers
	2 A series of steady price increases is preceded by steep price declines
	3 Price rises and imports decline
	4 Firms' prices are strongly positively related
	5 A high degree of uniformity across firms in product price and other dimensions including the prices for ancillary services
	6 Low price variance
	7 Price is subject to regime switches
Quantity	8 Market shares are highly stable over time
	9 There is a subset of firms for which each firm's share of total supply for that subset of firms is highly stable over time
	10 A firm's market share is negatively correlated over time

Source: Hüscheleth (2010), based on Harrington (2006).

57. Before discussing the collusive markers that are often used in cartel behavioural screens, it is worth emphasising that many markers (e.g. price parallelisms, stable market shares, low price variance, etc.) can be present even in non-collusive situations. This is to remind that the purpose of markers (and of screens) is to flag situations which could be consistent with collusion, but the final determination as to whether there is a cartel must be further investigated and actual evidence of collusion gathered by the competition agency.⁸⁹

3.2.4.1 Markers based on the analysis of prices

58. The purpose of any cartel is to raise prices above the competitive level. The analysis of prices therefore can provide very useful indications as to whether a cartel is possibly in action. Various price

⁸⁹ As Rey concludes, "[o]verall, while further research in this area is probably warranted, at the moment it appears difficult to rely solely on this approach to detect cartels." (Rey, 2006).

patterns may be the result of the forming or the breaking-up of a cartel, rather than the result of the normal competitive process. For example, in a number of cases cartels were formed after a rather sharp fall in prices; prices were then raised steadily by the cartel over the course of a number of years. If demand is not cyclical, such abrupt decline followed by a steady rise in price may be explained by collusion.⁹⁰ Abrupt price movements can also be associated with so called “regime changes”, which may result from cartels entering or exiting punishment phases,⁹¹ or from “price wars” designed to discourage entry or to persuade a new entrant to join the cartel, etc. If a cycle of declining prices is followed by price increases, one might suspect that collusion has affected the market. In such cases, prior information on events which may have caused structural breaks may be helpful in focusing the analysis on the relevant timeframe and in interpreting the observable patterns.

59. A first group of price markers analyses movements in each firm’s own price:

- If a firm charges a high price that may, in some circumstances, be a symptom of a coordinated behaviour, particularly if associated with other commercial practices which one would not expect in a more competitive environment. This is, for example, the case of the adoption of a price list (as opposed to a variety of individually negotiated prices), the elimination of discounts and the simultaneous increase in prices by several suppliers. All these practices increase price uniformity which might be explained by the need to simplify the functioning and the monitoring of a cartel agreement.
- When price levels vary significantly across geographic areas that may be an indication that the market with the high price level may be affected by collusion.⁹²
- Unless markets have a cyclical nature, sharp and steady price increases by individual firms following a steep price decline can be explained by the fact that the cartel was established as a reaction to an event which caused a sharp decline in prices (e.g. a weakened demand or excess capacity). These sharp price movements can be used to detect possible cartels in their formation phase.
- If a firm price increases and competitors imports decline, that could be an indication of the presence of a market allocation cartel. In these cases, competitors reduce their sales outside their “home market” and increase prices in their own market.

60. Other price markers focus on the analysis of the prices charged by different competitors:

- Parallel pricing behaviour, for example, can be an indication of explicit collusion in particular if price movements are simultaneous and of the same entity.⁹³ This is the case, for example, of the identical bids submitted in response to a sealed-bid public tender.⁹⁴ For this reason, many empirical screens are designed to detect if competitors’ prices are strongly and positively correlated. The analysis of identical or highly correlated prices can also be accompanied by a

⁹⁰ Harrington (2006).

⁹¹ Harrington (2006).

⁹² ABA, 2010. This approach is implemented for example by the Dutch competition agency (NMa) in the framework of its Competition Index (see Annex 2, Section 1.1).

⁹³ Rey (2006).

⁹⁴ See further in Section 3.3.1.

high degree of uniformity of other terms and conditions, such as terms for ancillary or post-sale services.

- Part of the literature has identified a relationship between price variance and competition, whereby price variance is low under collusion.⁹⁵ In a competitive setting, prices are volatile over time, while under collusion prices will vary less. Unusually stable prices are a characteristic of a cartelised industry. This is because if price variance is low it can be much easier for colluding firms to agree on uniform prices. Price uniformity also facilitates the monitoring of cartel members' behaviour. Hence, firms involved in cartels are also likely to reduce price variation across their different customers. This suggests that looking at the variability of firms' prices may provide useful indications about whether those price were set in a competitive or in a collusive context.
- Looking at price variability can also be useful to detect situations where the cartel has moved from a collusive phase to a punishment phase (usually associated with a fall in average prices) and then moves back to a collusive phase (with a rise in average prices). Behavioural screen can be designed to detect situations where prices are subject to regime switches and flag price movements which could reflect different phases of the life of a cartel.

Box 4 - Price markers in the Antitrust Primer of the U.S. Department of Justice

The United States Department of Justice published an "Antitrust Primer" as part of its efforts to encourage citizens to report any suspicions of antitrust law violation.⁹⁶ This publication provides the general public with a brief description of certain patterns or events which may indicate collusion. The Antitrust Primer identifies five pricing patterns as possible indicators of explicit collusion:

1. Prices stay identical for long periods of time.
2. Prices previously were different.
3. Price increases do not appear to be supported by increased costs.
4. Discounts are eliminated, especially in a market where discounts historically were given.
5. Vendors are charging higher prices to local customers than to distant customers. This may indicate local prices are fixed.

3.2.4.2 Markers based on factors other than price

61. Price is not the only variable that can be affected by collusion. Cartels for example can affect the quantities produced by the cartel members if the objective is to achieve market shares stability over time. Similarly, the cartel can exercise its power by limiting its members' production and therefore it may want to have some form of control over their individual production capacities. Or the cartel main objective may be to increase the overall profits of its members by gain supra-competitive rates of return. Behavioural screens can use these and other non-price variables to detect and flag situations which can indicate a lack of competition.

⁹⁵ See further in Annex 1, Section 1.

⁹⁶ United States, Department of Justice, *Price Fixing, Bid Rigging, and Market Allocation Schemes: What They Are and What to Look For* (<http://www.justice.gov/atr/public/guidelines/211578.pdf>)

62. A first group of non-price related markers analyses measures of *quantity*:

- Various cartel schemes lead to the stabilisation of market shares.⁹⁷ Hence, highly stable market shares over time can be used to detect the presence of a cartel. For example, agreements to allocate customers or geographic regions would tend to reduce variation in cartel members' sales.⁹⁸ There are cartels whose members explicitly agree that the working rule for the cartel is to maintain past market shares (i.e. the *status quo ante*), thus eliminating any fluctuation in market shares over time.⁹⁹
- A similar conclusion can be reached if a firm's market share is negatively correlated over time. In a competitive market, market shares of firms are expected to vary over time along with the firms' costs. If one observes a negative correlation between the market shares of one firm over time, i.e. an unexpectedly high market share in one period is followed by an unexpectedly low market share in the following period, that can be used as an indication of collusion. If a cartel agreement involves firms compensating one another, e.g. for sales in regions or to customers that were allocated to a different firm, then one might observe a negative correlation between a firm's market share over time.¹⁰⁰ There are some documented cartels where members agreed to changes in allotted market shares over time.¹⁰¹

63. Other non-price markers rely on the analysis of *production capacities*:¹⁰²

- Some cartels may induce output restrictions by reducing the cartel members' actual production capacities or by limiting their capacity expansion. Where data on capacities across time is available, a review of firms decisions on capacity expansion or investment may flag periods where competition is presumed to have prevailed.¹⁰³
- Similarly, the review of the utilisation rate of production capacity can provide insights on whether capacity utilisation has been affected by the existence of a cartel. In the long run, collusive equilibria tend to involve excess capacities.¹⁰⁴

64. Markers can also refer to firms *profits and rate of returns*.¹⁰⁵ This approach relies on the comparison between the actual performance of an industry and the performance that one would expect from 'normal' competition in a comparable industry. Markers based on supra-competitive performance include:

- Successful cartels can achieve an excess rate of return both during their formation phase and during the life of the cartel. The analysis to the rate of return of firms can be used as a screen for

⁹⁷ For a brief description of a theoretical model supporting this conclusion, see Harrington (2008) and Harrington (2006).

⁹⁸ ABA (2010).

⁹⁹ Harrington (2008).

¹⁰⁰ ABA (2010); Harrington (2006).

¹⁰¹ Harrington (2008).

¹⁰² von Blanckenburg and Geist (2010).

¹⁰³ ABA (2010).

¹⁰⁴ Benoit and Krishna (1985); Davidson and Deneckere (1990).

¹⁰⁵ von Blanckenburg and Geist (2010).

collusion, although many consider that a high price-cost margin (i.e. an excess rate of return) may not necessarily indicate collusion but may simply be an indication of market power.¹⁰⁶

- Another marker for collusion can be found in the correlation between rate of return difference and capacity growth rate changes. In a competitive market, it is normal to expect a positive correlation between an excess rate of return and capacity growth. If the excess rate of return is given, an increase of capacity growth rate is expected and vice versa. In cartel phases, when firms agree on their investments, independence of both indicators is expected. An increase in capacities during a cartel phase is expected only in growth markets, where positive demand shocks dominate.

65. Collusive markers can also relate to the analysis of *firms' cost and firm's efficiency levels*.¹⁰⁷

- Screen can detect possible collusion when price levels fail to reflect cost levels, or are not responsive to cost shocks. Empirical evidence show that in competitive markets price reflect more closely changes in costs.¹⁰⁸
- Because of the lack of competitive pressure, cartelization affects productivity negatively. A comparison of costs and efficiency levels can provide an indication as to whether firms cost and efficiencies are affected by their participation to a cartel.¹⁰⁹

¹⁰⁶ See discussion in Harrington (2008).

¹⁰⁷ von Blanckenburg and Geist (2010).

¹⁰⁸ Abrantes-Metz, Froeb, Geweke and Taylor (2006). In particular, for the analysis of the relationship between price and cost during competition and during the cartel period see Fig. 1.a in Annex 1 from the same article which illustrates the movements of prices and costs of frozen perch fillets during the cartel period, during the transition period from the cartel to a more competitive environment, and during competition. It shows that prices followed costs movements more closely under competition than under collusion, and that gross margins were higher under collusion.

¹⁰⁹ Empirical studies find a positive correlation between competition and firms' efficiencies. Primeaux (1977) estimated the effect of competition on the average costs of production of municipally-owned electric utility companies facing competition with the average costs of production of municipally-owned electric utility companies having monopolistic power. He found that the average costs of the municipally operated firms in duopoly markets were 10.75% less than the average costs for those facing no competition. Carlsson (1972) used an actual output (efficiency) index for 26 Swedish industries in 1968. He regressed this efficiency rating against several measures of product market competition. His general conclusion was that efficiency is positively related to the degree of foreign competition faced by Swedish industry. Bergsman (1974) found similar results for six countries. For a more in-depth overview on the evidence relating competition, and competition policy, to macroeconomic outcomes, such as growth, see the Secretariat paper "Factsheet on Competition and Growth" [DAF/COMP/WP2(2013)11] available at <http://www.oecd.org/daf/competition/productivity-growth-competition.htm>.

Box 5 - A note of caution on the use of profitability and cost measures

There is an extensive literature inviting competition enforcers to exercise caution when undertaking profitability assessments and drawing conclusions from them.¹¹⁰ This literature emphasises two main limitations with a profitability analysis. First, conceptually, it is not well established what profitability analysis should be measuring, i.e. what is the relevant measure of profitability, and what is the most appropriate competitive benchmark. Second, profitability analysis raises various measurement and interpretation issues:

- Measurement issues: accounting data is normally the primary source of information for profitability analysis. However, companies rarely present such data in a way that it can be easily and readily used for economic analysis for competition policy purposes. Furthermore, accounting policies are far from uniform across companies and countries.
- Interpretation issues: even if profits could be measured, profitability figures can be difficult to interpret. For example, when are profits too high or too low, and what is the relevant time period to consider? And what should be the appropriate cost measure? Marginal costs or Long Run Marginal Costs? And even if high profits are found, are they due to market power or to superior efficiency?¹¹¹

We should also add that using high profits as a measure of a potentially anti-competitive conduct would send distorted signals to the market and could have a chilling effect on competition. It is for these reasons that profitability measures are rarely used by competition agencies in enforcement cases, despite the fact that they could have (at least conceptually) a wide range of applications in various stages of a cartel, an abuse of dominance or a merger investigation. These applications could range from the definition of the relevant market and the determination of market power, to applications to specific abuse of dominance cases (e.g. excessive pricing,¹¹² predatory pricing and cross-subsidisation, margin squeeze cases), to the assessment of co-ordinated effects and failing firm defences in merger cases.

While the limitations with profitability measures raise particularly troublesome concerns if competition agencies were to rely on them to prove the existence of an antitrust infringement or of an anti-competitive merger, their use in screening programmes raises more limited concerns due to the fact that screens only aim at flagging situations which should then be properly investigated by the competition agency. That being said, profitability measures in screening programmes should be adopted with some caution. Rey, for example, points out the challenges with screens based on these types of markers. He notes that these screens require “*detailed data and analysis of costs and demand conditions (not only in the current situation but in the supposedly competitive one as well). This exercise is all the more difficult to realize in concentrated industries, which will often be subject to ‘imperfect competition’ anyway (that is, even a purely static, non-cooperative form of ‘normal’ competition would still yield significant price-cost margins and profits). More generally, this type of in-depth study requires deep knowledge and expertise about the industry, and it is more naturally associated with regulatory supervision than with the antitrust oversight.*”¹¹³

While it is beyond this paper to discuss the complexity of the use of profitability measures in competition policy and in enforcement cases, it should be emphasised that it would be unwise for competition agencies to rely *exclusively* on findings of high prices and excess profits to detect cartels. Profitability analysis, however, could be seen as one among a number of complementary economic indicators and techniques that agencies could use in a competition analysis. It is for this reason that this paper lists profitability and price/cost measures as possible markers for collusion. If available data indicates, among other things, that for example rates of returns have fluctuated significantly over time or that in a certain time period prices moved away significantly from any measure of cost, these are situations which could potentially be the outcome of a cartel activity. Further inquiries, however, would be necessary to ascertain that conclusively.

¹¹⁰ Oxera (2003) and literature cited therein.

¹¹¹ See discussion in Harrington (2008).

¹¹² OECD (2011).

¹¹³ Rey (2006).

3.2.4.3 Identifying structural breaks and the appropriate benchmarks for screens

66. Identifying the appropriate marker(s) for screening markets is only the first step in effective screens design. Markers represent the basic elements for analysis but in order to flag possible collusion, markers need to be collected over time and then compared with an appropriate reference point. Benchmarking is the key to the ability of a screen to distinguish between collusion and competition. Finding events that have led to a distinct change (“structural break”) in how markets work can also be used to model and predict market performance or firms’ behaviour. Sometimes these events can be explained by the life of the cartel. Cartels form or break-up, and firm behaviour changes as a result of various events such as mergers, firms’ exit or entry, or perhaps even news reports.¹¹⁴ The central idea of identifying structural breaks is to establish a proper assessment of the counterfactual, that is, how the markets would perform “but for” collusion.¹¹⁵ If markers focus what is the relevant for distinguishing competition from collusion, here the focus is on finding changes and breaks in market outcomes, not necessarily on the outcomes themselves (e.g. high prices vs. low prices).

67. Benchmarks can be of different nature, and can rely on observations based on one (or more) of these factors:

- Different timeframes - Many screens compare firms behaviour and market outcomes across various timeframes.¹¹⁶ A common regression model used to analyse allegedly collusive markets is a “before-and-after” regression, which compares prices over time. Data for the same market but from different time periods can serve as a reference point, assuming that data covers both the collusive and non-collusive periods.¹¹⁷ If prices are similar before and after the allegedly collusive period, this may be an indication of collusion. For this analysis to be reliable, however, economists must control for demand and supply factors that might have changed over time, so that the model presents a valid comparison of prices even if market conditions are changing.¹¹⁸
- Different product markets - A price series and its properties can be compared with those of other products in a similar industry, which are not under suspicion of possible cartelisation. These “yardstick” models compare prices among collusive and non-collusive markets during the same time period. Again, models must control for differences in market conditions between the test and

¹¹⁴ See Friederiszick and Maier-Rigaud (2008) for a detailed discussion of the types of critical events that one can detect during the life of a cartel, from its start-up phase and its life span to its breakdown.

¹¹⁵ According to Friederiszick and Maier-Rigaud, to identify these critical events, “two questions based on the information collected in the industry analysis have to be addressed: (1) Is it possible to identify exogenous shocks that result in different reactions in a cartelized versus a competitive environment? (2) Is it possible to observe structural breaks that cannot be explained along the lines of a competitive environment?” (Friederiszick and Maier-Rigaud, 2008).

¹¹⁶ For example, as shown by Abrantes-Metz, Froeb, Geweke & Taylor (2006), price variance for frozen perch fillet was significantly higher and prices were lower in the periods before and after the cartel was operational.

¹¹⁷ E.g., Friederiszick and Maier-Rigaud (2008); Harrington, (2008). For practical implementation, see, e.g. Abrantes-Metz and Metz (2012). See also the discussion on the importance of information on “the beginning and the ending date of conspiracies” in Bolotova, Connor and Miller (2008). It is, however, very important to note that in some cases it may be difficult to observe distinct changes as a result of cartel formation, break-up etc. For example, if cartel members are weary of detection, they may agree to conceal the structural break by raising their prices gradually to a steady-state level or even by raising them gradually and then letting them decide to such a level. See Harrington (2004).

¹¹⁸ ABA (2010).

the benchmark market. Alternatively, a price series from one specific industry can be compared against a large number of other industries at the same time, on the basis that it is unlikely that all the benchmark industries are subject to cartelisation.

- Different geographic markets - In some cases, it may be possible to identify markets which are comparable with the market subject to screening, i.e. they constitute a separate market but may share similar general dynamics. Where firms behaviour or market outcomes in the market under screening are different from those observed in a market known to be competitive, that may be indicative of collusion.¹¹⁹

68. In situations where data is not available over a period of time which covers both the collusive and non-collusive period, or where an external observer cannot identify a structural break for the benchmarking exercise, another approach can be followed. This is to model firm behaviour or market outcomes in a particular market, based on theories of what competitive or collusive equilibriums would look like in that same market. Observations on the market can then be compared with the predictions of the model, and where inconsistencies occur, further scrutiny may be warranted.¹²⁰ For example, in public procurement markets where the distance from the firms' consumers is strongly correlated with costs, it is reasonable to predict that, in normal circumstances, firms located at a great distance from a worksite would refrain from submitting bids. It follows that suspicions may rise if distant firms' behaviour is inconsistent with this prediction. One possibility is that these firms are submitting so called "complementary bids" designed to create a perception of competition, while in reality the designated winning bid is artificially inflated.

3.3 *Empirical screens for bid rigging conspiracies*

69. Detecting bid rigging conspiracies has been a fertile ground for the development of behavioural screens. The richness of data available on public tenders has allowed economists and competition agencies to develop several screens and offered the opportunity to test them empirically. The fact that bid rigging cases represent a significant share of cartel enforcement in many jurisdictions has also facilitated the definition of collusive markers for the design of the screens.

3.3.1 *Markers for bid rigging conspiracies*

70. Screens to detect bid rigging are based on specific markers that competition agencies and researchers have identified over time. These are bidding patterns that are commonly found in bid rigging cases. Markers relate to different variables, such as the finding of improbable events in the bidding process or the statistical analysis of the bidding behaviour of the various bidders when they bid one against the other. In general, there are two types of intuitions underlying bid rigging screens:

- First, that in a competitive tender process, bids should be submitted independently. If a cartel is at work, bids will show signs of co-ordination between the bidders. If bids are "too correlated" this can be explained by collusion.
- Second, bids submitted by independent competitors should reflect appropriately the costs of each bidder in a competitive market.

¹¹⁹ For example, heavy commodities that are rarely transported long distances, such as ready-mixed concrete, can be analysed in this way (Oxera, 2013).

¹²⁰ E.g. Porter and Zona (1999) discussed further in Annex 1, Section 2. Note, however, that Porter and Zona base their predictions and their analysis of the cartel in the Ohio milk market not only on theory, but also on data from control groups.

71. Based on these two criteria, economists have developed a number of screens to detect possible bid rigging conspiracies. These screens will be discussed in more detail in Annex 1, but here we list the main markers on which they often rely.

72. A first improbable event in a market where competition works effectively is when bidders submit identical bids.¹²¹ While it may seem unlikely that bidders who are involved in an illegal conspiracy would submit the same bid, many bid rigging cases have been flagged to competition agencies by procurement officials who have detected identical bids submitted by allegedly competing bidders.¹²²

73. Another collusive marker that is often used to detect possible bid rigging conspiracies is a high correlation between bids, after controlling for costs and market power variables.¹²³ Often correlation across bids is significantly higher among bids in one particular market than across bids in another comparable market. In this case, if the differences in correlations cannot be explained by observable differences in market conditions, then it is possible that this can be explained by coordinated behaviour among bidders in the first market. The higher the degree of correlation and its persistence over time, the more likely it is that the correlation can be explained by coordination among bidders.

74. Another set of markers looks at the existence of a disconnect between the bid and the underlying costs of the bidder. When firms collude, the relationship between bids and cost is broken, as conspiring firms will aim at achieving supra-competitive profits. If, for example, distance is a competitive variable in the market, bids should be an increasing function of distance owing to transportation costs (everything else being equal). Similarly, bids submitted by a given firm should reflect the engineering cost estimates of that same firm. If holding all else equal, a firm submits a higher bid for a contract with a lower engineering cost estimate than for one with a higher cost estimate, that could indicate a pattern of bids that is consistent with collusive activity.¹²⁴ The analysis can be made by comparing bids submitted by the same bidder in similar market situations or tenders, or by comparing bids of different bidders in markets with similar competitive conditions.¹²⁵

75. A third set of markers points at unexpected and significant differences between the winning and the losing bids. Of course, differences can be explained by legitimate reasons. However, in a competitive environment one would not expect significant differences between competitors. If, once discounted factors that can be relevant for the winning bid, there are still significant differences between the bids submitted by the winning bidder and the others participants, which can be a sign that collusion materially affected the competition in the tender process.

3.3.2 *National and international guidelines for detecting bid rigging in public procurement*

76. Many national competition agencies and international organisations have used these markers to adopt guidelines for procurement officials that can help them detect unusual bidding patterns or behaviour.

¹²¹ Abrantes-Metz and Bajari (2012).

¹²² In a well known bid rigging case in the market for electrical appliances in the 1950s in the United States, seven bidders had submitted the same identical bid to the cents (USD 198,438.24) in a sealed-bid tender process. The chances that this event would occur if the bidders did not coordinate their bid is close to zero.

¹²³ Porter and Zona (1999); Porter and Zona (1993).

¹²⁴ NERA (2010). A similar test can be developed for capacity utilization based on the idea that, holding all else equal, one would expect firms to bid more aggressively for contracts when they have idle capacity.

¹²⁵ Bajari and Ye (2003).

These guidelines have been quite successfully disseminated and implemented in various jurisdictions.¹²⁶ They typically provide a list of suspicious behaviour or patterns that may be indicative of bid rigging, and encourage procurement officials to report their suspicions to the competition agency.

Box 6 - The OECD Guidelines for Fighting Bid Rigging in Public Procurement

The OECD Guidelines on Fighting Bid Rigging in Public Procurement, for example, were adopted by the Competition Committee in 2009, are now included in the 2012 OECD Recommendation on Fighting Bid Rigging in Public Procurement.¹²⁷ The Guidelines include a specific checklist on how to detect bid rigging during the procurement process. The checklist recommends that procurement officials remain vigilant for:

- warning signs and patterns when businesses are submitting bids (e.g. the same supplier wins all tenders);
- warning signs in tender documents submitted (e.g. identical mistakes);
- warning signs and patterns related to pricing (e.g. large differences between the winning bid and other bids);
- suspicious statements (e.g. spoken or written references to an agreement among bidders); and,
- suspicious behaviour (e.g. suppliers holding regular meetings).

According to the Guidelines, “*odd patterns in the ways that firms bid and the frequency with which they win or lose tender offers*” and various subcontracting or undisclosed joint venture practices may indicate bid rigging. Suspicions may arise for example when “[*t*]he same supplier is often the lowest bidder,” “[*r*]egular suppliers fail to bid on a tender they would normally be expected to bid for, but have continued to bid for other tenders,” “[*s*]ome suppliers unexpectedly withdraw from bidding,” “[*e*]ach company seems to take a turn being the winning bidder,” “[*t*]he winning bidder repeatedly subcontracts work to unsuccessful bidders”, etc.

Clues of bid rigging may appear on documents submitted by bidders. For example, “red flags” may be raised if “[*b*]ids from different companies contain similar handwriting or typeface or use identical forms or stationery”, “[*b*]ids from different companies contain identical miscalculations”, “[*t*]he packaging from different companies has similar postmarks or post metering machine marks” or if “competitors submit identical tenders or the prices submitted by bidders increase in regular increments.”

Suspicious pricing patterns, such as “[*s*]udden and identical increases in price or price ranges by bidders that cannot be explained by cost increases,” “certain supplier’s bid [*being*] much higher for a particular contract than that supplier’s bid for another similar contract”, or if “[*t*]here are significant reductions from past price levels after a bid from a new or infrequent supplier, e.g. the new supplier may have disrupted an existing bidding cartel”, may also be cause for concern.

The same applies to suspicious statements, whether written or spoken, which for example make “*references to an agreement among bidders*”, “*justify their prices by looking at ‘industry suggested prices’, ‘standard market prices’ or ‘industry price schedules’*”, or indicate “*that a supplier submitted a courtesy, complementary, token, symbolic or cover bid.*”

Finally, procurement officials ought to be alerted by suspicious bidders’ behaviour. If, for example, “[*s*]uppliers regularly socialize together or appear to hold regular meetings”, or “[*a*] company requests a bid package for itself and a competitor,” or “[*a*] company submits both its own and a competitor’s bid and bidding documents etc.,” they should notify the competition agency of their suspicions.

¹²⁶ See e.g. United States Department of Justice, *Price Fixing, Bid Rigging, and Market Allocation Schemes: What They Are and What to Look For* (<http://www.justice.gov/atr/public/guidelines/211578.pdf>); Konkurrentsverket – Swedish Competition Agency, *Honesty Pays! How to Detect and Give Tip-Offs About Bid-Rigging Cartels in Public Procurement* (http://www.kkv.se/upload/Filer/ENG/Publications/Honesty_pays.pdf).

¹²⁷ The OECD Recommendation and the Guidelines can be found at <http://www.oecd.org/daf/competition/fightingbidrigginginpublicprocurement.htm>.

77. National and international guidelines to detect bid rigging are an interesting example of how screens can be used without incurring in some of the limitations and costs that will be discussed in the next Section. Bid rigging detection guidelines are addressed to procurement officials and at least part of the pro-active detection effort is outsourced to them. They are asked to flag possible bid rigging conspiracies by detecting possible sign of collusive behaviour.¹²⁸ This has enabled competition agencies to overcome some of the limitations of market screens and the difficulties associated with their implementation: first, through the dissemination of guidelines and the training to a large amount of public procurement officials, competition agencies may be able to have multiple markets screened, for a reasonably low cost. Second, procurement officials are likely to have better information on the functioning of the market and the activity of firms than economists running screens at the competition agency; such information may be crucial for effectively monitoring the market and also for limiting the number of false positives and negatives. In particular, because procurement officials interact with bidders directly, they are able to observe behaviour or notice statements which are not recorded in the documents submitted by the bidders, and may be outside the direct reach of the competition agency.

3.4 *Challenges posed by the implementation of cartel screening programmes*

78. Systematic market screening is part of few competition agencies' anti-cartel enforcement programmes.¹²⁹ Many competition agencies, including some of the better funded and more established agencies, are reluctant to implement screens which require complex economic analysis of data, relying instead on other tools that they consider a more effective and a more efficient use of their resources.¹³⁰ Competition agencies' perceived reluctance to allocate the necessary resources for developing, implementing and regularly running a pro-active screening programme can only be partially explained with the success of amnesty/leniency programmes. Indeed, intrinsic limitations and challenges associated with the adoption of empirical screens has also contributed to the limited use so far of screens as a detection tool.

3.4.1 *Screens do not provide sole and sufficient proof of cartelisation*

79. While screens can be very useful to identify and flag unusual patterns in market outcomes, screens will not provide sole and sufficient proof that any wrongdoing did take place. Generally, the main purpose of screening is not to deliver the final evidence based on which colluders will be convicted, but instead to identify markets where empirical red flags are raised and which are worth of further investigations.¹³¹ In doing so effectively, screening results will induce cartel members to come forward and

¹²⁸ It is however important to note that while procurement officials may be trained to raise red flags, they do not necessarily develop expertise in detecting cartels, nor is that their main duty. Procurement officials may therefore fail to detect cartels or may lack incentives to report suspicions to the competition agency.

¹²⁹ See, for example, the Korean BRIAS system for bid rigging detection and the U.S. FTC gasoline prices monitoring programme, both discussed in Annex 2.

¹³⁰ ICN (2010), reporting for example that "[...] the Antitrust Division of the US DOJ does not use economic tools or data to attempt to detect cartel activity. Such efforts in the past have not proven fruitful and the US DOJ does not believe that such efforts are a good use of its resources." This approach is confirmed by the U.S. submission to this roundtable which concludes that "[...] DOJ has employed several methods for cartel screening and found that those methods did not produce solid leads for cartel investigations. At this time, the DOJ has no plans to redeploy investigative resources into screening for indications of cartel activity." [DAF/COMP/WD(2013)117].

¹³¹ There are cases, however, where the results from screens have been used by agencies in courts as part of the evidence brought to support their case. The Mexican example discussed in Annex 2, Section 2.1 is an example where courts concluded that the results of the screening exercise were sufficient to prove the illegal conduct.

file for amnesty/leniency, and they will also assist in deterring cartel formation in the first place. However, agencies will still have to go through the verification and prosecution/investigation phases before a final cartel decision can be adopted. Structural screens in particular can be useful to identify markets and industries where collusion *could* take place, but they cannot be used to determine if cartelisation has actually taken place in one of those markets. They are just a first step that requires further investigation into firms' behaviour (e.g. through the implementation of a behavioural screen) and then an actual investigation to collect the evidence that courts require to prove the standard for cartelisation.

3.4.2 Screens can generate false positives and false negatives

80. Cartel screens can produce false positives (flagging cases which do not merit further scrutiny) or false negatives (failing to identify collusion in a particular market) and this is something that competition agencies should be aware of when deciding whether to implement a cartel screening programme.¹³² While minimising both types of errors is a priority for screen developers, it seems that the risk of screens failing may be inherent or very difficult to minimise in certain cases. Economic models and assumptions upon which a particular screen is based greatly influence the probability of that screen producing either type of errors.¹³³ For example, a structural screen designed to flag markets which show the traits that, in theory, are likely to increase the probability of collusion is inherently likely to produce false positives,¹³⁴ for the simple reason that the *propensity* for collusion is not an indication that an anti-competitive behaviour has *actually* taken place. Such screens, while perhaps more simple to implement, provide only limited guidance to competition agencies seeking to initiate independent *ex-officio* investigations.

81. Conversely, a behavioural test narrowly tailored to fit a specific market setting, such as an auction characterised by distinctive rules,¹³⁵ will only be useful for the circumstances for which it was designed. Applying the same test to other settings may not necessarily produce the correct results, if the screen for example is based on assumptions which do not apply to this second situation or accounts for specific market characteristics which are not present in the second setting.¹³⁶ In such cases, the indicators used to detect collusion in a specific market may either be inconsistent with collusion in the second market, or consistent with both competition and collusion in said market. For specified screens to function properly in a given market, screen designers may require a certain amount of information on the functioning of that market, on the various possible competitive or collusive equilibriums therein, etc.¹³⁷ So even if one assumes that competition agencies have sufficient and accurate data to run screens, screens may fail as a result of design flaws. While it may be possible to reduce the probability of screens failing by adapting the

¹³² See remarks by Oliver Guersain and Julian Joshua of the European Commission, in European Competition Law Annual (2006).

¹³³ See generally ABA (2010).

¹³⁴ Harrington (2008). False negatives are also an issue for structural screens: enforcement record from around the world shows that cartels form and prosper for many years also in markets which do not exhibit any of the structural characteristics which are considered to make markets more prone to cartelisation.

¹³⁵ See for example Conley and Decarolis (2013) "bid test" developed in the context of "average bid auctions".

¹³⁶ For example, a screen used to detect a bid-rigging conspiracy may be limited in its capacity to detect other types of collusive activity. See Bolotova, Connor and Miller (2008) (discussing Abrantes-Metz, Froeb, Geweke and Taylor, 2006).

¹³⁷ E.g. ABA (2010); Bolotova, Connor and Miller (2008); Doane, Froeb, Sibley and Pinto (2013). For examples of indicators which are consistent with either competition or collusion, see, e.g. Rey(2006). Another interesting issue to consider in screen design and model specification is that screens are based on economists' current knowledge of cartels, which may be naturally biased due to the lack of information on the characteristics of cartels which have been able to conceal their actions.

model and underlying assumption to any given market, this may prove costly, especially for competition agencies seeking to systematically screen a large number of markets.¹³⁸

82. The fact that empirical screens may fail and generate false positives/negatives should not necessarily discourage competition agencies. One option to minimise errors is running screening programmes which employ a series of tests, rather than using a single test.¹³⁹ Concerning the risks of false positives, empirical screens are generally not intended to serve as sole and sufficient evidence that illegal conduct has occurred, but as a starting point for competition agencies to pro-actively seek out cartels. If competition agencies are aware of the possible shortfalls of screens and consequently are careful about interpreting their results, they should seek to reduce the likelihood of false positives in any final decision. As for false negatives, failure to detect cartels may indeed be costly. However, an empirical screen that fails in one particular market, does not necessarily fail in other markets. In addition, screening is intended not only to directly detect cartels, but also to maximise incentives for leniency programmes and to increase deterrence levels. Therefore, empirical screens which produce some false negatives may still contribute to cartel deterrence and desistance if they succeed in putting cartelists off and causing them to desist from their activities, or to apply for leniency.

3.4.3 *Screens fail to distinguish explicit from tacit collusion*

83. A specific type of false positive may result from screens' apparent failure to distinguish between different types of collusion, i.e. between situations of explicit and tacit collusion. Collusive equilibria may be attained and maintained through explicit communications and agreements, which are generally considered *per se* illegal, but also through "conscious parallelism" and therefore without firms having to engage in any sort of illegal behaviour. Empirical screens will often focus on market characteristics and outcomes, or on firm behaviour, which may be observable both in cases of explicit and tacit collusion. In such instances, screens would be incapable of distinguishing between legal and illegal activity.¹⁴⁰ In other words, the risk of this specific type of false positive (i.e. the detection of the "wrong" type of collusion) is almost inherent to screening.

¹³⁸ For example, according to Harrington, one argument against using a price-cost margins as an indicator of collusion is due to the considerable variation in such margins across different industries, which can be explained by many factors other than collusion (Harrington, 2008).

¹³⁹ E.g. Lorenz (2008).

¹⁴⁰ Harrington (2006); Friederiszick and Maier-Rigaud (2008).

Box 7 - Can screens distinguish tacit from explicit collusion?

There can be particular circumstances where screens can actually distinguish between explicit and tacit collusion, for example where the outcome detected by the screen is highly unlikely unless it is the result of an explicit coordination.

Abrantes-Metz and Metz,¹⁴¹ for example, attempted to determine how far screens can go in distinguishing explicit from tacit collusion. In doing so, they considered evidence from the LIBOR setting and in particular the coefficient of variation (across banks) in daily LIBOR quotes for a cross section of the participating banks. They found that there was almost no variation across the quotes submitted by the banks from early August 2006 through early August 2007, becoming abruptly positive thereafter. They were expecting that if all banks were submitting unique quotes each day (which happened to average to the same level day after day), the coefficient of variation should be larger.¹⁴²

To exclude tacit collusion between the banks, Abrantes-Metz and Metz also analysed the individual LIBOR quotes from the banks and saw that the banks submitted the same quote day after day and that they were submitting a common but different quote the next day.¹⁴³ This evidence excluded that banks were “learning” and “reacting” to the strategy of the other banks to converge toward that common quote.¹⁴⁴ The authors concluded that *“given that quotes are submitted sealed, the likelihood of banks moving simultaneously to the same value from one day to the next without explicit coordination is extremely low, particularly given that their idiosyncrasies would not imply completely identical quotes under a non-cooperative outcome. And it is difficult to attribute it to tacit collusion or strategic learning, since the change is abrupt, the quotes are submitted sealed, and the quotes themselves sometimes change from one day to the next in an identical fashion. It would seem that explicit collusion is more likely to be the cause. Only time, and careful investigation, will answer definitively.”*

3.4.4 Screening as a data-intensive activity

84. Sufficient, relevant and accurate information and data are necessary for all stages of screen implementation, from screen design, to the implementation of the screen, up to the interpretation of its results. Accessing this information is a key issue in any empirical methodology and subjects screens to a serious risk of failure if gathering the necessary information reveals the on-going agency scrutiny to cartel members.¹⁴⁵

85. The correct specification of the economic model on which a screen is based may require information on the functioning of the industry or market to be examined. For example, firms’ distance from their clients is used in some models as a measure of costs,¹⁴⁶ while distance may be irrelevant to the

¹⁴¹ Abrantes-Metz and Metz (2012).

¹⁴² The lack of variation between the LIBOR quotes could not be explained by identical borrowing costs. The banks considered differ significantly in terms of their characteristics and borrowing costs (i.e., they have asset portfolios of varying risk, varying liability structures, and participate to different degrees in different market segments).

¹⁴³ Note that the individual bank quotes are submitted in sealed envelopes and are made public only after the LIBOR is computed.

¹⁴⁴ This evidence used to support this analysis is reproduced in Annex 2, Section 3.3 of this paper, which discusses the application of screens to detect possible manipulation of the LIBOR index.

¹⁴⁵ Most agencies that use screening techniques partially addresses these concerns by basing the exercise on data available through public sources, such as industry reports or official databases, to the extent possible.

¹⁴⁶ E.g., Porter and Zona (1999).

analysis of other types of industries (e.g. industries based on on-line distribution systems). Overlooking such information may lead the screen to fail. Screens may also be quite sensitive to the quantity and quality of the data used as input.¹⁴⁷ For example, running a price-variance screen¹⁴⁸ on aggregated data (e.g. average yearly or monthly prices) found in market studies may lead to completely different results from running the same screen on disaggregated data (e.g. daily quotes).¹⁴⁹ Furthermore, data obtained directly from firms may be more accurate and reliable than publicly available data appearing in the media, market studies, etc. but may not be available to the competition agency.¹⁵⁰ Finally, lack of information on the market may lead to the misinterpretation of the screen results. For example, a screen may identify patterns consistent with collusion between two sister companies; if the competition agency lacks information on the joint ownership of these firms, the results may be misleading.

86. Because failure to meet data requirements may cause a screen to fail,¹⁵¹ the issue of data collection raises several questions. Lack of data might discourage the use of screens altogether, as data collection may be time consuming and resource intensive, or may result actually impossible. Another source of complication could result from the fact that attempts to collect the necessary information may sometimes alert conspirators of the competition agency's intention to investigate that particular market, causing them to make conscious efforts to conceal any direct or indirect evidence of the cartel. It may be worth mentioning that a competition agency may also be misled where it relies on data published by conspirators who have an interest in concealing their illicit behaviour. Some scholars address this issue by suggesting that competition agency use screens which require easily available data as input, as it is for example the case of screens to detect bid rigging conspiracies.¹⁵² This approach, however, may at times lead to false negatives, because easily available data are often aggregated. In addition, screens based on easily available data such as prices may fail to take account of many factors, such as costs, demand shocks, etc., which affect firms' behaviour and market outcomes.

3.4.5 *Screening as a resource-intensive activity*

87. Implementing a screening programme may require extensive human resources with specific skills and know-how. The mere existence of resource costs, however, should not be an argument against the use of screens as such. Competition law enforcement requires extensive resources, and prosecuting a case requires many more resources than any typical screen. But we still advocate for effective enforcement. Agency, however, should be aware that developing or adapting an existing screen for the use by a competition agency may in some cases require special expertise, for example in the field of econometrics. Data collection and processing, training personnel, running the screen, interpreting results and finally following up on the leads provided by the screen, may also be quite burdensome and may be expensive also in terms of opportunity costs.

¹⁴⁷ It is not a coincidence that many screens were developed using bidding data from public procurement tenders. The richness of the public procurement data and their quality, makes the design and testing of empirical screens for bid rigging detection easier.

¹⁴⁸ Such as the one proposed by Abarantes-Metz Froeb, Geweke and Taylor (2006).

¹⁴⁹ E.g. Esposito and Ferrero (2006).

¹⁵⁰ Moreover, requesting such information from companies may tip them off to the existence of an investigation.

¹⁵¹ According to Abrantes-Metz one of the golden rules for screens is based on the principle "garbage-in-garbage-out". This rule states that, as is always the case in empirical work, a screen is only as good as the data on which it relies for its analysis (Abrantes-Metz, 2011).

¹⁵² Harrington (2008) who also suggests that competition agencies actively collect high-frequency price data.

88. To illustrate this point, consider once again a structural screen of the type designed to flag industries prone to collusion. This screen may be simpler to implement than highly specific screens. However, such structural screens tend to produce false positives; competition agencies may therefore require additional resources for following up on flagged markets to investigate further if cartel activity is likely to take place on that market. Conversely, highly specific models designed for specific industries may produce fewer false positives, but their implementation may be far more complex in terms of developing or adapting the screen, training personnel, collecting the necessary data and interpreting the results.¹⁵³

3.4.6 *The risk of firms evading screen detection*

89. Another concern about screens relates to the conspirators' ability to evade detection by adjusting their concerted behaviour in a manner which would enable them to "beat" the screen. This can happen especially when information regarding the competition agency's general approach and screen methodology is publicly known.¹⁵⁴ For example, if competition agencies search for "structural breaks" in pricing patterns, cartels may avoid detection by increasing prices moderately (and thus lose some measure of supra-competitive profit), in order to conceal the "regime change" from competition to collusion in the market.¹⁵⁵ This is for example what happened with the U.S. DOJ programme to detect suspicious public procurement tenders based on the so-called "Identical Bid Unit" programme. Bidders alerted to the existence of the screening programme took the necessary countermeasures to avoid detection by submitting very similar but not identical bids, and the programme was consequently discontinued.

90. Scholars address these concerns, first, by suggesting tests which would be difficult, costly and dangerous for cartels to beat.¹⁵⁶ Ideally, beating screens would prevent firms' from profiting from the conspiracy they are part of (e.g. by forcing conspirators to mimic competition and charge a competitive price) or would significantly raise the probability of detection (e.g. by forcing conspirators to communicate or meet frequently in order to coordinate their action).¹⁵⁷ Second, keeping the specific design of screens employed by competition agencies secret may prevent some cartels from beating the tests.¹⁵⁸ Finally, there is a possibility that some "naive" cartels may fail to beat even simple tests.¹⁵⁹

4. Conclusions

91. This paper has tried to answer two fundamental question that competition agencies ask themselves in their daily work: where and how to look for cartel activity?

92. While amnesty/leniency programmes have successfully mushroomed in many jurisdictions and have provided a unique impetus to global cartel enforcement, many have suggested that relying on reactive

¹⁵³ In this regard it may be interesting to note that the U.S. FTC's programme for monitoring gasoline and diesel prices (see Annex 2, Section 1.3) has been subject to criticism for its resource intensiveness. According to one commentator, duplicating such a programme and implementing for monitoring other industries is not feasible. See remarks of Thomas Barnett and William Kovacic, in European Competition Law Annual (2006).

¹⁵⁴ E.g., Friederiszick and Maier-Rigaud (2008); see also remarks by Patrick Rey, in European Competition Law Annual (2006).

¹⁵⁵ Harrington (2008).

¹⁵⁶ E.g. Abrantes-Metz, Froeb, Geweke and Taylor (2006).

¹⁵⁷ Harrington (2008).

¹⁵⁸ Laitenberg and Huschelrath (2011).

¹⁵⁹ Harrington (2008).

detection tools exclusively is not a sound cartel policy, and that amnesty/leniency programmes should be combined with more pro-active techniques to flag markets and situations where collusion may be at work. Reactive detection would not just increase the number of cartel cases uncovered by competition agencies but would increase incentives of firms to enter into amnesty/leniency programme, increasing cartel deterrence and desistance overall.

93. Among reactive detection tools, the use of economic analysis to detect markets structures, behavioural pattern and outcomes which can be consistent with collusion can prove particularly promising. The economic literature has developed screening techniques which can be used by competition agencies to enhance the deterrent effect of their enforcement action and provide even stronger incentives to firm to enter into amnesty/leniency programmes.

94. Empirical screens for cartel detection can have an important role in cartel enforcement: they flag possible situations of collusion which should be subject to further verification and possibly prosecution/investigation by the competition agency. The economic analysis can contribute to effective cartel enforcement. However, if only helps flagging “suspicious” behaviour which is only a first step in the identification of actual cartel conduct. This initial detection activity must be supplemented by other evidence before a final determination on the infringement of the competition rules can be made. For this reason, screens generally complement other reactive and pro-active detection tools which help agencies to access actual evidence of collusion.

95. A sound approach to cartel detection through the use of economic screens should include both a structural assessment of industry sectors in an economy to flag industries which are more prone to collusive practices and a behavioural analysis of individual firms’ behaviour and market outcomes. This in-depth behavioural screening of those industries which have been flagged as “at risk” by the initial structural assessment will help focussing resources on cases to be fully assessed by the competition agencies through traditional reactive tools (such as amnesty/leniency programmes) and/or other investigative tools (such as dawn raids, interviews, and information requests) to obtain evidence of the anti-competitive conspiracy.

96. Screens are subject to a number of limitations. Some of them are intrinsic to the nature of screens (e.g. they generally do not provide actual evidence of cartelisation, and they generally do not distinguish tacit from explicit collusion). Others important limitations relate to the resources and skills required to run screening programmes on a regular basis. Access to data and information also represent a serious challenge to screening in situations where reliable data is not easily accessible. Because of these limitations and of the success of amnesty/leniency programmes, most competition agencies seem to remain quite sceptical about implementing systematic empirical screening programmes. The ICN survey summarises this point by noting that “*[m]ost agencies, including well-established agencies, do not use economic tools or data to detect cartels, relying instead on other tools they consider more effective and a more efficient use of their resources.*”¹⁶⁰

97. As screening methods become more robust and easier to implement, it is likely to expect an increased use of screens by competition enforcers. Competition agencies’ positive experiences with empirical screening may also change perceptions of competition agencies towards screening programmes.¹⁶¹ Some scholars emphasise the value of information on discovered cartels gathered by competition agencies, as such information may provide insight into the inner workings of cartels, and may prove quite useful in the design of better screens in the future. Future academic research may also yield additional methods for distinguishing between (illegal) explicit collusion and (legal) conscious parallelism,

¹⁶⁰ ICN 2010.

¹⁶¹ See further Annex 2.

which is one of the main limits of screens. Finally, the effect of screens on deterrence is sometimes underestimated. Even if it is difficult to accurately quantify this effect, it is important to recall that the number of cases brought by a specific enforcement programme is not necessarily the right criterion (or the only criterion) for assessing its efficacy.

ANNEX 1

EXAMPLES OF BEHAVIOURAL SCREENS DEVELOPED IN THE LITERATURE

1. This Annex offers an overview of the main behavioural screens developed in the empirical literature. This literature is grouped into four categories: (i) screens based on price/bid variance; (ii) screen based on the analysis of anomalous bidding; (iii) screens based on variables other than price; and (v) screens to detect manipulations and fraud other than anti-competitive cartels.

1. Examples of cartel screens based on price/bid variance

2. Among the collusive markers suggested in the literature,¹ price-related markers are among the most frequently used to design empirical screens. These typically include prices higher than expected average prices; changes in prices that cannot be explained by demand and/or cost movements; lower responsiveness of prices to costs; reductions in price variations across customers; prices that are strongly and positively correlated across firms or entities; a high degree of price uniformity across firms. This section will review some examples of screens based on the analysis of price/bid variations.

3. In 1993, Froeb, Koyak, and Werden reviewed bidding data from an existing bid rigging conspiracy in the sale of frozen seafood to the Defense Personnel and Support Center (DPSC) in Philadelphia.² Their model estimated the price effects of bid rigging and price fixing conspiracies based on observed price differences between collusive and competitive periods. Their observations compared data from three distinct time periods: (i) a “pre-conspiracy” period characterized by relatively constant prices despite big seasonal swings in fresh fish prices; (ii) a “transition” period characterized by a rapid decline in the price of frozen perch and rising costs; and (iii) a “post-conspiracy” period. To estimate the “but-for” conspiracy prices, the authors used weekly time series data in the post-conspiracy period and fit a regression model of frozen perch log price as a function of current and lagged costs, as measured by fresh perch log prices. The model is used to back-cast the “but-for” conspiracy price in two earlier periods that preceded the collapse of the bid rigging scheme. They found that the price during the conspiracy period was significantly above the “but-for” predicted price in every auction, with an average cartel mark-up in the range of 23.1% to 30.4%, depending on the period chosen to define the bid rigging conduct.

4. Using the data from the same bid rigging conspiracy in the sale of frozen seafood to the DPSC, Abrantes-Metz, Froeb, Geweke and Taylor examined the price movements over time around the collapse of the bid rigging conspiracy and concluded that while the mean decreased by 16%, the standard deviation increased by over 200%.³ To estimate the effect of the conspiracy, they focussed on the period around the cartel’s collapse and further restricted the analysis to frozen perch fillets (one of the different products rigged by the cartel). They plotted the average weekly price paid by the Philadelphia DPSC for frozen perch fillets, as given by the winning bids; cost data were the average monthly price of fresh perch. The result is illustrated in Fig. 1.a below which illustrates what happened to prices when the conspiracy

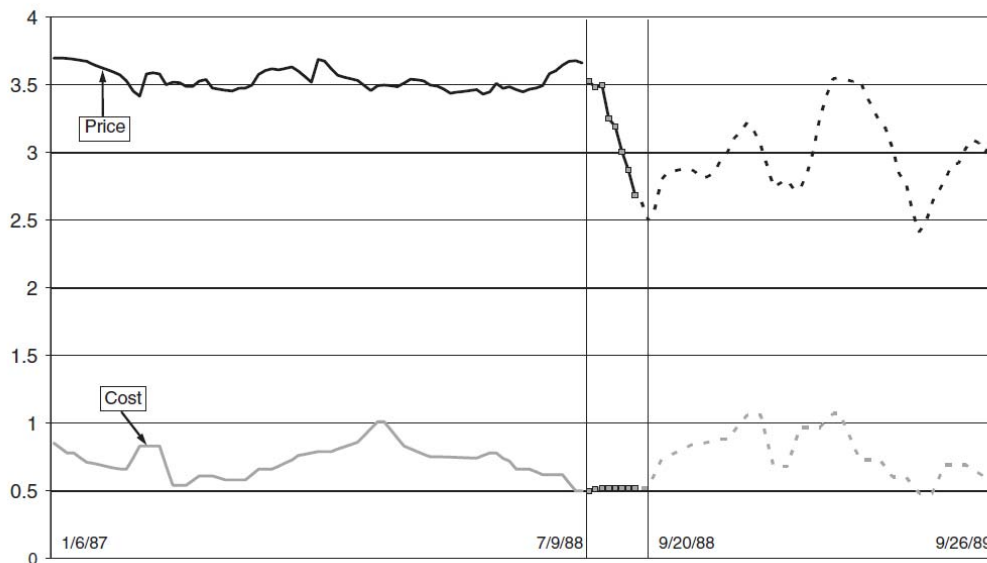
¹ See Section 3.2.3 of this paper.

² Froeb, Koyak, and Werden (1993).

³ Abrantes-Metz, Froeb, Geweke and Taylor (2006).

collapsed following reports of an investigation by the U.S. DOJ. Relative to costs, prices of frozen perch dropped dramatically in August, 1988. In the post-conspiracy period, prices began to co-vary more closely with costs, and exhibited a larger variation (over time). They then compared prices and costs in the “collusive” period (to the left of the vertical lines) to prices in the “competitive” period (to the right of the vertical lines), and assumed that the period in between the two lines represents a transition from collusion to competition.

Fig. 1.a - Frozen perch prices and costs: Jan. 6, 1987 – Sept. 26, 1989



Source: Abrantes-Metz, Froeb, Geweke and Taylor (2006).

5. They then calculated the mean price and the standard deviation of price, and found that when standardized by the mean, the standard deviation of the price, or its coefficient of variation, increased by 332% from collusion to competition (see Table 1.a below). The mean and standard deviation of the cost were also higher under competition, but not enough to account for the increase in price variance. They concluded that the bid rigging conspiracy not only increased the price level but reduced its variance as well.⁴

⁴

Based on this finding, the authors applied the “variance screen” to the retail gasoline stations in Louisville, Kentucky, in 1996–2002. If a cartel existed in that market, the variance screen would identify clusters of gasoline stations located close to one another and exhibiting lower price variation and higher prices relative to other stations in the city. However, they found no such clusters and concluded that competitive conduct was a more plausible explanation than collusion.

Table 1.a - Means and standard deviations for perch price and cost (\$/pound)

Statistics	Collusion	Competition	Differences across regimes (%)
<i>Price</i>			
Mean	3.544	2.97	-16.2
Standard deviation	0.078	0.283	263
CV=standard deviation/mean	0.022	0.095	332
<i>Cost</i>			
Mean	0.722	0.771	6.8
Standard deviation	0.114	0.173	51.8
CV=standard deviation/mean	0.158	0.224	41.8

Source: Abrantes-Metz, Froeb, Geweke and Taylor (2006).

6. In contrast, the review of two well-documented cartels, the lysine cartel and the citric acid cartel, by Bolotova, Connor, and Miller⁵ indicated that the variance of prices during the lysine conspiracy was lower and the variance of prices during the citric acid conspiracy was higher than during more competitive periods. The authors used extended ARCH⁶ and GARCH⁷ models to examine the differences in the behaviour of the first two moments of the price distribution during collusive and competitive phases. They hypothesised that the mean price is higher and the variance of the price is lower during collusive periods relative to non-collusive periods. According to their results, mean prices were higher in both cartels during the collusive period.⁸ They concluded that the variance screen may be a useful tool to detect conspiracies that do not significantly raise price but tend to homogenize business practices, which may raise profits and also reduce variance.

7. Abrantes-Metz, Kraten, Metz and Seow applied several different screening methods to determine if the U.S. dollar 1-month LIBOR rate had been manipulated by banks.⁹ The analysis is based on the comparison of LIBOR with other short-term borrowing rates, and analysis of individual bank quotes, and the comparison of individual quotes to the credit default swap (CDS) spreads during three different time periods. First, they examined the relationship between LIBOR and other major benchmarks, which they assumed were not manipulated, and concluded that the evidence on the average level of the LIBOR rate was consistent with the absence of a material manipulation. Then they examined the pattern of individual LIBOR quotes and how likely it is that a large number of banks will submit identical LIBOR quotes absent coordination.¹⁰ The results of this analysis indicated the possibility of manipulation. Finally, they

⁵ Bolotova, Connor, and Miller (2008).

⁶ This is the traditional autoregressive conditional heteroscedasticity model (ARCH).

⁷ This is the generalized ARCH (GARCH) models.

⁸ The authors explain this as a consequence of the especially long period of the citric acid cartel: it would be more difficult to enforce cartel discipline during longer period. Another explanation for the result could be the shortage of data for non-collusive periods compared with the greater availability of observations for the cartel period (see Esposito and Ferrero, 2006).

⁹ Abrantes-Metz, Kraten, Metz and Seow (2012). A more detailed account of the application of screens to detect possible manipulations of the LIBOR index is included in Annex 2 of this paper.

¹⁰ To that end, they first examined the intra-day variance of these individual quotes. They also calculated the frequency with which each bank appeared in the “deciding group”, and identified banks that tended to be in the deciding group most often. They hypothesized that “manipulative” banks should cluster together in non-random patterns. To test this, the authors computed pairwise correlations between all possible bank-

analysed the relationships between individual LIBOR quotes and proxies for individual borrowing costs as determined by CDS spreads to test if banks with relatively low CDS spreads were also banks with relatively low LIBOR quotes. They found that several banks' LIBOR quotes were unrelated to their ordinal positions in CDS spreads, and therefore raised again the possibility that the LIBOR index had been manipulated.

8. The use of variance screens has become rather widespread in empirical work and a number of screens based on price variance have been designed and applied to specific markets. Just to mention some examples, Eruthku and Hildebrand used a differences-in-differences approach to determine whether a public announcement of an antitrust investigation (which triggered the collapse of a cartel) may be used to detect a price-fixing conspiracy in the retail gasoline markets in Quebec.¹¹ Jiménez and Perdiguero applied a price variance (over time) screen to the retail gasoline market in the Canary Islands, Spain.¹² In another example, Abrantes-Metz and Pereira analysed the mobile phone sector in Portugal before and after the entry of a new operator.¹³

2. Examples of cartel screens based on the analysis of anomalous bidding

9. Several screens have been developed to detect bid rigging conspiracies in public procurement tenders. There are several reasons which favour the development of these type of screens. First, public procurement markets are very rich with data; tenders are generally public and the bids are disclosed at the end of the process allowing for building comprehending datasets which can be then used to empirically test the screens. This allows the comparison of bidding patterns across tenders, across time and across different procurement entities purchasing the same goods or services. The particular rules of the tender also allow to make assumptions on how bidders should behave in a competitive environment.¹⁴ For example, in sealed bid tenders, one should assume that bid reflects the bidder's costs and the market conditions. If bids by independent bidders are highly correlated (even once discounted the different costs and market conditions) that can be used as an indication of possible collusion.¹⁵ Building on these assumptions or patterns for competitive bidding, the economic literature has developed a number of screens to detect anomalies in bidding strategies which in turn could indicated that bidders' behaviour is at odd with a competitive process.

10. In 1993, Porter and Zona examined bidding behaviour in auctions for the construction of a State highway, with the aim of determining if bid rigging occurred.¹⁶ They developed a test based on the existence of "phantom bidding" (or phony or complementary bidding) in procurement auctions, based on the differences in bidding between cartel members and non-members. Using procurement data from the New York State Department of Transportation (DOT), they applied their test to the Nassau and Suffolk

pairs and calculated the frequency with which each bank appeared in the deciding group, and identified a group of banks that tended to be in the deciding group very often.

¹¹ Eruthku and Hildebrand (2010).

¹² Jiménez and Perdiguero (2011).

¹³ Abrantes-Metz and Pereira (2007).

¹⁴ See also discussion on collusive markers for bid rigging conspiracies, in Section 3.3.1 of this paper.

¹⁵ For example, if the correlation across bids is significantly higher across bidders in one market than across bidders in another comparable market, this is an indication that there might be some form of coordination between bidders in the first market. This would be the case particularly if differences in correlation between the two markets could not be accounted for by observable and legitimate differences in market conditions.

¹⁶ Porter and Zona (1993).

county DOT contracts from 1979-1985, and found that the behaviour of the firms involved in the conspiracy was statistically different from that of the firms which did not belong to the cartel. In particular, they found that collusion did not take the form of a bid rotation scheme. Instead, several ring members bid on most contracts. However, a number of bidders submitted phony, higher bids. While the bids of non-cartel firms, as well as their rank distribution, reflected cost measures, they found that, in contrast, the rank distribution of phony bids was unrelated to similar cost measures and differed from that of the low cartel bid.

11. In 1999, Porter and Zona developed a test to detect bid rigging in school milk procurement auctions based on the economic prediction that in competitive markets bids should closely reflect costs. They examined (i) the institutional features of the school milk procurement process, (ii) the bidding data of 13 sealed bids submitted to supply pint-size milk to Ohio schools between 1980 and 1990, (iii) the statements of dairy executives, and (iv) the supply characteristics in Ohio during the 1980s. They compared the bidding behaviour of three defendant firms to that of non-defendant firms (the control group)¹⁷ and using a simple econometric model, they found that each defendant firm's bidding function was statistically different from the bidding functions of non-defendant firms. They argued that the behaviour of these firms was consistent with collusion. The estimated average effect of collusion on market prices was about 6.5%.

12. Bajari and Ye (2003) examined bids for seal coating by highway contractors in the Upper Midwest of the United States during the 1990s.¹⁸ Their screen was based on the assumption that distance and backlog are important pricing determinants in this market. Using a regression model with a firm's bid as the dependent variable and an engineering cost estimate, distance from the project and backlog as explanatory variables, they found that bids increased with both these measures, as would be expected under competition. The evidence was consistent with two firms (out of 11) colluding. Both firms, incidentally, were later successfully prosecuted for bid rigging.

3. Example of cartel screens based on variables other than price

13. Price is not the only competitive variable that can be used to detect collusion.¹⁹ There are other variables that manifest themselves differently if collusion is present, including industry processes such as market clearing, technological innovation, rate of return, and product innovation among others.²⁰ The outcomes of these processes are different under competitive and collusive behaviour, and, thus, can be used as a way to detect cartels.

14. In 2008, Lorenz suggested a screen based on a number of tests designed to detect failures in these market processes (Coordination Failure Diagnostic or CFD), which could be the result of collusion.²¹ According to Lorenz, in economic theory there are five coordination tasks that market processes are supposed to fulfil in order to attain dynamic efficiency and to maximise society's welfare: (i) under competition, in the short run, supply should meet demand and markets should clear; (ii) in the long run, capacities and rates of returns on capital should be normalised; (iii) competition should erode market

¹⁷ In 1994, the state of Ohio charged thirteen dairies with bid rigging in school milk procurement auctions from 1980 to 1990.

¹⁸ Bajari and Ye (2003).

¹⁹ See Section 3.2.3.3 in this paper.

²⁰ Lorenz (2008).

²¹ Lorenz (2008).

power; (iv) there should be efforts to improve the quality or diversity of products; and (v) production methods should be improved in order to reduce costs.

15. The following Table 1.b summarises the collusive markers employed by Lorenz's proposed screen.

Table 1.b - Collusive markers in the CFD cartel-audit

Process	Indicator	Characteristics
Market clearing	Nominal price	Seldom and high volatile changes of price-index
	Capacity utilization	Small capacity utilization Permanent excess supply
	Correlation price/ quantity	Fixed prices in cyclical downturns
Rate-of-return normalisation	Rate-of-return	Excess rate-of-return, perhaps reduced by excess capacities or by fixed prices in recessions (under fixed costs)
	Capacities	Excess capacities, reduction only by acquisition
	Correlation capacity growths/ROR	Dysfunctional growth of capacities Excess capacities independent of rate-of-return
Erosion of market Power	HHI, equivalence index number	Concentration ratios show market power and oligopoly
	Volatility of market shares	Low volatility of market shares, especially by fixed quotas
Product innovation	Market share of new products	Obvious innovation lags
Technology innovation	Labour productivity	Innovation success hindered by X-Inefficiency
		Little incentives for productivity gains without competition

Source: Lorenz (2008), Table 2.

16. Lorenz applied his methodology to the German cement market, which had been affected by collusion for decades, and found that collusion could have been detected perhaps even in the early eighties.²² He concluded by advocating the implementation of the CFD cartel audit by competition agencies. First, he argued for the robustness of the CFD methods by applying the screen to additional markets, both markets affected by collusion (Table 1.c) and markets where it is believed competition prevailed (Table 1.d).

²² Lorenz (2008).

Table 1.c - Collusive markers in cartelised markets

Indicator/Industry	Cement	Cable	Paper	Lysine	Shipping	Concrete
Nominal price	+	–	0	+	–	–
Excess supply	+	+	+	+	+	+
Correlation price/quantity	+	+	+	+	+	+
Excess rate-of-return	+	–	–	0	+	–
Excess capacities	+	+	+	+	+	+
Correlation capacity growths/ROR	+	+	+	0	+	0
HHI	+	+	+	+	+	–
Market share volatility	+	0	0	+	0	0
Product innovation	+	+	+	0	0	0
Technology innovation	–	+	0	0	0	+

(A “+” symbols are indicator, which would have given an advice for cartelised structures, a “–” stands for an indicator, that failed to detect a cartel. Markets where the necessary data were too costly or not available for private individuals are market with 0)

Source: Lorenz (2008), Table 3.

Table 1.d- Collusive markers in competitive markets

Indicator/Industry	Electrical engineering	Steel	Textile	Automobile	Machine building
Nominal price	–	–	–	–	–
Excess supply	–	–	+ ^a	–	–
Correlation price/quantity	–	–	–	–	–
Excess rate-of-return	–	–	–	–	–
Excess capacities	–	–	+	–	–
Correlation capacity growths/ROR	–	–	–	–	–
HHI	–	–	–	+ ^b	–
Market share volatility	0	– ^c	0	+ ^d	0
Product innovation	–	–	–	–	–
Technology innovation	–	–	–	+ ^e	–

^a The permanent excess supply is caused by growing imports especially through the liberalised regulation of GATT (General Agreement on Tariffs and Trade) for the textile industry. The same argument explains the excess capacities

^b Caused by the oligopolistic market structure in the German automobile industry

^c Market share volatilities above the threshold were found only for the cartelised period

^d The market share volatility measured with car brands results in a variance of 0.0865 %, which is not indicative for cartelised structures. But looking at the variance of brands assigned to concerns leads to 0.0388 %, which is as small as in some cartelised industries

^e This shortfall of labour productivity is caused by Japan advance as world-cost leader

Source: Lorenz (2008), Table 4.

17. It appears that the screen was rather successful at detecting collusion and that at the same time the number of false positives was rather low. In addition, Lorenz noted a number of advantages of his methodology: (i) it uses easily available data that can be obtained from research institutions or statistical offices; (ii) it may be implemented using available software; and finally, (iii) is costly to beat, as it requires cartel members *“to change their real behaviour and to forego profits to fool the authority which results in unsuspecting market shares, prices, capacities, innovations and so on. These attempts are costly and can lead to higher instability of collusion by changing the market structure.”*²³

18. In 2009, von Blanckenburg and Geist, analysed the *“workability of markets”* based on several market variables in order to assess if market processes are consistent with competition or not.²⁴ They identified six variables: (i) utilization rate of production capacities, (ii) correlation between the utilization rate of production capacities and price changes, (iii) difference between the rate of return in the industry to a broader comparison rate of return, (iv) correlation between the rate of return difference and capacity growth rate changes, (v) variance of price changes, and (vi) variance of capacity growth rate changes.²⁵ They then used these six market variables to analyse real market processes by means of time series analysis and to investigate whether they operated efficiently or not. The authors submitted that this concept can be used as a tool for detecting cartels and tested it on five German industries from 1980-2007. They found that the German cement industry (which is known to have had a cartel that lasted from 1981 to 2002) showed significant differences from the other four industries which were used as competitive benchmark.

19. In 2010, the same authors applied their method to find if collusion had occurred on markets with observable market data.²⁶ They used the same variables and expected behaviour patterns such as low level of capacity utilization, slackness of price adjustments to exogenous shocks, excess rates of return, nearly constant capacities, less price changes and lower variance of capacity growth rate. However, they added a new variable as a further marker in order to detect cartels, i.e. cost efficiency. They assumed that if cartel members face lower competition they tend to be less cost efficient.

4. Examples of screens to detect manipulations and frauds other than cartels

20. Screens have been developed also to detect forms of illegal conduct other than cartels. In particular, screen for detection of frauds and manipulations are regularly used by regulators such as central banks, securities commissions, treasury departments and other oversight authorities.²⁷ While the purpose of this paper is not to provide an extensive account of these screens, some examples can exemplify the differences and commonalities that exist with cartel screens.

21. Manipulations and frauds can be very different from a cartel conspiracy and screens designed to detect these illegal behaviours need to reflect these differences. For this reason they tend to be more individualised and case-tailored than screens designed to detect collusion.²⁸ A market manipulation, in general: (a) involves fewer members, sometimes just a single firm, than a cartel and (b) it does not necessarily focus on maintaining a fixed price level *per se*, but might involve increasing price movements

²³ Lorenz (2008).

²⁴ von Blanckenburg and Geist (2009).

²⁵ For a discussion of how these variable can be used as markers for collusion, see above Section 3.2.3.3.

²⁶ von Blanckenburg and Geist (2011).

²⁷ For an overview of some examples of manipulations and frauds detected through the use of screens, see Annex 2, Section 3.

²⁸ Abrantes-Metz, Kraten, Metz and Seow (2011).

over a period of time.²⁹ The principles, however, on which these screens are built are similar to those described for the design of cartel screens.³⁰ Screens aim at detecting unusual behaviour or behaviour which is inconsistent with the correct functioning of certain processes. For example, screens to detect financial frauds or manipulations involve detecting price distortions which cannot be explained by seasonality and common demand and supply conditions.³¹

22. Recently, Abrantes-Metz and Addanki developed a screening methodology to detect possible manipulations in commodities markets.³² Their methodology proposes a variance (over time) screen to detect manipulation of commodity prices based on an analysis of the Hunt Brothers' silver manipulation episode of 1979-80. They assumed that manipulations induce noise in the market and distort market expectations about future prices because they provide an informational advantage to manipulators over the rest of the market. By fooling the market, manipulators distort the market's expectations of future prices, which in turn is reflected in the risk premium. By defining the price of a futures contract as the market's expectation of the future spot rate, they found that manipulations induce more volatile market forecasting errors regarding future prices. They also found that that longer maturity contracts show the effects of manipulation more clearly than the shorter duration contracts.

23. Pirrong analysed the manipulation of U.S. commodities law through the lens of the alleged distortion of the soybean futures market in 1989 by Ferruzzi.³³ He tested two hypotheses: (a) that the price of the manipulated contract was significantly larger than the price of the contracts expiring at a later date, a distortion that is often largest immediately before the manipulator liquidates his position, and (b) that the expiring futures price and the spot price at the delivery market were significantly larger than the prices at other, non-deliverable locations. His method relied extensively on historical data. The results of this study were consistent with the hypothesis that Ferruzzi exercised monopoly power, thereby creating an estimated price distortion of 5–10%.

24. Christie and Schultz, studied data on stock trades through the NASDAQ system and noticed some unusual behaviour, which could only be explained by manipulation -either explicit or tacit- on the part of stock dealers. On the NASDAQ market, bid or ask quotes must be multiples of an eighth of a dollar if the bid price exceeds \$10. As a result, bid or ask quotes end in either even-eighths (0, 2/8, 4/8, 6/8) or odd-eighths (1/8, 3/8, 5/8, 7/8). Thus, the narrowest inside spread is one-eighth. Christie and Schultz expected that if the market was not manipulated all fractions would be seen with roughly equal frequencies, as was the case on other stock exchanges. However, they found virtually no inside spreads on Apple Computer stock as small as one-eighth. Indeed, virtually all bids were in even eighths (which ensured that no one-eighth spreads could occur). When they looked at the 100 most actively traded stocks, they found that odd-eighth quotes were extremely rare for 70 of them, including for highly visible and actively traded stocks as Intel, Amgen, Microsoft, and Cisco Systems. Thus, Christie and Shultz concluded that the market makers had an understanding not to use odd-eighth quotes on these 70 stocks, a practice that ensured that their inside spread would not fall below two-eighths, 25¢, per trade. They tested three hypotheses which could explain such behaviours: (i) coarse pricing increments to lower negotiation costs, (ii) cost determinants of the spread, and (iii) tacit collusion among dealers. By elimination, the authors

²⁹ This is for example the case of manipulations of the commodities markets where large price increases often precede sudden price collapses.

³⁰ See Section 3.2 in this paper.

³¹ For example, a standard "red flag" for manipulations in futures markets is backwardation, i.e., a condition where the price of a futures contract is lower than its spot or cash price, an inversion of the more typical contango relationship (Abrantes-Metz, Kraten, Metz and Seow, 2011).

³² Abrantes-Metz and Addanki (2007).

³³ Pirrong (2004).

concluded that the only remaining hypothesis explaining the absence of odd-eighth spreads for NASDAQ securities was tacit collusion among market makers.

25. Other screens which aim at detecting manipulations and frauds are based on mathematical laws, such as the Benford's Law. This is a mathematical formula that describes the regularly occurring distribution of digits.³⁴ Because the law applies to a large number of data sets, it is commonly used in to detect a variety of frauds and manipulations, ranging from data tampering in taxes, in accounting, in financial ratios, and in survey data.³⁵ Recently, Abrantes-Metz et al. used the Benford second digit reference distribution to track the daily LIBOR over the period 2005 to 2008.³⁶ They found that in two periods, LIBOR rates departed significantly from the expected Benford reference distribution, which led them to raise potential concerns relative to the unbiased nature of the signals coming from the 16 banks from which the LIBOR is computed. They concluded that the LIBOR rate had likely been manipulated, questioning its usefulness as a major economic indicator.

³⁴ The Benford's Law refers to the frequency distribution of digits in many (but not all) real-life sources of data. In this distribution, the number 1 occurs as the leading digit about 30% of the time, while larger numbers occur in that position less frequently: 9 as the first digit less than 5% of the time. This distribution of first digits is the same as the widths of grid-lines on a logarithmic scale. Benford's Law also concerns the expected distribution for digits beyond the first, which approach a uniform distribution. See Benford, (1938) and Varian (1972).

³⁵ See for example, the applications made in Judge and Schechter (2009), Nigrini (2005), and Ashton and Hudson (2008).

³⁶ Abrantes-Metz, Villas-Boas and Judge (2011).

ANNEX 2 -

SCREENS APPLIED BY COMPETITION AGENCIES AND OTHER REGULATORS

1. Examples of *structural* screens used by competition agencies

1. Some agencies have used structural approaches to screen sectors and identify industries which present characteristics that make them more prone to collusion. Although they provide helpful insights, structural methods are often affected by severe shortcomings, as discussed in the main part of this paper.¹ Friederiszick and Maier-Rigaud identify four main limitations:²

- First, the level of aggregation used in structural screen is generally too high to identify specific antitrust markets and, in addition, industry classifications do not match antitrust markets.
- Second, an empirical analysis across various sectors requires well-defined, “automated” screens; this exposes the screening programme to evasion by cartelists.
- Third, the relationship between economic factors and the probability of collusion is often not linear, and various economic factors may have different effects on competition depending on the market features.³
- Fourth, by relying on past cartel detection to predict cartel activity in other industries in the future, a selection bias is introduced if the cartels detected are not a representative sample of cartels in general.

2. The following sections describe structural screening programmes put in place by competition agencies.

1.1 *The Dutch structural screening programme – The Competition Index*

3. In 2006, the Dutch competition agency (NMa) started using structural screening techniques to boost its cartel enforcement programme.⁴ At the time, the NMa had just had a positive experience with the detection of a shrimp cartel, suggesting promising prospects for these tools. The methodology relied on a two steps analysis: the first step classified industries according to their NACE codes based on the risk of collusion.⁵ This first step allowed the NMa to identify on a yearly basis the 20 top-ranked sectors which

¹ See Section 3.4.

² Friederiszick and Maier-Rigaud (2008).

³ For example, a high level of price parallelism in a highly concentrated industry may be considered as an indicator for a higher probability of collusion while price parallelism in a highly fragmented market matches the theoretical prediction of the behaviour of competitive firms.

⁴ Buijs and Vermeulen (2008).

⁵ The risk was determined on the basis of a series of structural indicators grouped in four categories: 1) concentration (measured as number of firms in an industry, the HHI, and the share of imports on the net

would deserve further scrutiny. The second step was industry-focused and relied on behavioural screens based on price, quantity, and market shares. This methodology was, however, subject to a number of criticisms when it came to its implementation. In the first phase, the NACE classification limited the usefulness of the screen when it came to identify potentially collusive markets in the antitrust sense. The outcomes also relied heavily on the chosen normalization and weighting scheme of the indicators, which exposed the ranking to many criticisms. As for the second phase of the methodology, often the behavioural testing could not be performed because of the lack of adequate data, leaving the possibility of many cartels going undetected.

4. Despite these initial pitfalls, mainly due to the high likelihood of false positives, in 2011 the NMa developed a revised version of the methodology. The revised methodology used structural methods in the framework of its “Competition Index” (CI).⁶ The CI relied on the same indicators as the former NMa approach: the number of trade associations, the product prices in the Netherlands versus European Union-averages, the Herfindahl-Hirschman Index (HHI), the number of firms, the import rate, market growth, churn rate, survival rate and R&D as a percentage of sales. These indicators were considered indicative of the likelihood of anti-competitive behaviour. The CI evaluates industries⁷ on the basis of public data and through a weighting scheme and it assigns to every surveyed industry a score indicative of its likelihood of being affected by collusion. Industries that score high on the CI may be considered worthy of further scrutiny by the NMa. The CI index ranks industries according to those which are most prone to anti-competitive behaviour. By looking at the top-30 industries in the CI ranking, manufacturing industries represent a significant part. This is largely due to the high number of trade associations in these industries. Another interesting observation is that the results under ‘number of firms’ often approach one (indicating possible oligopoly). Import rates, on the other hand, are generally not generating results that might indicate anti-competitive behaviour. In addition, it appears that transport industries and the renting of transportation equipment are concentrated; the standardized HHI score is one in these industries.

5. The CI methodology tries to address several problems identified in the earlier screening programme of the NMa, such as market definition and weighting issues. For example, in order to document the insensitivity of the CI to the weighting scheme, several different weightings were applied. Moreover, the results of the CI were tested against detected cartels in other countries (“practical test”), which revealed a high degree of overlap. Finally, a statistical comparison of the CI with other measures of competition, such as the price-cost margin or the Boone indicator (“theoretical test”) was conducted, resulting in signs of a weak but significant correlation. One of the key advantages of the CI methodology is that the entire economy is subject to scrutiny. In addition, it is easy to apply and it requires little capital and labour input.

turnover); 2) market dynamics (measured as average market growth, churn, survival ratio, and the share of R&D on gross value added); 3) price index in the Netherlands (in proportion to the weighted EU-15 mean); and 4) organization of the industry (measured by the number of trade associations in the analysed industry). The indicators are then standardized, and then followed by the calculation of a risk of collusion through a predefined weighting scheme.

⁶ Petit (2012).

⁷ We use the term industries because the CI screens data on 500 “industries” of the Dutch economy, which do not necessarily correspond to “relevant markets” defined for antitrust purposes. Grout and Sonderregger adopt a similar approach in their study (Grout and Sonderregger, 2005). While adopting this classification and using industry level available data simplifies the data collection process, it has been heavily criticised for not being very informative, as industries do not correspond to relevant markets for antitrust purposes. See e.g. Laitenberger and Hüschelrath (2011).

1.2 *The UK OFT attempts to set up a structural screening programme*

6. The United Kingdom looked into the possibility to use structural economic analysis in competition law enforcement. In a study commissioned by the OFT in 2005, Grout and Sonderegger developed a detailed methodology which aimed at predicting the existence of a cartel by using a standard industrial classification.⁸ This methodology identified industry-level variables (such as industry turnover, cost measures, concentration measures, entry barriers, and employee costs, among others) that allows to predict cartel activity and used a data set of U.S. DOJ's price-fixing cases since 1994, and European Commission's price-fixing cases since 1990.

7. Grout and Sonderegger relied on several econometric models to estimate how structural factors can influence the presence and frequency of detected cartels in a given market. They then used the respective estimation results to predict the likelihood of a cartel presence in all industries and concluded that telecommunications, manufacture of aircraft and spacecraft, manufacture of grain mill products, starches, and starch products were industries especially prone to collusion. The regression analysis allowed the authors to derive a probability of collusion for industries that have not been suspected of collusion in the past, thereby providing a tool for competition agencies to generally redirect their enforcement priorities.

8. Similarly to the Dutch experience, the methodology developed by Grout and Sonderegger for the OFT has been subject to similar criticisms because of the lack of alignment of industry classifications with actual antitrust markets,⁹ and the difficulty to distinguish between explicit and tacit collusion. The OFT today recognises that structural factors can contribute to predict the incidence of cartels with an industry but that they are not a perfect science. Therefore, the OFT cartel detection strategy relies on a multi-faceted approach which includes consumers/competitors complaints and, under some circumstances, internal economic analysis.

1.3 *Structural screens in the experiences of the U.S. Federal Trade Commission*

9. In 1998, to detect competition problems, the U.S. FTC initiated a broader screening project focusing especially on price movements. The screening methodology was based on the hypothesis that the exercise of market power (and indeed of a cartel) would cause prices to increase throughout a business cycle. The U.S. FTC economics department started identifying industries that experienced price increases during periods where output was stable and the industry was still in recession. Using various data sources such as production price indices of the Bureau of Labor Statistics, the U.S. FTC detected approximately 600 suspicious industries, 25 of which were selected for further investigation. Of these 25, no benign reason for the price increases could be found for 3 industries. One industry was already under extensive investigation by the U.S. DOJ. There is no public record about the outcome of the other investigations.¹⁰

10. These experiences show that a “blind” approach has a high likelihood of generating false positives, and this may have led the U.S. FTC to abandon the systematic use of cross-industry screening tools. The U.S. FTC, however, continues to screen on a systematic basis prices in one particular market, i.e. the market for gasoline and diesel products as part of its monitoring functions of the oil and natural gas

⁸ Grout and Sonderegger (2005).

⁹ For example the Grout and Sonderegger study identifies “telecommunications” as an industry prone to collusion but does not distinguish within the telecommunication industry, between fixed and mobile telephony (just to make an example) which have different histories and a different affinity for cartelization.

¹⁰ Reported in Abrantes-Metz and Bajari (2012).

industry.¹¹ Since 2002, the U.S. FTC has been monitoring wholesale and retail prices of gasoline in an effort to identify possible anti-competitive activities and determine whether a law enforcement investigation would be warranted. Today, this project tracks retail gasoline and diesel prices in some 360 U.S. cities and wholesale (terminal rack) prices in 20 major urban areas. The U.S. FTC's Bureau of Economics receives daily data from the Oil Price Information Service (OPIS), a private data collection company, and reviews other relevant information that might be reported to the U.S. FTC directly by the public or by other Federal or State government entities.

11. An econometric model is used to determine whether current retail and wholesale prices each week are "anomalous" in comparison with historical data, after controlling for known shocks and seasonal effects. The model compares contemporaneous price differences between cities, not the dynamic price adjustment process itself. If retail prices in two areas adjust to the same costs shocks at different rates, prices in these two areas will be observed as diverging for some period of time. For most cost shocks, small differences in adjustment speeds across cities would not normally lead to the identification of price anomalies. However, if a cost shock were relatively large, different pass-through speeds between areas could lead to very noticeable changes in contemporaneous price differences. So far, all price anomalies observed by the U.S. FTC could be explained by non-collusive events (such as pipeline breakages or the malfunctioning of refineries).

¹¹ See http://www.ftc.gov/ftc/oilgas/gas_price. See also US submission to the Roundtable on "*Competition in Road Fuel*", June 2013 [DAF/COMP/WD(2013) 45].

Box 2.a - U.S. FTC gasoline prices monitoring programme
(Excerpts from the U.S. submission to the OECD Roundtable on “Competition in Road Fuel”)¹²

[...]

18. Collusion does occur in petroleum markets. Since 1970, the DOJ has brought 23 criminal cases involving price-fixing conspiracies in local gasoline and diesel fuel markets, in over a dozen states. These cases resulted in convictions of 22 individuals and 55 companies. The Division filed its most recent gasoline price-fixing case in 2008.¹³

19. Much concern about gasoline and diesel pricing focuses on developing a data screen to identify pricing “anomalies” as potential indicators of tacit or overt collusion. In a programme unique to petroleum markets, the FTC actively monitors wholesale and retail prices of gasoline and diesel fuel in an effort to keep up with pricing trends in the markets. This project tracks retail gasoline and diesel prices in some 360 cities across the U.S. and wholesale prices in 20 major U.S. urban areas. The FTC’s Bureau of Economics staff regularly receives and reviews data from a private oil price data collection company, as well as information from the U.S. Department of Energy and other relevant information. FTC staff uses an econometric model to determine whether current retail and wholesale prices each week are anomalous compared to historical data.

20. The Monitoring Project alerts FTC staff to unusual changes in gasoline and diesel prices so that further inquiry can be undertaken expeditiously. It is important to understand that these price changes do not indicate the existence of anti-competitive conduct. Instead, they suggest only that something has changed. Most frequently, they occur because of changes in market forces, such as a temporary supply disruption caused by unplanned refinery outages. When unusual price changes do not appear to result from market-driven causes, staff consults with the Energy Information Administration of the Department of Energy. FTC staff also contacts the offices of the appropriate state Attorneys General to discuss the anomaly and appropriate potential actions, including opening an investigation.

21. The Agencies belong to a multi-agency Oil and Gas Price Fraud Working Group that the Attorney General established pursuant to President Obama’s request in the spring of 2011. Members of the Working Group meet in person or communicate through other means to share information about their activities in the energy markets. These interagency communications are helpful to the member agencies as they individually formulate and pursue law enforcement and other programmes involving petroleum and other energy products.

[...]

2. Examples of *behavioural* screens used by competition agencies

12. If structural screens can be applied to a wide range of sectors and industries, behavioural approaches focus on economic outcomes in a particular market. In this respect, behavioural screens are more flexible and can rely on a more case-based approach. Obviously, also behavioural screens methods have their own limitations. The most important ones relates to the difficulty to access market data and to the resource requirements for implementing behavioural screen. These are also main reasons why screens

¹² DAF/COMP/WD(2013) 45.

¹³ Press Release, U.S. Department of Justice, Convenience Store Company and Individual Charged with Retail Gasoline Price Fixing in Oklahoma (Sept. 19, 2008), available at www.justice.gov/atr/public/press_releases/2008/237430.htm; Press Release, U.S. Department of Justice, Tennessee Oil Company and its President Charged with Gasoline Price Fixing (July 21, 1993), available at www.justice.gov/atr/public/press_releases/1993/211645.htm.

have been rarely used by competition agencies to detect cartel cases. Today, they represent more the exception to the rule. The next Sections will provide an overview of some of these national experiences.¹⁴

2.1 Mexico

13. The Mexican competition agency (Comisión Federal de Competencia (CFC), today Comisión Federal de Competencia Económica) was able to successfully identify bidding patterns consistent with collusion in the procurement markets for several drugs through the use of screens. The CFC discovered that during the collusive period, prices quoted in winning bids or in losing bids were identical across auctions, while the identity of the winning bidder alternated. It also appeared that the number of contracts allocated for the purchase of some types of drugs was practically the same. In the Mexican case, screens proved to be useful not only to detect suspicious patterns but also to focus the CFC's investigation and make the CFC's case in court.¹⁵

14. The use by CFC of screening tools to detect possible collusion is described in detail by Estrada and Vazquez¹⁶ and by Mena-Labarthe.¹⁷ By applying price and market share screenings, the CFC identified instances where identical bids were submitted and where market shares of bidders converged over time. The CFC also found that the number of instance of identical bids dropped and the market share converging pattern disappeared after aggressive entry in the market or after a change in the procurement strategy of the procuring entity (e.g. procurement consolidation occurred). These events were used by CFC as structural breaks for its analysis.¹⁸ The findings triggered a formal CFC investigation in two of the largest families of drugs (insulin and saline solutions) and subsequently led to the adoption of an infringement decision by the agency.¹⁹

15. According to CFC, the effective functioning of the bid rigging conspiracy was also facilitated by structural factors in the bidding process, which helped bidders allocate bidding opportunities and monitor compliance with the bid rigging scheme. Mena-Labarthe identified these facilitating factors in the fact that (i) the bidding guidelines issued by the contracting entity contributed to the standardisation of products, limiting scope for further competition; (ii) there were repeated bidding opportunities allowing for the monitoring of compliance with the collusive arrangement; (iii) communications between bidders were facilitated by regular meetings organised by the contracting entity to clarify procedural and/or technical

¹⁴ For a general discussion on the implementation of various screens by competition agencies see Laitenberger and Hüschelrath (2011).

¹⁵ Mena-Labarthe (2012). It must be noted that at the time of the investigation the CFC did not have the power to conduct unannounced inspections (dawn raids) of the companies involved in the alleged conspiracy. This limited significantly the possibility for the CFC to obtain direct evidence of the cartel and led the courts to be more opened to the use of indirect, economic evidence.

¹⁶ Estrada and Vazquez (2013).

¹⁷ Mena Labarthe (2012).

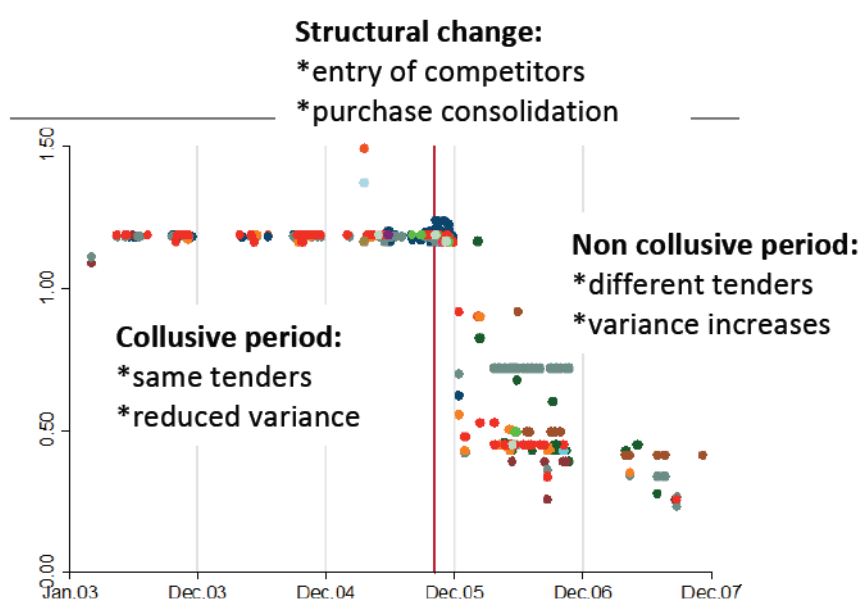
¹⁸ The CFC used as structural break the change in IMSS' procurement strategy. IMSS decided to consolidate procurement opportunities of each drug into a few large national contracts instead of many fragmented local contracts. This consolidation involved all drugs and increased incentives to compete and made market allocation agreements more difficult. Furthermore, even before this consolidation, some drugs registered aggressive entry with similar effects.

¹⁹ According to Mena-Labarthe the investigation followed an informal complaint made by the Mexican Social Security Institute (IMMS) and the CFC used screens to analyse a large amount of data provided by IMMS. In that case, screens "*proved to be an excellent tool to focus the resources of a certain investigation but also helped provide evidence in the case.*" (Mena-Labarthe, 2012)

issues related to the tenders; (iv) rules on “split awards”²⁰ allowed an easier allocation of the collusive earnings; (v) stable procurement strategies made the procurement process more predictable and more easy to “play”; and (vi) entry barriers made new entries costly and transparency rules (e.g. requirement to disclose the name and the bid of the winner) made monitoring easier.

16. For its case, the CFC relied mainly on two results from the screening exercise. First, the annual average of the winning and losing bids presented by the pharmaceutical cartel members were extremely similar between them and they only changed with the entry of a new winner or upon the consolidation of bids some years later (see Fig. 2.a and Fig. 2.b below).²¹ The average price was much higher during the collusive period, sometimes even 72% higher.

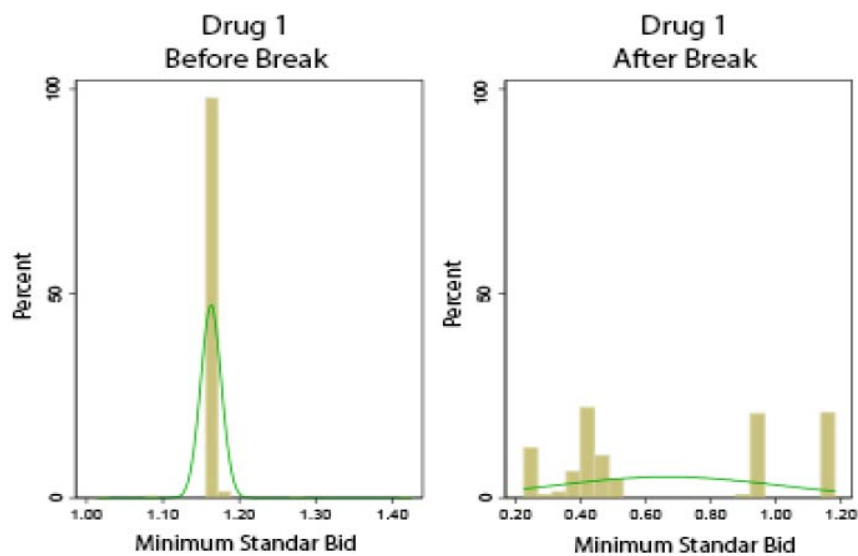
Fig. 2.a – Drug 1, average price/bid (Jan. 2003 – Dec. 2007)



Source: Mena-Labarthe (2012).

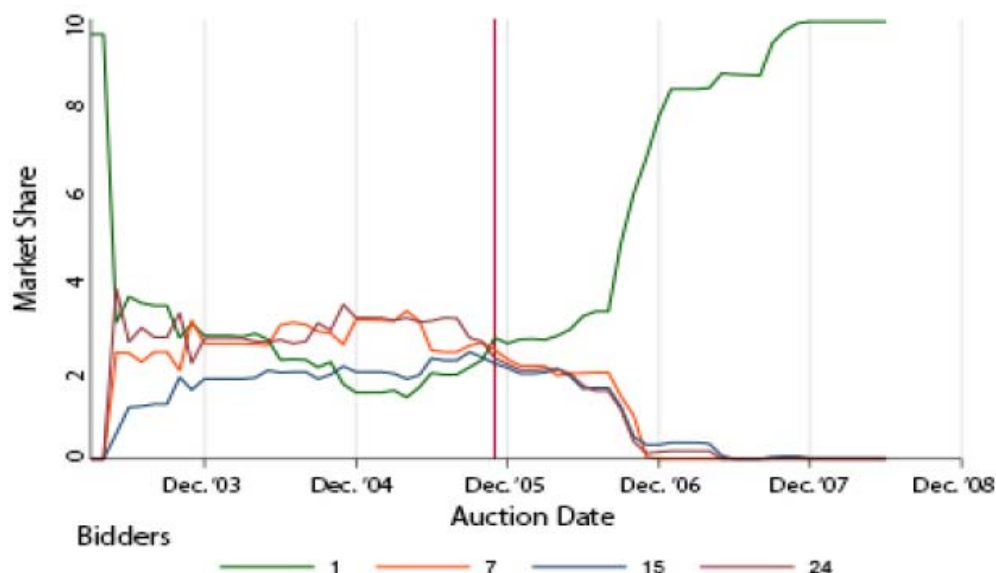
²⁰ The supplier with the lowest price is awarded the contract, provided such price is greater or equal to the reserve price (i.e. the price at which a person is willing to purchase or sell a given asset) determined by the contracting entity. Should the difference in price between lowest bidders round 5%, the bid value was proportionally allocated among them (so called “split award”).

²¹ The prices of winning and losing bids were always the *same*. The only variations were in the identity of the winner, which after winning, kept participating with loser bids, waiting for their turn to win again (bid rotation).

Fig. 2.b – Drug 1, Histogram and estimated density function

Source: Estrada and Vazquez (2013).

17. The second suspicious pattern identified by the CFC referred to the amount of the allocated contracts for each of the identified medicines (market share of each bidder on that procurement market). The screen showed that contracts were concentrated in the pharmaceutical companies involved in the cartel and, in some cases, the achieved portion for each of them was practically the same. During the life of the cartel, the market shares of the participants rapidly converged over time, until a structural break occurred and they started evolving in different directions (see Fig. 2.c below).

Fig. 2.c – Insulin, accumulated market shares²²

Source: Estrada and Vazquez (2013)

2.2 Korea²³

18. In 2006, Korea institutionalised a programme for bid rigging detection through the use of screens. The Bid Rigging Indicator Analysis System (BRIAS) automatically and statistically analyses bid rigging indicators based on the data on public tenders provided to the Korean Fair Trade Commission (KFTC) by public institutions. Using the data delivered on-line from the public institutions, the BRIAS system calculates the probability of bid rigging by giving weighted values to various indicators (e.g. bid-winning probability, the number of bidders, bid prices, competition methods etc.). The KFTC has used the BRIAS system since early 2006 to screen for bid rigging conspiracies in the public sector. The main objective of the system is to help the KFTC better uncover bid rigging conspiracy by enabling it to monitor automatically public tenders. BRIAS' success in detecting cartels is important not only in itself, but also because of its possible contribution to overall cartel deterrence: the system dissuades companies from entering into bid rigging schemes by signalling to the market that the KFTC is screening every public tender. On average, BRIAS flags more than 80 cases per month for further analysis by the KFTC staff.

19. Prior to the creation of the BRIAS system, the KFTC used to request public organizations the information on bidding opportunities above a certain size so that it could investigate possible collusive bidding. The information, however, was usually sent in written form which made it physically impossible for the KFTC to thoroughly review and analyse it. Since 2000, with many public institutions adopting electronic bidding systems, Korea developed a more efficient way to monitor public tenders. On-line bidding platforms made it possible for the KFTC to directly receive bid-related information (and

²² The vertical line indicates the date of the potential structural break.

²³ This Section was prepared with the research and drafting assistance of Sunmi Lee on secondment to the OECD Competition Division from the Korea Fair Trade Commission.

documents) from procurement departments via the Internet for automatic screening of the possible bid rigging conspiracies. The KFTC applied the BRIAS screening system first to tenders of the Public Procurement Service, the largest public procurement office in Korea, in 2006. Later, in 2007, the system was extended to include tenders of four major state-owned companies (the Korea Electric Power Corporation, the Korea Land and Housing Corporation, the Korea Expressway Corporation and the Korea Water Resources Corporation). Today, a total of 332 public procurement agencies are participating to BRIAS, including central administrative agencies, local governments and government-own companies.

Box 2.b - How does BRIAS work?

BRIAS operates in three phases, from the gathering of the data and input, to generating the results.

- In a first phase, BRIAS collects all bid- related data and information concerning large scale bidding contracts awarded by central and local administrations.²⁴ All data and information is collected automatically within 30 days of the tender award.
- In a second phase, the system analyses the data and information received and it automatically generates scores on the likelihood of bid rigging by assessing each relevant factor for the analysis (i.e. the successful bid rates, the number of bidders, competition method, the number of bid prices above the estimated price, how close are between the prices of the second and third bidders and the price of winning bidder). To each of these factors is assigned a weighted value. The scores of each evaluation items are the added up.
- In a last step, the bidding opportunities are screened by BRIAS according to search criteria, e.g. the name of a winner bidder, or bid opportunities which had similar score (90 or 85) of possibility bid rigging.

To design the system and to identify the criteria to detect possible bid rigging conspiracies, the KFTC relied on its past enforcement experience and used as benchmark pre-determined red flags for collusion. On the basis of these markers, the system was designed to give a higher score when (i) the successful winning rate of a company is high, (ii) there are few bidders in the tender process, (iii) there are several bidders whose bid is higher than the estimated price, (iv) non-competitive bidding processes are used, and (v) there is a large gap between the winning and the losing bids. The system, however, is effective only if the weighting system is correctly balanced. For example, in the SeongNam·Pangyeo apartment construction bid rigging case, the BRIAS was not in a position to flag the case for potential collusion because it was designed to give a higher score if the number of bidders in the tender process was less than 10. In this case, there were more than 10 bidders and the system did not flag the case for further investigation by the KFTC.

20. The BRIAS screening system has recently given encouraging results. KFTC investigators analysing the BRIAS database suspected that the bids submitted for the extension of Seoul's subway line 7 were rigged. In addition to the tenders scoring high on BRIAS, the investigators noticed that the six companies which were contracted for each of the six separate sections of the project, had won 27 out of the 33 tenders held by the Municipalities of Seoul and Incheon between 2003 and 2005 for railway/subway design and construction. They also found that the winning bids were higher than expected, that only 2-3

²⁴

This includes bidding information for public construction projects of more than 5 million dollars and for good or service purchase of more than 500 thousand dollars. In addition, the data and information including 1) bid-letting institution, 2) type and method of bid, 3) date and content of bid announcement, 4) estimated cost, expected cost and bid to cost ratio, 5) number of participating bidders, 6) tender records of each participating bidder, 7) matters related to winning bidder, 8) winning bid price, 9) number of bid failures, and 10) number of expected cost increases, etc. should be sent from to BRIAS by the electronic procurement system.

companies submitted bids for each one of the project's separate sections, and that except for the six winning companies, the companies participating in the auctions did not have the capability of independently completing the project and lacked the experience necessary to deliver such projects. Following-up on these suspicions, the KFTC searched the premises of the suspected firms, and seized incriminating documents.

2.3 Italy

21. Italy has not used screens to detect cartels to be subsequently investigated by the Italian Competition Authority (AGCM). In 2006, however, the AGCM tested the effectiveness of the price variance screen initially proposed in Abrantes-Metz and others²⁵ on two markets which had been cartelised in the past, as documented in Esposito and Ferrero (two AGCM officials).²⁶ In a paper describing this exercise, the authors tested the power of the price variance screen to see whether the AGCM could have detected two well-known Italian cartel cases involving gasoline and diesel on the one hand, and baby food products sold in pharmacies on the other, had it applied *ex ante* a price variance screen. They also asked whether such a screen could have correctly identified who was involved in the cartel and during which time period. The answer to both questions was positive, as Esposito and Ferrero concluded that the price variance screen would have correctly identified the two cartels before the AGCM did through other means.²⁷

22. For the gasoline-retailing cartel, Esposito and Ferrero conducted an EU-wide comparison of price volatility across different markets in Europe for different time periods. They concluded that price volatility for gasoline and fuel products in Italy was the lowest among European markets. The cross-country comparison of the average price levels gave a similar result. Average prices (i.e. net of taxes) in Italy for both gasoline and diesel products were among the highest in Europe, which was consistent with a cartel conspiracy scenario. The Esposito and Ferrero's paper also applied the price variance screen to markets for personal care and baby food products where the AGCM had previously fined the professional association of pharmacies for restricting competition in sales through pharmacies.²⁸ The authors compared prices of products sold in pharmacies with prices of the same products sold in supermarkets and found that prices of products sold in supermarkets were systematically lower than those of the same products sold in pharmacies. They also found that prices of products sold in pharmacies fluctuated less.

23. The authors concluded praising the effectiveness of a price variance screen to detect possible instances of collusion. In particular, they submitted that this method: (i) is intuitive and easy to implement, as it makes use only of (aggregate) prices data, and not also of costs data, which is more difficult to collect;

²⁵ Abrantes-Metz, Froeb, Geweke and Taylor (2006). See also discussion in Annex 1, Section 1.

²⁶ Esposito and Ferrero (2006).

²⁷ A similar exercise to the one of the AGCM was done by the Austrian Competition Authority which analysed gasoline retail prices in an EU-15 comparison. They pointed out that the results of a variance screen depend on the applied method (variance of price changes versus variation coefficient) and the type of prices chosen (gross versus net prices). Applying all possible combinations they partly received contradictory findings such as, e.g., for Finland, which showed a low variation when using the variation coefficient and showed a high variation when using the variance of price changes. They therefore concluded that further assistance from academics was needed before such methods could be successfully applied to Austrian gasoline markets. (see Sharma and Kaltenbrunner 2008, as described in Laitenberg and Huschelrath 2011).

²⁸ The association had adopted decisions (i) restricting individual discounting policies, (ii) recommending sale price lists, (iii) creating a commission in charge of monitoring prices in other distribution channels and of defining the recommended price list, (iv) inviting members to follow the producers' listed prices, and (v) limiting advertising activities of the members.

(ii) is grounded on computations of everyday use (variance of prices); (iii) has theoretical and empirical basis; (iv) it would be effective even if firms knew that competition agencies were adopting it to screen for cartels since, notwithstanding the risk of detection, there would be low price variance all the same as a consequence of cartel members behaviour.

2.4 *Brazil*

24. In order to deal with an increasingly high number of complaints on alleged anti-competitive behaviour in the gas retail market,²⁹ the Brazilian Competition Policy System (SBDC) developed screens to separate cases worth of further investigation from complaints to be rejected because ill-grounded.³⁰ Complaints to the SBDC were based on common concerns by consumers: (i) similarity in retail prices, (ii) retail price adjustments that were almost simultaneous or occurred within close dates, and (iii) prices or margins in one city were higher than those in adjacent or nearby cities. The SBDC was faced with a difficult choice because while these signs could indicate the existence of a cartel, a similar outcome could be expected (even in the absence of explicit collusion) in markets with a concentrated supply, a high degree of price transparency and product homogeneity, and extensive vertical relationships. These were precisely the characteristics that fuel retail markets show in Brazil as well as in most economies around the world.³¹

25. In order to deal with the many complaints it receives every year, the SBDC decided to screen all the complaints based solely on economic evidence before deciding whether to pursue the complaint and open a formal investigation or not. The screen methodology includes three statistical tests:³² (i) an analysis of the evolution of the retail profit margins of the city where the alleged cartel operates; (ii) an analysis of the correlation between the retail margins and the coefficient of variation (level of dispersion in prices) for the city; and (iii) an analysis of the correlation between the retail profit margin of the city compared to the retail profit margin of the respective state. The methodology assumes that all the three tests are performed and that the analysis can give two opposite result: (i) no likelihood of a cartel (i.e. reduction in the retail margins from time to time, a positive association between increases in the margins and price variability, and retail margins that evolve similarly to the state average); or (ii) likelihood of a cartel (i.e. increase of the retail margins over time; a negative association between the retail margins and price variability, and retail margins with a disparate evolution or an evolution that is not similar to the State average).

26. The screen quickly became an effective tool to analyse and eventually reject groundless complaints. In a limited number of cases, the results of the screening programme allowed to flag possible cartel behaviour. Fig. 2.d below, for example, shows the screen results for the investigation in the gas retail market of the city of João Pessoa, in the State of Paraíba.³³

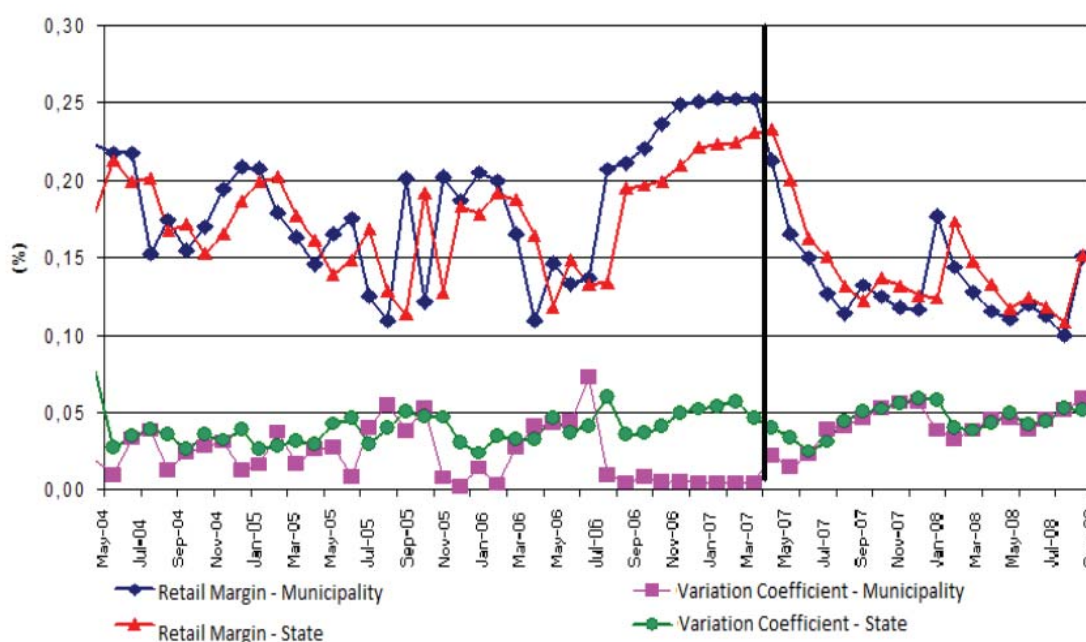
²⁹ According to Ragazzo (2012), in 2010 approximately 23% of the pending cases concerned alleged cartelisation of the fuel retail market; and of the 370 administrative procedures that were sent to CADE for final judgment between 2007 and 2009, 56 (i.e. 15%) dealt with the same market.

³⁰ Ragazzo (2012).

³¹ OECD (2013) (forthcoming).

³² The screen can be effectively implemented because the fuel retail market is a sector which is rich with data. Average prices and margins for consumers (and also average prices practiced by fuel wholesalers) are made available by the Petroleum National Agency, a regulatory agency that monitors and collects and releases data on a wide number of cities.

³³ The graph shows what happened with the retail margins after the Brazilian Competition Authorities and the Federal Police raided the companies under investigation in May 2007.

Fig. 2.d – Fuel retail margin (Municipality of João Pessoa; State of Paraíba, Brazil)

Source: Ragazzo (2012).

3. Examples of screens used by regulators and other supervisory agencies

27. Screens have been developed and implemented not only to detect possible anti-competitive behaviour but also to detect a wide variety of other illegal conduct, such as manipulations of stock and commodities prices and indices, revenues management, stock options back-dating, insider trading, tax evasion, and various types of accounting manipulations. Many regulators and supervisory agencies make regular use of screens in their enforcement and monitoring responsibilities, also thanks to the large amount of data at their disposal. This is often the case of regulators and supervisory agencies in financial markets, where they are responsible for detecting and investigating financial crimes,³⁴ and of agencies supervising the correct functioning of securities and other commodities trading markets.³⁵ In many countries central banks, the treasury and tax authorities are also making use of screens on a regular basis in their monitoring and supervisory functions.³⁶

³⁴ Screens also first flagged Bernie Madoff's fraudulent scheme in 1999 through the observation that returns were always higher than any other observable returns in other asset classes, they were almost perfectly steady and they did not react to market and economic conditions (see Abrantes-Metz, 2013). The fraud (also called Ponzi scheme) involved the payment of returns to investors from their own money or the money paid by subsequent investors, rather than from profit earned by the individual or organization running the operation. New investors are attracted to the scheme by the prospect of high returns in the form of short-term returns that are either abnormally high (compared to similar other investments) or unusually consistent.

³⁵ In the United States, this is for example the case U.S. Securities and Exchange Commission and the U.S. Commodities Futures Trading Commission.

³⁶ For example, in the United States, the U.S. DOJ has set up in 2006 the National Procurement Fraud Task Force to promote prevention, early detection, and prosecution of fraud in federal procurement contracts. The Task Force focuses on defective pricing, false claims, grant fraud, labour mischarging, and bid-

3.1 *U.S. stock options back-dating and spring-loading cases in mid-2000s*

28. In the United States, in the mid- and late-2000's several cases were initiated for alleged manipulations of stock options by way of back-dating³⁷ or spring-loading.³⁸ These cases were triggered by the development of an empirical screen for stock options back-dating.³⁹ The screen was based on observations that stock excess returns tended to be negative before executive option grants and positive after such grants.⁴⁰ These patterns of excess returns were interpreted as due to the back-dating of stock options grant dates. The U.S. Securities and Exchange Commission (U.S. SEC) acted upon this evidence and required that stock options grants be reported within two business days. This broke the unusual pattern in stock excess returns and for the cases in which stock options grants were reported within one day of the grant date the pattern completely disappeared. Excess returns continued to exist for grants reported with longer lags, with the magnitude of the effect typically increasing with the reporting delay.

29. The implementation of this screens at company level allowed the detection of several back-dating and spring-loading cases, triggering regulatory investigations and private litigation.⁴¹ For example, in 2006, LAMPERS, a pension fund responsible for managing and investing current and retired employees of the Louisiana Police Force sued Countrywide Financial Corporation alleging several instances of spring-loading. LAMPERS case was based on the Lie's back-dating and spring-loading screen detecting particular days as red flags for the potential illegal behaviour. The court accepted the use of this screen. The existence of these patterns showed by the screen was used as evidence that Countrywide's executives had used inside information to ensure excess returns from the option grants.

3.2 *The 1998 manipulation of NASDAQ*

30. The screen developed in 1994 by Christie and Shultz to detect abnormal patterns of odd eighths avoidance in the NASDAQ inside spreads⁴² triggered an investigation by the U.S. DOJ on potential illegal behaviour in U.S. financial markets and an investigation by the U.S. SEC. The U.S. DOJ alleged that the understanding among NASDAQ dealers on how bids and asks would be displayed on NASDAQ had the purpose to raise, fix and stabilise the inside spread on a substantial number of NASDAQ stocks. Although the manipulation did not arise from an express agreement, these practices by market makers directly harmed the NASDAQ market, other market participants, and the investors.

rigging. (See <http://www.usdoj.gov/criminal/nptff/>). The U.S. DOJ has also engaged in pro-active efforts in partnership with state and local agencies to protect stimulus funds provided for by the American Recovery and Reinvestment Act of 2009 from fraud, waste, and abuse. In the past, the U.S. DOJ attempted to set up a systematic screening programme for public procurement tenders bases on the so-called "Identical Bid Unit" to detect and deter collusion in public tenders. The programme was abandoned after six years and with meagre results. (See the U.S. submission to this roundtable [DAF/COMP/WD(2013)117]; see also discussion in Abrantes-Metz and Bajari, 2012)

³⁷ The back-dating of employee stock options refers to the grant of the options effective at a date actually prior to the date they are physically given.

³⁸ Spring-loading refers to a practice in which options are granted ahead of positive news or to the withholding of positive news until after the options are granted.

³⁹ Lie (2005).

⁴⁰ A description of these cases and the role of screens in supporting the allegation can be found in Abrantes-Metz (2010).

⁴¹ Abrantes-Metz (2010) discusses the legal battle of screens in stock options backdating and spring-loading.

⁴² See Annex1, Section 4.

31. According to U.S. SEC's Report Pursuant to Section 21(a) of the Securities Exchange Act of 1934 Regarding the NASD and the NASDAQ Market, "[a]dherence to the pricing convention often affected the prices reflected in the Nasdaq quotes, thereby impacting the fairness and accuracy of quotation information disseminated in the market and interfering with the economically efficient execution of transactions. The convention also impaired the ability of investors to ascertain the best market for their trades, increased the costs of transactions, and resulted in unfair discrimination among classes of market participants. The undisclosed activities of market makers that coordinated price quotations, transactions in securities, and the timeliness and sequence in which they reported trades, misled market participants and customers, impaired disclosure of the quotations and prices at which dealers were actually willing to buy and sell, and lessened the ability of investors and other market participants to obtain competitive prices. The interests of market participants in accurate, fair, and reliable pricing were not served. Moreover, the duties that those market makers owed to their customers were compromised by undisclosed sharing of customer information and the repeated failure to honor quotes or report trades promptly or with appropriate designations."⁴³

3.2 *The 2008 manipulation of the LIBOR index*

32. The U.S. DOJ, the U.S. SEC and the U.S. Commodities Futures Trading Commission (U.S. CFTC) are investigating the possible manipulation of the U.S. dollar LIBOR by major banks.⁴⁴ Other regulatory agencies worldwide have followed suit and are looking into possible manipulations of LIBOR denominated in other currencies, and similar benchmarks (e.g. EURIBOR in Europe and TIBOR in Japan). These investigations were triggered by the application of empirical screens by the Wall Street Journal (WSJ) in April and May of 2008 and by Abrantes-Metz, Kraten, Metz and Seow in August of 2008,⁴⁵ which all flagged suspicious and unusual patterns in the quotes submitted by the banks involved in the setting of the LIBOR index.⁴⁶

⁴³ Available at <http://www.sec.gov/litigation/investreport/nd21a-report.txt>.

⁴⁴ In the US, the U.S. CFTC started investigating the allegation of manipulation of LIBOR in 2008; later in 2011 one of the major banks under investigation decided to enter the immunity programme of the U.S. DOJ.

⁴⁵ Their initial paper was later refined and published in 2012 (Abrantes-Metz, Kraten, Metz and Seow, 2012).

⁴⁶ Abrantes-Metz, Kraten, Metz and Seow (2012).

Box 2.c - The London Inter-Bank Offered Rate

Established in 1986, the London Inter-Bank Offered Rate (LIBOR) is the average interest rate estimated by leading banks in London that they would be charged if borrowing from other banks. Along with the EURIBOR, LIBOR is the main benchmark for short-term interest rates around the world and serves as a benchmark for numerous financial instruments, involving literally trillions of dollars' worth of transactions.⁴⁷ In addition to derivatives contracts, LIBOR is the reference rate for numerous consumer lending products such as mortgages, credit cards, student loans, and many more.

LIBOR is calculated for ten currencies and is published daily by the British Banking Association (BBA), based on quotes received from a panel of 16 banks for each currency selected by the BBA. Each business day, the banks on a given LIBOR Contributor Panel are asked to answer the following question, with regard to the currency for which the bank sits on the Contributor Panel: 'At what rate could you borrow funds, were you to do so by asking for and then accepting inter-bank offers in a reasonable market size just prior to 11 am?'⁴⁸ The quotes are then ranked in descending order and the daily rates are obtained by calculating the arithmetic mean of the middle two quartiles for each currency and maturity set.⁴⁹

33. As widely covered by the media, a number of enforcement agencies in different jurisdictions, including some competition agencies, are in the process of investigating the alleged manipulation of the LIBOR index by the participating banks. The LIBOR investigations and private litigations are considered the most important example of how screens can be used to detect possible manipulations and conspiracies.⁵⁰ The on-going probes have already resulted in some banks agreeing to pay millions of dollars in fines as well as in damages from civil suits. The manipulation apparently took the form of suppressing the LIBOR, with the aim of concealing financial difficulties which were experienced by some banks.⁵¹ As reported by the WSJ, who first uncovered possible manipulations of LIBOR, "[s]ome banks don't want to report the high rates they're paying for short-term loans because they don't want to tip off the market that they're desperate for cash."

⁴⁷ In re: LIBOR-Based Financial Instruments Antitrust Litigation, 2013 U.S. Dist. LEXIS 45909, 31.

⁴⁸ In re: LIBOR-Based Financial Instruments Antitrust Litigation, 2013 U.S. Dist. LEXIS 45909, 29. Every member of each panel is asked this question regarding to fifteen different maturities. Id.

⁴⁹ In re: LIBOR-Based Financial Instruments Antitrust Litigation, 2013 U.S. Dist. LEXIS 45909, 30.

⁵⁰ According to Abarantes-Metz, "it is likely that LIBOR manipulation and conspiracy may never have been uncovered had screens been used" (Abrantes-Metz, 2013).

⁵¹ Barclays Bank, which is among the banks which settled their case with the U.S. DOJ agreed to the following statement: "Senior managers within Barclays expressed concern about the negative publicity. The managers on the money markets desk and in the treasury department who gave the instruction to submit lower LIBORs, which resulted in improperly low LIBOR submissions, sought to avoid inaccurate, negative attention about Barclays's financial health as a result of its high LIBOR submissions relative to other banks. Those managers wanted to prevent any adverse conclusions about Barclays's borrowing costs, and more generally, its financial condition, because they believed that those conclusions would be mistaken and that other Contributor Panel banks were submitting unrealistically low Dollar LIBORs. Those Barclays managers sought to avoid what they believed would be an inaccurate perception that Barclays was not in good financial shape when compared to its peers. Thus, Barclays engaged in this misconduct in order to reduce the reputational risk associated with proper, higher LIBOR submissions. In other words, as Barclays employees stated in internal communications, the purpose of the strategy of under-reporting Dollar LIBORs was to keep Barclays's 'head below the parapet' so that it did not get 'shot' off." (Statement of Facts incorporated by reference as part of the non-prosecution agreement, dated June 26, 2012, between the United States Department of Justice, Criminal Division, Fraud Section, and Barclays Bank PLC (<http://www.justice.gov/iso/opa/resources/9312012710173426365941.pdf>), para. 40.

3.2.1 *Detecting likely LIBOR manipulations – Phase I (early detection)*

34. In April 2008, the WSJ published an article raising concerns about LIBOR “*becoming unreliable*”.⁵² Whereas this first article was mainly based on various sources in the banking industry, a second article from May 2008 provided some economic analysis which indicated that something might have been wrong with the setting of the LIBOR rate. According the WSJ report, until January 2008 “*the cost of insuring against banks defaulting on their debts moved largely in tandem with Libor -- both rose when the market thought banks were in trouble*”. But “*as fears grew about possible bank failures, the two measures began to diverge, with reported Libor rates failing to reflect rising default-insurance costs [...]*”.⁵³ The WSJ also noted that “*during the first four month of [2008], the three-month borrowing rates reported by the 16 banks on the Libor panel remained, on average, within a range of only 0.06 percentage point – tiny in relation to the average dollar Libor of 3.18%.*”

35. The first and central element of the WSJ’s analysis combined two general approaches to screening discussed in the literature: (i) comparing the observable performance and outcomes of the market allegedly affected by the manipulation (in this case, LIBOR) against an appropriate benchmark (the default insurance market) across time choosing a comparable benchmark;⁵⁴ and (ii) finding “structural breaks” in firms’ behaviour (around January 2008).⁵⁵ The second element of the analysis focused on the actual rates submitted by the banks, which, according to, Prof. Duffie (one of the independent academics who reviewed the WSJ’s methodology), were “*too similar to be believed*”.

3.2.2 *Detecting likely LIBOR manipulations – Phase II (the application of screens)*

36. Prompted by the WSJ articles and by the suspicions they described, a number of academic papers applied different screening techniques to test the likelihood that banks may have actually manipulated the LIBOR index.⁵⁶ These papers compared the LIBOR with other short-term borrowing rates and individual quotes by banks against measures of their individual costs and also analysed the intra-day variance of banks’ individual quotes. They analysed data over the period between January 2007 and May 2008, and identified two important dates, August 9, 2007 (news reports on the spread of the financial crisis and central banks’ intervention) and April 17, 2008 (announcement of BBA’s intention to investigate possible manipulation of the LIBOR), which could serve as candidate dates for a structural break in banks’ quoting decisions.⁵⁷

37. The first type of observation that screens revealed was that when looking at the 1-month LIBOR for the period January 2007 to the end of May 2008, as well as other benchmark indexes such as the Federal Funds Effective (FFE) Rate and the 1-month Treasury Bill (T-Bill), two striking features emerged (see Fig. 2.e below): (i) the nearly constant LIBOR for at least 7.5 months and (ii) the different volatility pattern between the LIBOR rate and the benchmark rates T-bill and Federal Funds Rate, when no reason seemed to justify such pattern differences.

⁵² Carrick Mollenkamp, *Bankers Cast Doubt on Key Rate Amid Crisis*, WSJ April 16, 2008.

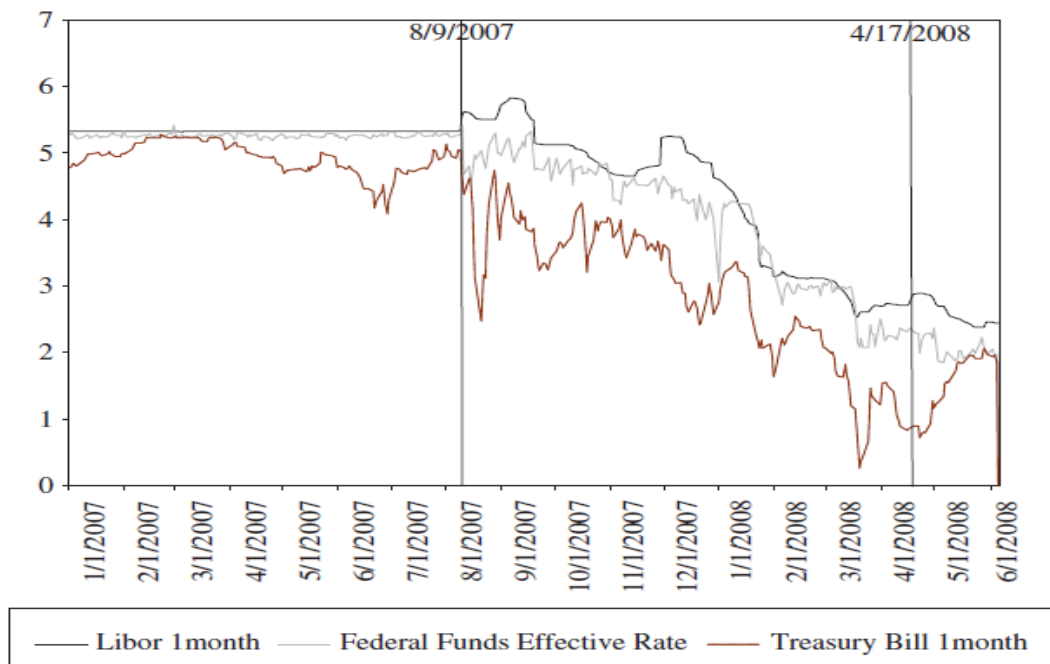
⁵³ Carrick Mollenkamp & Mark Whitehouse, *Study Casts Doubt on Key Rate*, WSJ May 29, 2008

⁵⁴ E.g. ABA (2010).

⁵⁵ Harrington (2008).

⁵⁶ Abrantes-Metz, Kraten, Metz and Seow (2012), Abrantes-Metz and Metz (2012), Abrantes-Metz, Bajari and Judge (2011).

⁵⁷ Abrantes-Metz, Kraten, Metz and Seow (2012).

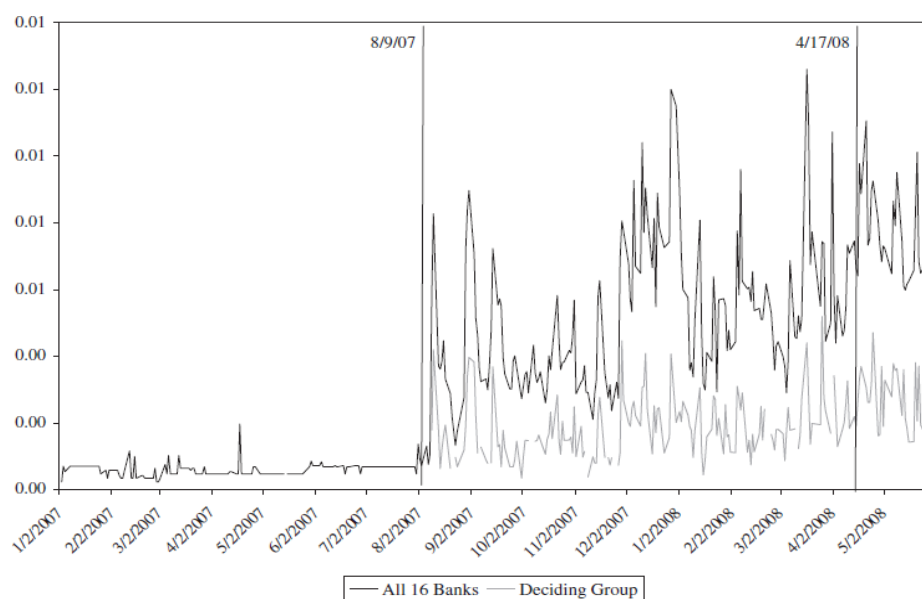
Fig. 2.e - LIBOR 1 month, Federal Funds Effective Rate and Treasury Bill 1 month

Source: Abrantes-Metz and Bajari (2011)

38. A second element that screens revealed about LIBOR was the correlation of 100% among individual quotes of the majority of the banks submitting sealed (!) quotes. The analysis of the individual quotes submitted by the banks and the analysis of the intra-day variance of quotes provided some apparently abnormal results: individual quotes appeared to be very similar in the period preceding August 9, 2007, while quotes were much more varied afterwards; in addition, “owing to the large number of identical quotes”, it appeared that “the vast majority of the banks joined the deciding group more than 95% of the time”, and that “the composition of the deciding group is relatively constant” over said period. The picture was rather different when looking at later periods, as shown by Fig. 2.f below.⁵⁸

⁵⁸

Abrantes-Metz, Kraten, Metz and Seow (2012).

Fig. 2.f - LIBOR 1 month: cross-sectional coefficient of variation for banks' quotes

Source: Abrantes-Metz, , Kraten, Metz and Seow (2012).

39. To show that these results were indeed the outcome of a manipulation and not the effect of some form of tacit parallelisms between the banks, Abrantes-Metz and Metz analysed individual banks quotes for specific periods of time.⁵⁹ Table 2.g and Table 2.h below list the individual quotes for the first days of August 2006 and list the unique values that determined the LIBOR on those days, and the number of banks that shares that quote.

⁵⁹

Abrantes-Metz and Metz (2012).

Table 2.g - Individual quotes from early August 2006

	2006				
	August 3	August 4	August 7	August 8	August 9
BTMU	5.410	5.430	5.370	5.370	5.330
Bank of America	5.400	5.420	5.380	5.370	5.325
Barclays	5.410	5.420	5.370	5.370	5.340
JPM Chase	5.410	5.420	5.380	5.370	5.330
Citi Bank	5.405	5.420	5.360	5.370	5.330
CSFB	5.405	5.420	5.360	5.370	5.330
Deutsche Bank	5.405	5.415	5.365	5.365	5.325
HBOS	5.410	5.420	5.350	5.370	5.330
HSBC	5.400	5.420	5.370	5.370	5.330
Lloyds	5.410	5.420	5.360	5.370	5.330
Norinchukin	5.410	5.420	5.370	5.370	5.340
Rabobank	5.405	5.415	5.370	5.370	5.330
Royal Bank of Canada	5.405	5.420	5.370	5.368	5.330
Royal Bank of Scotland	5.400	5.420	5.370	5.370	5.330
UBS AG	5.405	5.420	5.370	5.370	5.330
West LB	5.405	5.460	5.360	5.370	5.330

Source: Abrantes-Metz and Metz (2012). Highlighted are the quotes that were excluded from the calculation of LIBOR.

Table 2.h - The distribution of “middle 8” quotes

	2006				
	August 3	August 4	August 7	August 8	August 9
Value 1	5.405	5.420	5.360	5.370	5.330
<i>Count</i>	7	12	4	14	12
Value 2	5.410		5.365		
	6		1		
Value 3			5.370		
			8		

Source: Abrantes-Metz and Metz (2012).

40. The observation of this data showed clearly that banks submitted largely the same quote day after day, and that they were not “learning and converging” toward that common quote, rather they submitted an identical (sealed!) quote one day, and then submit an identical but different (sealed!) quote the next day. The authors, for example, note that on August 3, seven banks submitted the quote 5.405 and six banks submitted the quote 5.410. But then on August 4, twelve banks submitted a quote of 5.420 - different from any of the quotes submitted the previous day. On August 7, there were three different values that were part of the “middle eight” quotes on that day, 5.360 (submitted by four banks), 5.365 (submitted by one bank) and 5.370 (submitted by eight banks). But then on August 8, fourteen of sixteen banks submitted a quote of 5.370. This was taken as evidence that these patterns were not the effect of a tacit behaviour, but rather that of an explicit understanding between the banks to manipulate the quotes.

41. The last interesting result from the application of screens to the LIBOR manipulation emerged from the comparison of banks’ credit default swaps (CDS) spread, which appeared to correspond to banks’ financial stability, with individual banks’ LIBOR quotes, which can also be perceived as an indicator of

banks' risk.⁶⁰ It appeared that for some banks, counter to what one would expect under normal circumstances, there was a negative correlation between individual LIBOR quotes and banks CDS spread. In other words, for some banks, two indicators of risk were pulling in different directions at the same time. This too suggested that LIBOR may have been artificially suppressed. In the same paper, the authors also observed variations in banks' market-implied bond ratings provided by Moody's, which "*transform market indicators such as bond prices into a scale comparable to credit ratings*". Given this variation implied that different banks presented different degrees of risk, "*we would not expect to observe the banks' Libor quotes to be completely identical on a daily basis*" like they were in the period before August 9, 2007. The authors further noted, that while the variance in market-implied bond ratings increased between January and August 2007, the variance between banks' LIBOR quotes did not, and that the drastic change in variance in the LIBOR after August 9, 2007, was not explained by the slight increase in the variation in market-implied bond ratings. Once again, two indicators of banks' health appeared to be performing inconsistently.⁶¹

42. Finally, the LIBOR was analysed in light of the Benford's Law.⁶² According to Benford's First Significant Digit Law, "in many naturally occurring numerical data sets, the leading digits are not uniformly distributed but instead follow a logarithmic weakly monotonic distribution." Studies have shown that the law applies to "a surprisingly large number of data sets, including populations of cities, electricity usage and the daily returns to the Dow Jones. Market data reflect nominal values that often do not vary much over limited periods of time."⁶³ While the LIBOR's first digit did not vary much, the authors expected the second and following digits to vary according to Benford's Law. It appeared that while LIBOR's second digits had followed the path of Benford's Law distribution rather closely for two decades, a significant divergence was observable over most of the period between February 2006 and October 2008. This divergence again suggested to the authors some artificial interference with the LIBOR index.

⁶⁰ Abrantes-Metz, Kraten, Metz and Seow (2012).

⁶¹ Abrantes-Metz, Kraten, Metz and Seow (2012).

⁶² Abrantes-Metz, Villas-Boas and Judge (2011).

⁶³ See Annex 1, Section 4.

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