Guidelines
Competition Advocacy

Estimating cartel damages

Seprac Secretariat for Productivity and Competition Advocacy

MINISTÉRIO DA FAZENDA

BRASIL

Team

Secretary

João Manoel Pinho de Mello

Deputy Secretary

Angelo José Mont'Alverne Duarte

Chief of Staff

Thalia Lacerda de Azevedo

Economic Advisor

Isabela Ferreira Duarte

Legal Counsel

Roberto Domingos Taufick

Ministry of Finance

Esplanada dos Ministérios, bloco P, 2º andar, Gabinete SEPRAC.

70.048-902 - Brasília-DF

Cover and Interior Design

Gleyce Kelle

Talia Lucchezi Ramalho

Table of contents

1. Introduction

1.1. Economic analysis of the law, value of the compensation and deterrence

The definition of the amount of the fines that the decision-making bodies must apply, or of the compensation that the victims can demand, depends on several stages. The first one, according to the Economic Analysis of Law (L&E), is to define which rule will govern the fine. Economic law scholars generally define three rules: the property rule, the liability rule and the inalienability rule – provided that, in practice, hybrid forms are quite common[1].

In the first case, the title is conferred by the state on an individual, who may demand compensation for any interference with his property right. According to the property rule, the parties define the value of the compensation after market negotiation. In other words, one cannot interfere with the property of another, except if -- and to the extent -- authorized by the owner. There is no *ex ante* value that third parties can pay to make use of the property of others, against the will of the owner. Conversely, the liability rule encompasses a state that both defines who holds the right and sets the value of the compensation. According to this rule, the offender may choose to interfere with the property of others, if she pays the penalty defined by the state. In other words, the state arbitrates the amount of the compensation that is necessary to place society in a better situation if the good changes hands. The main purpose of this rule is to create a Pareto-optimal allocative efficiency, with net social welfare gains.

At last, the inalienability rule prevents the transfer of ownership of a given good whose preservation society deems desirable. Conversely, every activity that threatens the integrity of that good is regarded as socially undesirable, and therefore must be discouraged at all costs.

It is therefore necessary to distinguish the objective of compensating the damage caused to the direct victims of anti-competitive behavior from the *a priori* objective of

[1] Guido Calabresi and A. Douglas Melamed, Property Rules, Liability Rules and Inalienability: One View of the Cathedral, 85 Harvard Law Review 1089 (1972).

curbing that very behavior because of its broad consequences, which affect far beyond their direct victims and harm the economic and social development of the country. The differentiation includes:

(i) the aforementioned distinction of objectives – to compensate for the damage (property and liability rules) or to prevent the behavior (inalienability rule);

(ii) the value (of the fines or of the compensation) that must be paid – the value of the damage (liability rule), the negotiated value (property rule), or the utility/gains that the offender derives from the offense (inalienability rule); and

(iii) the possibility (property and liability rules), or impossibility (inalienability rule) to determine the victims of the behavior.

In other words, we have before us a hybrid rule – as recognized in Calabresi and Melamed's seminal article – that allows us to set both (i) the civil compensation of the victims of the harm and (ii) the optimal fine to deter anticompetitive behavior.

According to L&E, the penalty or the compensation must be set taking into account:

(i) the probability of detection;

(ii) the risk aversion of the offender; and

(iii) the objective of the payment:

a. to internalize the damage (by compensating the injured parties in in civil lawsuits); or

b. to deter the behavior (by means of criminal lawsuits and other punitive actions).

In the unlikely scenario where the probability of detection is 1 (100%), the average individual would be deterred from inflicting harm by simply paying back the gains earned with the harmful behavior. That would happen because, under this hypothesis, *coeteris paribus*, the offender would always lose (losses equivalent to the costs incurred, including the fines and opportunity costs).

As the probability of detection falls, the law enforcers must increase the fines and compensations so that the degree of enforcement is preserved. This corollary came to be

known as "the Becker's solution", named after the economist Gary Becker[2]. This raise in the fines and compensations is justified by the fact that the potential offender, in taking the decision to infringe or not the law, takes into account not only the value of the fine or compensation, but also the chances that she will ever be caught. Thus, for example, paying $ 1,000 for "breaking a window" may be worthwhile if the probability of detection is low (if, for example, only 1% of cases are caught, the *expected fine* equals miserable R$ 10 - in other words, the low probability of punishment affects the potential offender's perception, raising the incentives to commit the offense). That cannot be said of a fine of $ 1,000,000 for "breaking a window," even if the probability of detection is only 1%: however remote the chance of being caught, the offender may lose all her wealth[3].

The influence of the probability of detection on the value of compensation for the damage (liability rule) follows the mathematical formula f = h/p, where the compensation (f) is the ratio between the amount of harm (h) and the probability of detection (p). Since the risk-neutral and rational offender of the model measures the reward based on the likelihood of being detected and because legal persons are, on average, regarded as risk-neutral[4], this formula captures the optimal compensation. Accordingly, it is common that the value of the compensation be used for the calculation of the fine that, based on the liability rule, confers the ownership of the property to those who derive most utility (whose benefit from ownership of the property exceeds the losses of welfare imposed on others). It is important to consider, though, that however common in torts, only rarely is the value of the damage weighed against the likelihood of detection in Roman-Germanic civil law, where overcompensation is regarded as enrichment without proper cause. That said, in the case of the Common Law punitive fines, there is no such a case, because the

[2] Becker, Gary S. (March–April 1968) **Crime and Punishment: An Economic Approach.** Journal of Political Economy. 76(2): PP. 169-217.

[3] On top of the monetary raise of the fines and compensations, persons who are risk-averse (especially individuals) are not as prone to take risks as the risk-neutral. Risk aversion affects perception and works as if detection levels were higher than they actually are, meaning that fines can be raised at a slower pace for the risk-averse, without affecting deterrence levels. Also, according to Mitch Polinsky [**An Introduction to Law and Economics**, 4th edition. Wolters Kluwer: 2011, P. 83], when the loss is substantial relative to the wealth, individuals tend to take into account not only the expected fines or compensations, but also their nominal value: '*Individuals may care only about the expected loss if the worst possible loss is small relative to their wealth, but they are likely to care as well about the actual probability and magnitude of the loss if the worst possible loss is large relative to their wealth*.'

[4] This assumption is the outcome of the protection that the corporate veil confers on the personal assets of the manager, as well as of the greater risk diversification of the legal entities. The robustness of this assumption is corroborated by the most significant cases involving sophisticated market players judged by the Brazilian Competition Policy System.

aim of the law is punitive, not compensatory – which is precisely the topic of our next discussion.

As opposed to the liability rule (civil damages), the most appropriate value to serve as the basis for the calculation of a fine that seeks to dissuade an illicit behavior (punitive fine) is not the value of the damages, but the value of the utility of that infraction to the violator. In order to estimate those fines, we should adequate the formula to f = u/p, where the fine (f) is the ratio between the value of the utility extracted by the offender (u) and the probability of detection (p). In practice, however, measuring the value of utility to the offender is a chimera, which is why we use instead the estimate of the value of the gains with the behavior (in this case, f = g/p, where g = the advantage received and the other notations are preserved).

There is, therefore, an inversely proportional relationship between the level of detection and the amount of the fine that L&E seeks to solve. But detection levels are not the outcome of a country's authority work and risk-aversion alone. Also contributing to the analysis are: (i) international cooperation between competition authorities; (ii) the likelihood that foreign authorities will detect and punish the effects of anticompetitive conduct in Brazil; (iii) the likelihood of detection of the same behavior by non-competition foreign authorities; and (iv) the probability of private enforcement. More elaborately, it is possible to say that:

- the greater the likelihood that competition authorities will cooperate, the greater the chances that the detection of the behavior by one of them will lead to the knowledge of that behavior by another competition authority. The existence of fora between competition authorities, such as the Organization for Economic Co-operation and Development (OECD) and the International Competition Network (ICN), facilitates contact between competition authorities and, when national legislation allows, the sharing of privileged information;
- likewise, the greater the number of legal systems whose administrative (or judicial) authorities have jurisdiction to prosecute offenders for the behavior that took place abroad or whose harm is suffered abroad, the greater the likelihood that the offense will be detected and punished – even in duplicity;
- of particular relevance to Brazil, the concurrent authority for authorities to prosecute and punish a certain behavior under different statutes raises the likelihood of detection. This is the case, for example, of the concurrent authorities that Cade (according to Law 12,529 of 2011), the Comptroller General of the Union (and counterparts, at local and state level, according to Law 12,846 of 2013), the Public Prosecutor's Office (according to Law 8,625

of 1993 and Law 8,137 of 1990) and public administration bodies in general (Law 8,666 of 1993) have to process, punish and cartels in public bids;

- private enforcement (damages lawsuits) and public enforcement are complementary: If successful, the individual or collective damages actions, under the terms of Laws 8,078 of 1990 and 7,347 of 1985 as well as of art. 47 of Law 12,529 of 2011 subject the assets of the offender to the payment of a compensation for civil damages that sums up to the penalties mentioned in the previous items - which, in turn, aim to prevent the harmful behaviors (punitive fines).

If all victims of the harm were always compensated (private enforcement) and if the amount of compensation at least equaled the value of the gains obtained by the offender, there would be no need to impose any penalty on the offender (public enforcement) to prevent her from perpetrating any harm. And whenever the gains exceeded the amount paid as compensation for the damage, it would be enough for public enforcers to demand payment of the difference.

However, detection levels are still very low. According to the Commission Staff Working Paper on Damages actions for breach of the EC antitrust rules [SEC (2008) 405]:

> "*Even in the most effective system of private enforcement, not all the harm to consumers and other victims reflected in the above estimates will be compensated: this is because, inter alia, a considerable number of antitrust infringements will remain undetected. For hardcore cartels, the detection rate is generally assumed to be no more than somewhere between 10% and 20%. For other infringements, the detection rate is higher, but the "conviction" rate (i.e. the rate of successful damages actions) is likely to be much lower, since claimants often find it very difficult to produce proof that the contested conduct produced actual anticompetitive effects. It also has to be assumed that some victims do not come forward to claim compensation, for instance because they prefer not to disrupt an ongoing business relationship with the infringer. Moreover, in some instances, victims will find it rather difficult to convince courts of a sufficiently close causal link between any particular damage and the infringement*."

Following Becker's logic, this means that, in order to achieve the appropriate level of deterrence in cartel cases, the expected fines (+ expected compensation) must be much higher than the value of the gains of the offender: according to the White Paper, something as high as ten times the value of the cartel gains of the legal persons for hardcore cartels: f = gains/0.1. However, it is not possible to count on damages actions to reach this value yet: According to data released by Cade[5], until 2011 there were only 20

[5] FRIAS, Maria Cristina. **Ações movidas por lesados por cartéis crescem e criam conflito com leniência**. *In* Folha de São Paulo (20/6/2017). Available on

lawsuits filed in Brazil; even though Cade now estimates 110 cases, it is still an incipient amount. As a matter of consequence, until private enforcement is a reality in Brazil, it is up to the public enforcer alone to guarantee the appropriate level of deterrence.

Given the Cade's problems or resistance to quantify the value of the cartel gains, the optimal fine would only be reached in practice when, in parallel to the conviction by Cade, the Public Prosecutor's Office and, under anticorruption law, the competent bodies sought the application of substantial fines. However, this is an exceptional situation and, as long as private enforcement does not become a credible threat, anticompetitive behaviors will be underdeterred. In the case of cartels, there is also the possibility of increasing deterrence through the imposition of incapacitation penalties (Law 8.137, of 1990). In that case, however, the cost of incarceration to achieve deterrence is much higher than the imposition of the fine.

In any case, be it in violations of the competition law or in cases where the Public Prosecution Service makes use of a public civil action or a criminal action to impose a new punishment on the offenders for the same conduct, the penalties imposed by the different bodies on the offenders, based on the same conduct, are added in the effort of deterrence. The same is true for the private (enforcement) lawsuits to recover damages from the offenders.

Since, according to the Becker solution, there is no ceiling to the amount of the fines for offenses that should not be tolerated (inalienability rule), it is up to Congress to choose between punishing by the minimal necessary (the value of the gains as weighed against the probability of detection and the risk aversion of the offender) or by the value of the wealth (maximal fines). In Brazil, calibration relies in the principle of proportionality. On the other hand, the subsidiary or sole application of incapacitation, as we have seen, should only be adopted when overall enforcement is deemed insufficient.

Brazil's Congress, legitimately, chose, by means of art. 37, I of Law 12,529 of 2011, to punish the offender with large losses of assets and, in the cases of cartels, under the terms of art. 4, II of Law No. 8,137 of 1990, with incapacitation. The choice of Congress is in line with the perception, drawn up by the European Commission's White Paper, that the cartel detection levels are very low. As regards the incapacitation penalty, Congress'

<http://m.folha.uol.com.br/colunas/mercadoaberto/2017/06/1894220-acoes-movidas-por-lesados-por-carteis-crescem-e-criam-conflito-com-leniencia.shtml>. Last accessed on June 21, 2017.

choice stems from the underdeterrence of individuals pursuant to Law No. 12,529 of 2011: the fines for individuals can be set below the value of the gains from the behavior. Low fines set by Cade make law enforcement depending upon complementary and substantive incarceration -- making it more costly for the state to achieve deterrence. However, as the fine set forth in Law No. 8,137 of 1990 is low and because probation is certain, general enforcement of competition law, besides expensive, is low.

Those considerations are also important to make it clear why the imprisonment of managers is not enough to protect competition in Brazil and why it is also necessary to impose fines on legal persons. Besides underestimating the costs of incarceration, the argument is not flawless because Laws 12,529 of 2011 and 8,137 of 1990 underdeter the individual. In addition, the punishment of the individual alone incorporates other inconsistencies, such as[6]:

> "a) leads to the persistence of less competitive firms with greater moral hazard in the market; b) by sustaining contracts that the offender irregularly obtained by playing unfairly, the competitors that have lost those contracts are punished because they acted within the strict boundaries of the law. As such, moral hazard and adverse selection are promoted; c) raises incentives for free riding by equity holders, because although the absenteeism of the equityholders were central to the perpetration of the offense it will be rewarded by punishing the managers alone. In other words, the absenteeism of those who profit with offenses to competition is rewarded, and best practices of corporate governance are discouraged; d) in family businesses, entrenchment facilitates the maintenance of that legal entity, albeit indirectly, under the control of the same person, or her family, perpetuating impunity; e) underenforcement lowers the risk of acting in the shadow of the law, increasing the payoffs of the illegal behavior; f) given the impossibility of determining all those individuals who have fraudulently benefited from the illicit, underenforcement of the legal entity leads to general underenforcement (*e la nave va*); g) encourages behaviors that are socially reprehensible and for which it does not make sense to think exclusively from the standpoint of immediate economic benefits."

These guidelines do not, however, aim at estimating the amount of the fines to be imposed on the offenders by the competent authorities. Taking as a starting point that the levels of detection of cartels are low and that there is underenforcement (either because the fines do not take into consideration the levels of detection, or because they disregard the gains obtained by the violators), these guidelines seek to encourage private enforcement, or, in other words, private actions to collect damages.

[6] Taufick, Roberto. Nova Lei Antitruste Brasileira, 2nd edition. Almedina, 2017. PP. 378/379.

There are two main reasons for this choice. First, by creating incentives for individuals to redress damages, the ability to detect offenses to competition increases whereas incentives for cartelization decrease. With high detection levels, the expected fine (which takes into account the levels of detection) also decreases and gets closer to the value of the actual gains obtained. Second, by adding up the amounts of fines imposed by the competent bodies to the amounts of compensation for damages suffered by individuals, the (low) amount actually paid by the violator (in public enforcement) will at least converge to the amount of the benefit received by the violator and, thus, the opportunity costs for participation in cartels will be raised.

1.2. Quantifying Damage

Economic principles influenced the development of legal frameworks designed to promote competition in several countries. There is an extensive literature in economics dedicated to the study of practices that hinder competition. This literature focus, specially, studying the formation and operation of cartels. The findings of this literature have influenced the development of antitrust legislations.

The literature on cartels aims to answer a series of questions. Why do we observe the formation of cartels? Does market characteristic influence cartel formation? How to detect a cartel? How to analyze cartel behavior? How to identify the influence exerted by the cartel's leadership?

In the last decades, one line of questioning received greater attention. How to detect cartels and estimate its impact? This question has led to the development of models and methods aimed at providing researchers with the tools needed to quantify cartel behavior.

According to this literature, it is possible – under certain conditions[7] - to obtain reliable estimates of the impact of a cartel. There are methods that can help to detect cartels, to evaluate the damage cartels impose on consumers and society and to determine due damages. In theory, these methods could assist at every stage of antitrust enforcement, from the investigation process to the definition of private damage. Nevertheless, in only a few countries the use of such method is already common practice. In the United States there are decades-old examples of the use of quantitative methods

[7] Mainly data availability and validity of each method's assumptions

for estimating damage in private actions. In most countries the use of such method is incipient[8].

Brazil is no exception to this rule. There are a few successful cases of quantitative methods being used to detect cartels. Nevertheless, the use of such methods for the estimation of damages is treated with skepticism. The fact that many antitrust practitioners are not familiar with some of these methods - especially those developed more recently - explains part of this skepticism. We lack of references in Portuguese that present such methods in organized, direct and simplified manner. The publication of these guidelines by SEPRAC - Secretariat for Productivity and Competition Advocacy of the Ministry of Finance[9] - intends to fill this gap. The guidelines were designed to serve as an official reference used to assist all those involved in private actions against cartels.

We start by laying out the principles to be followed throughout the guidelines and the goal SEPRAC intends to achieve with its publication. First, the guidelines were designed to serve as practical tool readily available for real world analysis. That means reaching and influencing a broad audience. Throughout the guidelines, economic concepts and methods are presented in the most direct and simplified manner possible. The idea is to present methods and models to as many antitrust practitioners as possible, even those lacking a formal training in economics. Second, in defining the scope of the guidelines, SEPRAC focused on relevance and viability. The guidelines do not present an exhaustive review of the literature. They focus on the methods and models more likely to be useful in the process of: (i) detecting cartels; (ii) quantifying overcharge; (ii) quantifying the passing-on of overcharge. Our hope is that the publication of these guidelines encourage an increase in the reparation for damage suffered by victims of a cartel. As will be detailed moving forward, reparation for private damage is still rare in Brazil.

Before moving forward, we must clarify which definition of cartel we will adopt throughout the guidelines. There are mainly two definitions of cartel, a legal and an economic one. For some jurisdictions - though not in Brazil - a cartel presupposes the

[8] In the European Union, despite the recent publication of a White Paper, there still a lot of disbelief on the soundness of these methods. In Latin America, the issue was discussed in 2017 during the OECD Latin American and Caribbean Competition Forum. We can also add a recent study - *Estimating Economic Damages in Antitrust Actions in Latin America* - published by the Comsión Federal de Competencia do México.

[9] In accordance with its legal responsibility of promoting competition

existence of an explicit agreement between parts. Thus, in the legal definition, there is a concern on the mechanism that allowed the formation of the cartel. A cartel, in the legal sense, is an explicit agreement between firms intended to harm competition and promote economic gains for its participants. Economists, on the other hand, are only concerned with cartel behavior. If a group of firms behave like a cartel, coordinating their operation with the goal to increase profits, that group of firms is considered a cartel. It does not matter, for the economist, if that coordination began with hidden meetings or was tacitly agreed on. A cartel, in the economic sense, is any coordination between firms intended to hurt competition and increase overall profit.

Throughout the guidelines, we consider the economic definition of cartel. We present a review of methods and models that can be used to identify and analyze cartel behavior. In general, these methods and models are blind on the mechanisms that lead to the formation of cartels. Thus, they are not to be used independently, especially under legal frameworks that require the existence of an explicit agreement to characterize cartels. They are to be used in combination with other methods of antitrust analysis. Economic tools are not a substitute for traditional structures of antitrust investigation. They serve as a powerful complement that can be used to improve the efficiency and reliability of antitrust analysis.

The guidelines are structured as follows. In the first chapter, we present a brief introduction to basic economic concepts. In chapter two, we focus on the problem of detecting cartels. In chapter three, we present a review of methods and models useful to the quantification of overcharges. The fourth chapter focus on the problem of quantifying the passing on of overcharges. The Portuguese version of the guidelines includes an attachment that introduces statistical and mathematical basic concepts and reviews some of the most recent developments of the literature.

2. Identifying Cartels

2.1. Basic Concepts

2.1.1. Market Power and Cartel Formation

We aim, with these guidelines, to influence an audience of antitrust practitioners as broad as possible. That means introducing models and methods developed by the literature in economics to an audience with no formal training in economics. To achieve this goal, we need to introduce a set of basic concepts that are essential to the economic analysis of antitrust. In what follows, we present a brief introduction of these concepts.

We begin this chapter introducing the concept of market power, an essential concept for the analysis of cartels. Next, we focus the theory of cartels. We detail the economic definition of cartel and introduce the theoretical findings on cartel formation and detection. One central concept in this literature is the concept of market structure. We advance introducing basic models of market structure. Finally, we present a theoretical analysis of the social costs of cartels. The presence of such social costs justify the existence of legal frameworks intended to prevent cartels.

In general, the economic analysis of antitrust focus on evaluating evidences of firms creating, increasing or expanding in time their market power. We can loosely define **market power** as a firm's relative ability to control or influence prices. Market power is not an absolute concept. The analysis of market power is only useful within a context. The evaluation of a given firm's market power must always considers firm, industry and, specially, market characteristics.

In a **perfectly competitive** market, a large number of firms with similar costs sell an identical product. In perfect competition, consumers can respond to any increase in price transferring demand between firms. In this setting, each firm has a limited influence over price. Any firm that tries to increase prices is going to lose demand to its competitors. In a perfectly competitive setting, firms are price takers. In other words, firms have no influence over price and thus no market power. In equilibrium, price will equal firm's marginal cost of production, the cost of producing one additional unit.

In a **monopolistic** market, a single firm offers a product with no substitutes. Thus, the monopolist does not face competition from other firms and has total autonomy to determine prices. Prices are set with the goal to maximize profit – the monopoly profit. In this scenario, the monopolist has full market power.

The previous market structures – perfect competition and monopoly – are extreme theoretical constructs that help understand real world issues. Nevertheless, most market structures are somewhere between these two extreme descriptions. In real world applications, we observe competitive markets in which a large number of firms offer products with some degree of differentiation and thus are able to set different prices. We observe monopolists that have their ability to determine prices constrained by the threat of new entrants. We also observe oligopolistic markets, markets in which a small number of firms compete. In oligopolistic markets, firms must consider the influence of its competitors when setting prices. In each of these scenarios, we observe a level of market power that can be placed somewhere between null and full market power.

The main take from this discussion is the notion that different degrees of market power exist. Consider two different oligopolistic markets. In the first market, firms produce a relatively homogeneous product. In the second market, products are differentiated and thus cannot be considered perfect substitutes. These two scenarios characterize, for instance, the production of milk and yogurt. There are limited ways to differentiate the production of milk. On the other hand, the production of yogurt offers greater opportunities for differentiation. Yogurts can differ on flavor, consistency and sugar content, to name only a few. Based on these two types of information – number of competing firms and product differentiation – we can offer a partial diagnosis on the likely level of market power in each of these markets. Since there is a limited number of competitors, firms in each of these markets probably have some degree of market power. Nevertheless, market power of firms in the second market is probably larger. In the second market, products present different characteristics. Different consumers may value each of these characteristics differently and thus be willing to accept large price differences. Therefore, in the second market, the ability of firms to influence price is greater. This example shows that market power is not a binary concept. The relevant question is not if firms have or do not have market power. The relevant questions is the level or degree of market power of a given firm.

With a clear understanding of the concept of market power, we are in position to answer three important question. First, what is a cartel (in the economic sense)? Second, why do firms form cartels? Finally, how the findings from the literature in economics can boost the detection of cartels?

We observe a cartel, according to the economic definition, when firms competing for a given market coordinate their behavior with the goal to increment market power. As previously state, economists are not concerned if a cartel was established through an explicit agreement between firms or if it was the result of tacit interactions. We observe a cartel every time we observe an artificial increase in market power as a result of firm coordination.

Firms form cartels because there is a direct relation between market power and profit. Firms act with the main objective of obtaining maximum profit. The scenario in which firms maximize their profits is the full market power scenario. In a cartelm firms coordinate behavior with the goal to increase market power. The final goal is to come as close as possible of full market power. When a cartel functions perfectly, firms are able to behave like a single firm, replicating monopoly behavior and achieving maximum profit.

Finally, we briefly discuss the ways in which economic theory can help cartel detection. We observe, in real world cases, different degrees of market power. Market power depends on firm, industry and market characteristic. Large levels of market power are perfectly consistent with the predictions offered by economic theory, even for scenarios in which firms are not behaving with the intention to harm competition. Thus, the challenge antitrust practitioners face is how to distinguish between two types of case: cases that market power is a result of firm and/or market characteristics against cases in which firms manipulate market power through coordinated behavior. In what follows, we present method and models that can be used to overcome this challenge. In general, these methods and models offer strategies that allow the analyst or researcher to evaluate if actual market power corresponds to expected market power given the characteristics of each case.

2.1.2. Classic Models of Market Structure

In the previous section, we introduced two classical models of market structure: perfect competition and monopoly. In a perfectly competitive model, firms are price takers and thus have no market power. In equilibrium, price equals marginal cost. In a monopoly, we have a single firm that faces no real threat of competition. The monopolist has total control over market price - or full market power. In a monopoly, prices are set to the level that maximize the monopolist's profits. Both models are abstract representations that are useful for economic analysis. Nevertheless, they are uncommon outside the realm of economic theory. In the real world, market structures are usually placed somewhere between these two extreme structures. Economic theory do offer the possibility of creating models that represent more closely some aspects of reality. In what follows, we introduce a set of classic models that incorporate additional assumptions on firm and market characteristics. In some scenarios, these models can serve as a more suitable guide to analysis.

In **monopolistic competition**, a large number of firms sell differentiated goods. Since goods are not perfect substitutes, some consumers may prefer – and be willing to pay more for - goods that presents specific features. In this scenario, firms may enjoy some market power and thus have the ability to determine different prices. Thus, according to the monopolistic competition framework, price dispersion can be a feature of markets with a large number of competitors. The level of price dispersion depends on the characteristics of goods. Firms offering goods with no close substitutes can enjoy greater market power. Thus, the level of price dispersion depends on how closely related products offered by different firms are.

As previously stated, a model of market structure can be made more realistic with the incorporation different assumptions. Two features are especially useful to the analysis of cartel behavior. First, the operation of cartels requires some degree of market power. Second, the formation of cartels entails some type strategic interaction between firms. Oligopolistic models can easily incorporate both these features. In an Oligopoly, a small number of firms shares the market.

Oligopoly models explore how firms interact in a scenario where only a few firms compete. In this scenario, the behavior of any firm can influence the behavior of every firm in the market. Oligopoly models can be of two types: static and dynamic. We will focus on static models. In a static model, firms do not consider the effect that their current behavior may have on future interactions. That does not mean that firms assume they will interact only once. It means that each interaction is treated independently. Next, we introduce the two classical models of oligopoly: the Cournot and the Bertrand models.

In a **Cournot model**, a small number of firms compete offering a homogeneous product. Firms compete on quantity. They define - independently and simultaneously - the amount of output they will produce. The sum of the output produced by each form determine supply. Equilibrium between supply and demand determines market price. All firms in a Cournot model are aware of the fact that market price will depend on decisions made by other firms. Firms choose quantity to maximize profit taking the output of its competitors as given. In this setting, firms enjoy some market power and market price can be greater than marginal cost. The Cournot model is an adequate framework for the analysis of industries that offer firms little flexibility on the definition of output, e.g., industries in which increase in production depends on costly previous investment.

The Cournot framework offers a few insights on the relation between market power and firm/market characteristics. First, the Cournot model shows that there is a relation between cost and market power. Specifically, in a scenario with heterogeneous costs, lower cost firms enjoy greater market power. This advantage gives lower cost firms greater market share and the ability to define greater price-cost margin. The Cournot model also indicates that market power depends on the elasticity of demand. We can define elasticity of demand as measure of consumers' sensibility to price changes. Elasticity of demand is high when consumers respond to even small increases in price with a significant reduction in demand. The Cournot model shows that there is an inverse relationship between price-elasticity of demand and market power, i.e., when demand is highly sensible to increases in prices, firms enjoy little ability to determine prices. Finally, the Cournot model shows how the number of firms in a market can influence the market power of each firm. Within the Cournot framework, there is an inverse relationship between market power and number of competing firms. That is, the greater the number of firms in a market the smaller the market power each firm enjoys.

As the discussion on the Cournot model exemplifies, a situation in which firms enjoy some market power even in the absence of restrictions to competition is perfectly consistent with economic theory.

In a **Bertrand model**, a small number of firms compete in terms of prices. Firms interact setting prices and demand - at the set price - determines quantity sold. The insights offered by the Bertrand model depend on a specific set of assumptions. We introduce the Bertrand model accepting three basic assumptions: (i) there is no heterogeneity in costs between firms, i.e., costs are symmetric; (ii) firms do not face capacity constraints; (iii) firms offer a homogeneous good. Under these three assumptions, consumers will always choose the good with the lowest price. Every firm that decides to set a price slightly below market price will capture all market demand. As long as market price is above marginal cost, this price reduction will be profitable. Thus, as long as price are greater than marginal cost, firms will have an incentive to reduce prices. In equilibrium, the market price equals marginal cost. That is, under the three aforementioned assumptions, the Bertrand equilibrium replicates the perfect competition equilibrium.

The previous results is a direct consequence of the three basic assumptions. When we relax any of these assumptions, we alter the insights offered by the Bertrand framework. In a scenario with differentiated goods, consumers can choose to pay more for some goods. When a small number of firms compete in terms of price, but offer differentiated goods, these firms may enjoy some market power. This market power will be higher when goods offered can be not be considered close substitutes. It will also be higher if elasticity of demand is small.

We are now in position of characterizing cartels in light of market structure models. The goal of any cartel is to increase the profit for its participants. Profit is maximized in conditions of full market power, i.e., when cartels are able to replicate the Monopoly equilibrium. Throughout these guidelines, we show how the analysis of market characteristics inform on cartel behavior. The goal is to evaluate if observed market equilibrium corresponds to expected market equilibrium. When we observe less competition than expected, we have preliminary evidence of cartel activity.

2.1.3. Impact of Cartel Formation over Welfare

Antitrust legal frameworks serve the purpose of promoting competition. They are stablished under the assumption that competition promotes social welfare. In this section, we present the economic theory on how cartels harm welfare.

We observe a cartel – according to the economic definition – when firms competing for a market cooperate to harm competition and increase overall profits. Usually, profits increase through artificial raises in market price. Lande and Connor (2005) review the literature on cartels and show an average price increase of 25%. This price increase results in direct and indirect costs for society.

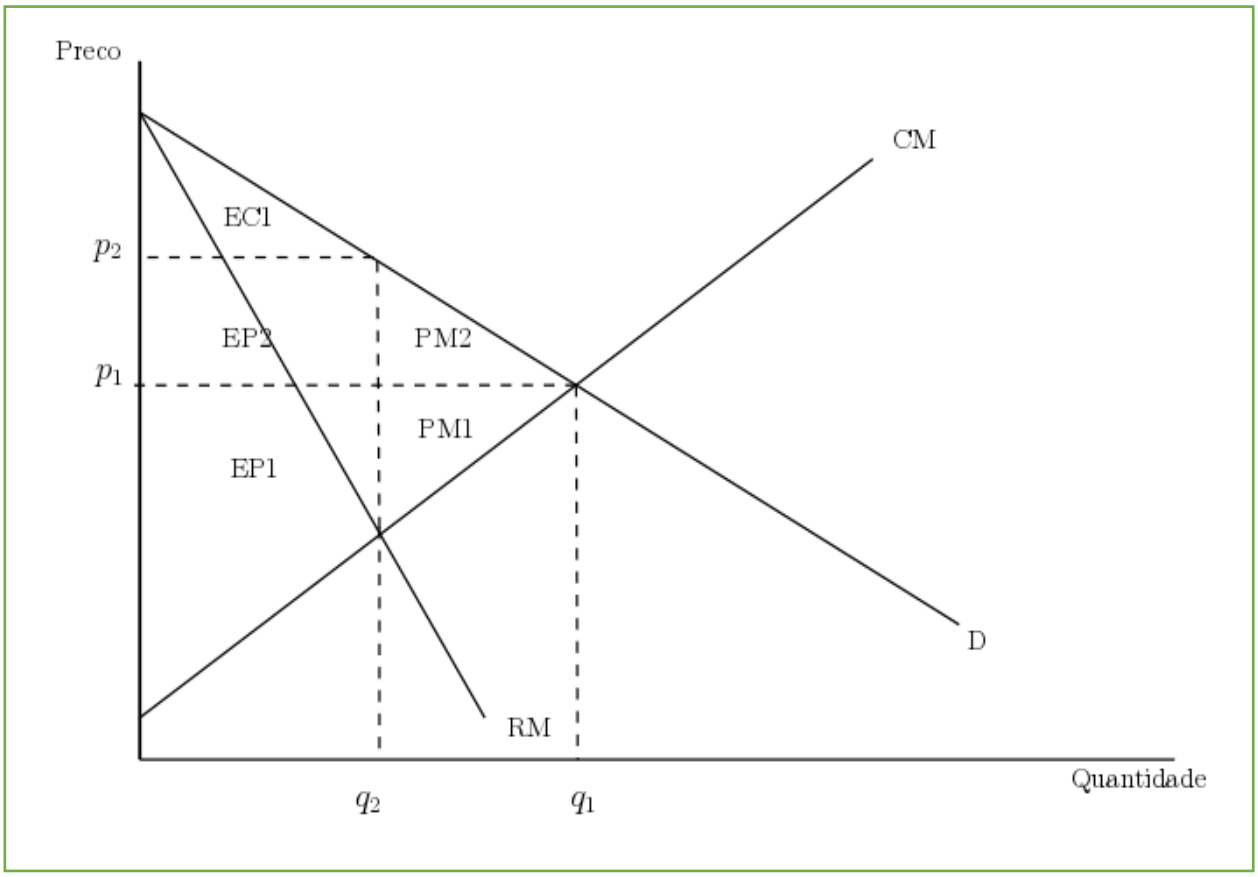
First, cartels impose costs on final consumers. Each unit sold by a cartel is sold at a price higher than the price that would prevail with no restrictions to competition. The difference between the cartel price and the competitive price – the overcharge – is beared by final consumers. This overcharge imposes a cost on consumption, since consumer's utility is lower when prices are higher. The increase in price, and consequent reduction in consumer's utility, is transferred to producer in the form of higher profits. In this case, there is no loss to society. We simply observer a utility transfer from consumers to producers.

This increase in price is not without consequence. There is also an impact over demand. Since there is an inverse relationship between price and demand, an increase in price results in a decline in quantity sold. Some consumers – those that value the good the least - will opt to not consume– or consume less of - the good, in response to the price increase. This reduction in quantity sold is a result of cartel operation. In this case, there is no transfer of utility. Both consumers and producers face a loss of utility that is not offset by an increase in the utility of any other market participant. Thus, the reduction in quantity represents a cost to society - what economists call the deadweight loss.

The following graph illustrates the impact of cartel operation over welfare. The graph shows demand and supply for two different scenarios: perfect competition and cartel. Line D represents the demand function. There is an inverse relationship between price and demand. In perfect competition, price equals marginal cost. Line CM represents the marginal cost function. In perfect competition, CM also represents the supply function. Price and quantity are determined by the intersection between supply and demand. In perfect competition, equilibrium price and quantity are given by $p_1$and q_1. A

cartel aims to replicate the behavior of a monopolist. A cartel is fully successful when is capable to determine a price that equates marginal revenue and marginal cost. Line RM represents supply under such scenario. Cartel equilibrium price and quantity are given by p_2 and q_2. Cartel operation increases price and reduces quantity sold in equilibrium.

The graph also illustrates the transference and loss of utility imposed by cartel behavior. In perfect competition, consumer surplus can be represented by the (EC1+EP2+PM2) area. Producer surplus is given by the (EP1+PM1) area. With the increase in prices caused by the cartel – and consequent reduction in quantity – both consumers and producers face a loss in utility. Part of the loss faced by consumers (EP2) is transferred to producers. On the other hand, another part of the loss (PM1+PM2) is not compensated by an increase in the utility of any market participant. The area (PM1+PM2) represents a loss to society, the deadweight loss.



Cartels do not have an impact only on the utility of final consumers. They can alter the utility of every participant across the production chain. They can also impact the utility of competitors that are not part of the cartel.

Consider, initially, a scenario in which the good sold by the cartel is used as an input in the production process of another good. We can expect two types of outcomes from this scenario. First, cartel activity will have an impact on the utility of the consumer who bought the good sold by the cartel. As usual, part of this consumer utility will be transferred to cartel participants through the cartel's overcharge. Since, this consumer is also a producer and the good sold is an input, the cartel also impacts production costs of some other good. If the producer decides to pass at least part of this increase in costs to final consumers, these final consumers will lose utility due to cartel's behavior. We refer to this transfer of costs as the passing on of overcharges.

Cartels also affect the utility of those firms that supply inputs used in the cartel's production process. When cartel participants coordinate their behavior with the goal to increase market price, there is also a contraction in output. This contraction in output reduces the demand for inputs affecting the firms that supply these inputs. Cartels may also affect the utility of rival firms that do not take part on cartel's activity, increasing barriers to entrance or allowing these firms to enact price increases.

In sum, cartels harm utility of other market participants through two mechanisms. First, there is a redistribution of utility. When cartel successfully increase market prices, utility is transferred from consumers/ other firms to cartel participants. Second, there is a loss of welfare. When cartels increase prices and consequently reduce output, there is a deadweight loss, a loss of utility that is not transferred to any market participant. Thus, legal frameworks intended to curb cartels are not intended only to protect consumers. They inhibit welfare loss, promoting a more efficient allocation of resources in society.

2.2. Methods for Cartel Detection

In the previous section, we showed why effective antitrust enforcement have a positive impact over welfare. This effective enforcement depends on the availability of a set of tools that: (i) allow antitrust practitioners to detect cartels; (ii) promotes reliability, transparency and efficiency to the process of detecting and imposing sanctions on cartels; (iii) enable the establishment of effective sanctions. In this section, we present tools that can help the process of detecting cartels.

The international experience reveals that the detection of cartels usually involves a traditional process of investigation. This process involves the collection of hard evidence and depositions. In general, such investigation is a legal requirement for the prosecution of cartels.

The process of collecting evidence is costly. The investigation of cartels - as any investigation - faces a number of difficulties. Since firms can enjoy some degree of market power even in the absence of artificial restrictions to competition, it is not easy to determine if there is indication that firms in a given market are cooperating to increase profits. It is not trivial to determine which cases offer sufficient indications of cartel to justify a costly investigation. Thus, antitrust authority must base its decision to open new investigations on a set of investigation triggers, such as indirect evidences, complaints or leniency programs.

These investigation triggers are often outside the control of the antitrust authority. Antitrust enforcement would certainly be more efficient if antitrust authorities had access to less costly methods of cartel detection. International experience reveals a tendency for the adoption of proactive investigation triggers.

Over the last few decades, we have seen a remarkable development in the econometric methods for cartel detection. This development - combined with a significant increase in computer performance – suggests that empirical analysis can serve as an effective tool for cartel detection. The use of econometric methods for cartel detection has already produced significant results. In 2008, for example, quantitative analyses showed evidence of manipulation of the LIBOR rate. This evidence triggered an investigation that concluded for the existence of a cartel that profited from fixing LIBOR.

In the following sections, we present a set of quantitative methods that can assist the process of detecting cartels. These methods allow antitrust practitioners to explore market and firm level information to assess the risks of opening a cartel investigation. We begin with market structure methods. Market structure methods identify a set of market characteristics that correlates with cartel formation and evaluates which markets presents these characteristics. Then, we present a set of behavioral methods. Methods of this type focus on the analysis of firm conduct. The rationale is that firms participating in a cartel tend to behave following a certain pattern.

There is mainly two different approaches for making these quantitative methods useful. In the first, the use of such methods is automatized. The competition authority can build systems that automatically analyze available information with the purpose of detecting cartels. These systems are built to signal the most suspicious cases. These cases can then be selected for further analysis. In the second approach, such methods are used during the investigation process of specific cases. The goal is to serve as an incremental evidence of cartel activity.

There are, of course, limitations to the use of these methods. First, these methods are useful for the detection of economic cartels. They usually are blind to the process that led to formation of the cartel. Second, most of these methods are based on statistical tools. As such, results are always presented in terms of probabilities. These results, though reliable when methods are properly used, cannot be considered irrefutable evidence. Finally, these methods often depend on the availability of data. It is possible that for some essential cases data is not available or access is restricted.

These limitations should be taken seriously. They should not, however, be used as a pretext for the dismissal of quantitative methods altogether. Quantitative methods reduce costs of enforcement, promoting a more efficient allocation of investigative resources. They can also provide complimentary evidence of cartel. Thus, quantitative methods can serve as powerful tool complementing the investigation process that leads to the prosecution of cartels.

2.2.1. Market Structure Based Methods

In a cartel, firms coordinate behavior with the intention to increase overall profit. The process of forming and maintaining a cartel presents several challenges. That is the reason why we do not observe cartels more frequently, even though firms can boost profitability through coordination. The literature has outlined a set of conditions that can increase the likelihood of success of a cartel.

The main challenge cartel participants must face is a coordination challenge. The success of a cartel depends on firms reaching deals and communicating – explicitly or tacitly – common strategies. This process is more likely to be successful under certain conditions. First, the cartel is more likely to succeed if it includes a group of firms that, combined, have the ability to influence market outcomes. Second, a cartel is only sustainable in the absence of significant competitive threats from non-participants. Thus,

the existence of some type of barrier to entry increases the cartel rate of success. Finally, the success of a cartel depends on the number of firms. The challenge of coordinating behavior is likely to increase if the number of cartel participants also increases. Thus, cartels are less likely to be successful in markets with a large number of firms.

Cartel are also inherently unstable. To see why this is the case, remember that cartel enact price increases with the goal to increase profits. In this scenario, a firm that deviates from the agreement and marginally reduces its prices is likely to capture a larger share of demand. Thus, in many scenarios, it is lucrative for firms to deviate from the agreement and there is an incentive to "cheat". The stability of a cartel depends on how much firms would profit if they decided to deviate from the agreed upon behavior. There is a relationship between this profit and a set of market characteristics. In addition, deviations are less likely to occur if cartel participants are in position to promptly identify and punish any deviation. Thus, cartels tend to be more stable when prices are transparent – in the sense that cartel can assess the price set by every cartel participant – and sanction are viable.

Certain features of market structure can have a significant influence on the stability of cartels. In what follows, we show how market structure influences the formation and the success rate of cartels. With this type of information, antitrust authorities can focus attention and resources on those markets where cartels are most likely to succeed.

There is an extensive literature that focus on evaluating the relationship between market structure and the success rate of cartels. We show how certain market characteristics can influence cartel behavior. Specifically, we show how the probability that a cartel succeeds can be influenced by the following market features: (i) market concentration; (ii) degree of excess capacity; (iii) elasticity of demand; (iv) barriers to entry; (v) transparency of prices; (vi) depth of firm relationship.

Cartels are more likely to succeed in markets that are more concentrated. As the number of firms in a market increases, it becomes harder to include every relevant firm in the deal. With a large number of firms, it is harder to agree on a plan of action. It is also harder to detect possible deviations from this plan of action and to impose sanctions. Concentration in consumers market also influences the success rate of cartels. In highly

concentrated consumers market, consumers may have a greater ability to negotiate prices, which reduces cartel's probability of success.

An analysis of excess capacity can help the detection of cartels. In general, firms participating in a cartel reduce their output to increase prices and profits. Thus, the operation of a cartel usually[10] involves some degree of unused capacity. It should be noted that cartels are less likely to be successful in market with high heterogeneity in excess capacity between firms.

The cost structure of firms is another variable that can influence the stability of cartels. Cartels are less likely to succeed in markets with heterogeneous cost structures. If firms have different production costs, lower cost firms have an advantage over their competitors. In the absence of restrictions to competition, lower cost firms are able to a guarantee a larger share of market demand. Thus, these firms will condition their participation in any agreements that restrict competition on the maintenance of their larger participation in market share. This increases the challenge of reaching a consensual plan of action. This challenge is even greater in the usual scenario, in which firms are not perfectly informed on the cost structure of their competitors. This is the reason why firms with more efficient cost structure - the so-called mavericks – are not usually part of cartels. Cost structure can also affects cartel`s stability through a different mechanism. Cost structure can have an influence on how profitable deviations from a cartel are. The more profitable these deviations are the more unstable is the cartel. In a setting, where cost of production increases with output, these deviations are less profitable and cartels are more likely to be successful.

Aggregate market power is another feature that can influence a cartel`s probability of success. First, the success of a cartel depends on the price-elasticity of demand. If demand is highly sensitive to price changes, any increase in price will have a significant impact over cartel`s output and will reduce profits. For instance, if participants of a cartel face competition from a group of non-participants that offer a similar product, price increases will likely transfer demand to these non-participants. In this scenario, part of the raise in profit due to higher prices is lost with the reduction in output. The presence

[10] It is possible that market conditions lead cartel participants to increase output, reaching full capacity. In this case, the cartel constrains capacity obstructing additional capacity increase investments.

of barriers to entry also influences the success rates of cartels. If cartels raise prices in markets with no significant barriers to entry, this price increase can attract new competitor firms, reducing cartel`s profits.

The stability of cartels depend on participant`s ability to impose sanction in case of deviations. To impose such sanctions cartel`s participants must be able to promptly identify any deviation from the agreed upon plan of action. Thus the ability of cartels to monitor the firm-level price of its participants influences cartel`s stability. Market concentration is a relevant variable in this process. It is usually easier to monitor prices and to identify deviations in more concentrated markets. This monitoring is also more efficient in scenarios with transparent prices. Cartels are less likely to succeed if there are obstacles to the monitoring of prices. For example, cartels are less likely to succeed if prices are a result of negotiations between consumers and producers. The existence of a trade association, that collects and publicizes prices for a given industry, can facilitate this monitoring and increase the likelihood of success of cartels. Not only trade associations can increase a cartel`s likelihood of success. Lawyers and other professional with access to sensitive information from different competitors and whose communication is protected by attorney client privilege can also facilitate the formation of cartels.

Not only the ability to impose sanctions matters for cartel`s stability. The cost of such sanctions is also a relevant variable. If imposing sanctions is too costly for cartel`s participants, the threat of such sanctions is less convincing. The size of sanctions also matter. Cartels are more stable in markets in which firms interact in the long term or in cases in which firms interact in multiple markets. In this scenario, a single deviation can result in long-term sanctions.

Table 1: Market Structure Based Methods

• Market Concentration	↑ market concentration → ↑ probability of cartel being successful
• Excess Capacity	The formation of cartels usually implies some excess capacity

• Price-Elasticity of Demand	↑ price-elasticity of demand → ↓ probability of cartel being successful
• Barriers to Entry	↓ barriers to entry → ↓ probability of cartel being successful
• Cost Structure	↑ heterogeneous costs → ↓ probability of cartel being successful
	↑ costs that increase as output increases → ↓ probability of cartel being successful
• Price Transparency	↑ price transparency→ ↑ probability of cartel being successful

2.2.2. Behavioral Methods

In the previous section, we presented market structure methods for cartel detection. Market structure methods identify market characteristics that increase (or reduce) the probability that cartels succeed. Market structure methods can increase the efficiency of cartel detection through the allocation of resources to the analysis of markets where cartels are most likely to succeed. Market structure methods have two main advantages. First, information on market structure characteristics are usually readily available. This reduces the costs of collecting and organizing data. Second, these methods are based on evaluating the presence of certain market characteristics. Thus, the implementation of these methods do not rely on the participation of professionals with formal training in economics.

Though useful in some cases, methods based on market structure present serious limitations. Generally, these limitations have to do with the fact that the relationship between market characteristics and the presence of cartel is not deterministic. It is perfectly possible that cartels are not formed in markets prone to the formation of cartels. Likewise, cartels can be formed in markets that, in theory, impose obstacles to the formation of cartels. Thus, the detection of cartels, in certain scenarios, rely on the use of alternative methods. In the last few decades, we have seen an increase in the popularity

of the so-called behavioral methods. These methods offer tools to analyze the behavior of market participants with the intent to detect cartels.

In what follows, we present a set of behavioral methods that can be used for cartel detection. We focus on the most popular methods. It is worth mentioning that there is no such thing as unique method suitable for the analysis of every case. The choice between different methods must rely on the characteristics of each case. This choice must be preceded by an analysis that informs on market characteristics, probable behavior of a cartel, influence of cartel over variables such as prices, market concentration and others. The previous analysis must also consider data availability and the possibility of establishing reference scenarios. Several methods rely on the identification of alternative scenarios that can be used as basis of comparison – the counterfactual scenario or the scenario that would prevail in the absence of restrictions to competition.

We divide the following section in two parts. In the first part, we introduce a brief presentation to the concept of collusion markers. The idea behind the definition of collusion markers is that the introduction of restrictions to competition is correlated with certain types of behavior. In general, a collusion marker is a feature of behavior that can be considerate an indicator of cartel activity. Collusion markers present the same type of benefits and limitations of market structure methods. These markers are common features of cartels in the real world. Nevertheless, the presence of such markers cannot be considered irrefutable evidence of cartel.

The literature presents several collusion markers that can be useful in different scenarios. We will focus on the markers used more frequently in actual antitrust cases.

We begin presenting the most popular collusion marker: the variable price. The monitoring of the variable price can indicate the presence of cartels. In general, cartels increase overall profits incresing market prices. We have evidence of cartel when prices follow a path consistent with the introduction of restrictions to competition or when prices are no longer responsive to market conditions. Some types of price behavior can be considered indication that prices are not responding to market conditions, e.g, high prices with low variance between firms; price movements that anticipate variations in demand; inversion of the relationship between price and quantity – prices negatively correlated with quantity; excessive correlation of price between firms; prices that are unresponsive to changes in cost or market structure.

The variable market share can also serve as a powerful collusion marker. Excessive stability in market share can indicate the absence of competitive pressures and is a regular feature of cartelized markets. We observe such excessive stability when market shares are stable through long periods of time or in markets with disproportionate customer loyalty.

For cases in which information on price-cost margins is available, the monitoring of this variable can be useful for the detection of cartels. In the monitoring of price-cost margins, one must be careful with simplistic conclusions. High price-cost margins alone cannot be considered evidence of cartel. As previously stated, high market power – and high price-cost margins – can be a feature of several market structures. Price-cost margins indicate the presence of cartel in the case of a sudden increase in price-cost margins that is not consistent with market conditions. Another indication of cartel are price-cost margins that are significantly higher than price-cost margins in similar markets.

There are collusion markers specifically designed for the detection of bid rigging cartels. In a bid rigging cartel, participants cooperate with the intention to manipulate the result of an auction. Usually, participants of bid-rigging cartel decide, previously, which participant is set to win the auction. Then, a bidding strategy is designed with the goal to achieve the intended result and maximize profits. Cartel's participants may implement this strategy by choosing to abandon the auction or by presenting non-competitive bids. Since the formation of the cartel influences bids, the monitoring of bids can inform on the presence of cartels. Bids that are not correlated with market conditions can be considered evidence of bid rigging. In a bid rigging, the auction winner must compensate cartel's participants for their cooperation. This compensation can take the form of side payments. It can also take the form of a multi auction strategy that establishes different winners for different auctions in a way that every participant benefits from the cartel. Thus, an analysis of bids across multiple auction can also be useful for cartel detection. Bids that are negatively correlated through time can be considered an indication of cartel.

Table 2: Collusion Markers	
Price	• High prices with low variance; • Prices that anticipate changes in demand; • Prices negatively correlated with quantity; • Prices highly correlated between firms; • Prices unresponsive to market conditions; • Structural changes in prices that are not related to changes in market conditions; • Prices unresponsive to changes in costs of production;

Market Share	• Excessive stability of market shares.
	  ○ Market shares stable through time;
	  ○ Excessive customer loyalty;

Price-Cost Margins	• Sudden increase in margins not related to market conditions; • Margins unrelated to the margins of similar markets;
Bids	• Bids unrelated to market conditions; • Bids negatively correlated through time;

Collusion markers – as market structure methods – offer a simple and low cost alternative for the analysis of non-competitive behavior. Such markers can be useful in the detection of suspicious behavior. They cannot be considered, however, strong evidence of cartel presence. Their main advantage is to direct resources towards those cases that deserve a more thorough investigation. In what follows, we present a set of methods that can be used for a careful analysis of cartel behavior. Each of these methods are designed to answer a specific question. We follow Harrington (2005) and divide the

methods into four categories, according to the question each method is intended to answer.

We begin with a set of methods designed to analyze if the behavior of firms in a given market is consistent with expected behavior in a market with no restrictions to competition. In general, these methods are implemented through three steps. First, we outline a presumed behavior based on market characteristics. Then, we use statistical tools to analyze if actual behavior is consistent with presumed behavior. If actual behavior is inconsistent with presumed behavior a third step is implemented. In the third step, we evaluate if actual behavior is consistent with cartel behavior.

Bajari and Ye (2003) develop an approach to identify and test for the presence of bid rigging cartels. The authors develop a first price sealed bid model for the procurement of a homogeneous service. In this scenario, each individual bid is, in part, a function of observed characteristics. For instance, the distance between a firm's headquarter and the location where the service must be performed. The bid is also a function of unobserved factors. The authors show that in a competitive scenario with independent costs the unobserved factors that influence bids are independent. The authors then test this hypothesis using data on bidding by construction firms in the states of Minnesota, North Dakota and South Dakota. The data covers the period between 1994 and 1998. The authors investigate the relationship between bid and a set of observable variables that affects expected profit.

$$Bid_{it} = \beta_0 + \beta_i characteristic_i + \epsilon_{it}$$

Where, ϵ_{it} represents the error term or the part of the bid that is not explained by observable factors. From this specification, it is possible to estimate errors ($\hat{\epsilon}_{it}$) and test the hypothesis of independence between unobserved factors.

Methods of a second type are designed to answer the following question: is it possible to identify structural breaks in behavior that are consistent with the formation of a cartel? This analysis is usually implemented in two steps. First, we analyze the behavior of prices through time to identify evidence of abrupt changes in pricing strategy. Then we analyze if this break is consistent with the pattern we would observe after the formation or dissolution of a cartel.

The Chow test is a test widely used in the identification of structural breaks. In general, the Chow test is a powerful tool to evaluate if there is a significant change – a

structural break – in the relationship between a given variable and a set of explanatory variables. The structural break can occur through time or between different groups. Consider for instance the following specification for the relationship between a variable y and a set of explanatory variables x in period t:

$$y_t = \alpha_0 + \alpha_1 x_{1t} + \alpha_2 x_{2t} + \varepsilon_t$$

When cartels are formed, market conditions change. In this scenario, it is reasonable to assume that the relationship between the explained variable and the explanatory variable change. For example, when cartels are formed there is probably a break in the relationship between price – an explained variable – and production costs – the explanatory variable.

If we have evidence that a cartel was formed in period s, the previous specification is not a suitable representation. In this scenario, a more reasonable representation of the relationship between the explained variable price - y – and the explanatory variable production costs - x – would be given by:

$$y_t = \alpha_0 + \alpha_1 x_{1t} + \alpha_2 x_{2t} + \varepsilon_t \qquad se\ t < s$$

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \epsilon_t \qquad se\ t \geq s$$

This representation allows for the possibility of structural breaks in the relationship between prices and production costs in the period before ($t < s$) and after ($t \geq s$) the formation of the cartel. In theory, the formation of a cartel would weaken the relationship between prices and production costs. Thus, we can test for the presence of cartels investigating if a structural break actually occurred in t=s. That is, testing if $\alpha_0 = \alpha_1, \beta_0 = \beta_1$ and $\alpha_2 = \beta_2$.

The Chow test is a powerful tool for the detection of cartels. It has, nevertheless, its limitations. The implementation of the Chow test requires previous information on the exact moment of time in which the alleged cartel was formed or dismantled. In some cases, this type of information is readily available. In other cases, a previous investigation can lead to a reasonable approximation.

An option is to focus on periods in which expected profit from a cartel change significantly. For instance, the moment firms enter or exit a market. Another option is to focus on events that alter the stability of cartels, such as the creation of trade associations. The beginning of a formal investigation by antitrust authorities is known trigger for cartel dissolution and can also be used an approximation to the date the cartel ceased its activities[11].

An alternative approach is to monitor the behavior of variables that can signal the presence of cartels. It is important to highlight that this approach must be taken with certain caution. Results are not reliable when we use the same variable to define the timing of the possible structural break and to test for the existence of a structural break. Thus, if we use the variable price to determine the period in which the structural break likely occurred and to test for the existence of such structural break we reach spurious results. We can, instead, monitor average price to identify potential periods of structural break and use price variance or price correlation between firms to test for the existence of structural breaks.

Methods of a third type – the comparison-based methods - are designed to answer the following question: how can we compare the behavior of firms in a possibly cartelized market with the behavior of firms in a similar market with no artificial restrictions to competition – the so-called counterfactual market? In general, these methods focus on evaluating if the behavior of firms possibly participating in cartel is significantly different from the behavior of similar firms facing similar market conditions in markets with no restrictions to competition. In case we identify significant differences, we must also evaluate if behavior is consistent with cartel behavior.

The most crucial step of any comparison-based approach is to define a suitable counterfactual. There are several possible counterfactuals. If firms interact across several markets, we can compare the behavior of these firms in markets with evidence of collusion against markets with no such evidence[12]. If there is evidence that some firms in a possibly cartelized market are not part of the agreement, we can compare the behavior of participants and non-participants. If we have evidence of collusion in certain periods and evidence of no restraints to competition in other periods, we can implement a

[11] Abrantes-Metz, Geweke e Taylor (2005).
[12] Porter and Zona (1999)

comparison across time. In this case, it is important to evaluate it the competitive period does not correspond to a price war period. As will be discussed later, we have price wars when cartel's participants cut prices to punish deviations from the agreement.

The results obtained from comparison-based methods are only as good as the counterfactual. Specifically, the reliability of these results depends on two conditions. First, the counterfactual firms and markets must mirror the conditions of firms and markets under analysis. Second, there can be no restrictions to competition in the counterfactual market.

Once we define a suitable counterfactual, there are several approaches available. One option is to perform two independent regressions: one including only the firms possibly involved in collusion and the other including only the firms not involved. We can then compare these groups of firms testing if the results from these two regression are statistically different. When behavior is statistically different, the analysis demands a second step. In the second step, we evaluate if the behavior of firms included in the possibly cartelized group is consistent with collusion. We also have to evaluate if the behavior of firms in the counterfactual is consistent with competition.

The literature on comparison-based methods is extensive. Porter and Zona (1993), for instance, develop an approach for cartel detection in a first price sealed bid auction framework. The authors examine bidding in auctions for state highway construction projects in New York in the early 1980s. Information on the identity of a group of bidders allegedly involved in a collusion scheme is available. Porter and Zona (1993) implement a comparison-based approach. They examine if there are significant difference in the behavior of a group of firms allegedly involved in a cartel against the behavior of firms not involved in anti-competitive schemes.

Porter and Zona (1993) implement several exercises intended to identify significant differences in the behavior of firms participating and not participating in an alleged cartel. First, the authors evaluate if there are significant differences in bidding strategy. Specifically, they estimate two independent regressions – one for participants and other for non-participants – designed to investigate differences in the relationship between bids and project characteristics. They conclude that, for non-participants, project characteristics have a significant influence over bids and that this influence is in the expected direction. For participants, there is no significant relationship between bids and

project characteristics. Then, Porter and Zona (1993) implement a formal test and conclude that differences in behavior are statistically significant. Another test evaluates bid ranking. They estimate[13] the relationship between the likelihood of observing a ranking of bids and a set of relevant characteristics. They estimate independent specifications that consider all bids, only high rank and low rank bids. The idea is to investigate if differences in ranking alter the relationship between bids and characteristics. Results indicate ranking does not influence the relationship between bids and characteristics for the group of non-participant firms. Results are different for the group of participants. For these firms the relationship is significantly altered by ranking. The authors then argue that this result is consistent with bid-rigging. Specifically, this result is consistent with a cartel that chooses a different winner for every auction. In this scenario, the winning bidder is the only participant of the cartel to submit a competitive bid. Thus, project characteristics will only influence the bids of the winning bidder. In this scenario, there will be significant differences between competitive – high ranking – and non-competitive – low ranking – bids.

Porter and Zona (1999) examine procurement auctions for school milk in Ohio. The authors had information on the identity of a group of firms allegedly participation in a bid rigging scheme. Exploring this information, Porter and Zona (1999) independently estimate the relationship between bids and observable characteristics for a group a participants and non-participants firms. They also estimate the relationship between observable characteristics and the decision to bid in each auction. The intention is to analyze the existence of systematic difference in the bids presented by the group of firms allegedly involved in the bid rigging and the bids of non-participants. They conclude for the existence of such systematic differences. The relationship between bids for firms that are not part of the alleged cartel and explanatory variables is on the expected direction. Specifically, bids are negatively correlated with costs of production and positively correlated with expected profits. This is not the case for firms participating in the alleged cartel.

Finally, we have methods designed to answer the following question: is observed behavior more consistent with a model of collusion or with a model of competition? These

[13] Using a Multinomial logit.

methods evaluate if actual behavior is closer to expected behavior under collusion or competition exploring tools provided by economic models. In general, these evaluations are based on parametric approaches. That is, they rely on the assumption that a specific functional forms and a fixed set of – usually unknown - parameters can adequately represent the relationship between relevant variables.

The need to define – usually under arbitrary criteria – a model that can adequately represent firms' behavior is the greatest disadvantage of the methods in this fourth category. The choice between different models is not always straightforward. In certain cases, we do not have information or cannot adequately evaluate every variable that influences behavior. In these cases, we incur in the risk of functional form misspecification. Thus, it is essential to evaluate the robustness of the choice between different models and different functional formals. This evaluation demands a careful analysis of market characteristics and of the validity of required assumptions.

Abrupt changes in prices that are not related to changes in cost or demand conditions are not consistent with models of competitive markets. Green and Porter (1984) show that, in a framework with imperfect monitoring of competitor's prices, cartel can be associated with periods of artificially reduced prices – the so-called price wars. Price wars serve the purpose of punishing cartel's participants for deviations. Porter (1983) tests this proposition empirically analyzing the Joint Executive Committee railroad cartel from 1880 and 1886. The author estimates a dynamic oligopoly model with assymetric firms. The test is based on the assumption that in a competitive scenario any sudden change in price is correlated with changes in costs or demand. Porter finds evidence of unexplained price movements and concludes for the presence of a cartel.

Ellison (1994) complements Porter`s analysis. The author investigates if price wars coincide with periods of deviation from cartel. Specifically, the approach investigates the hypothesis that periods of cartel stability are persistent in time. Results indicate the validity of this hypothesis.

Finally, Banerjee e Meenakshi (2004) also explore the tools offered by economic theory to evaluate if the behavior of firms in a given market is more consistent with a model of competition or with a model of collusion. The authors use auction theory to analyze wholesale markets for wheat in Northern India. Information on the identity of a

group of bidders allegedly involved in a bid-rigging scheme is available. The author develop models of competition and collusion suitable for this framework. Each model establishes the expected characteristic of the winning bid. The collusion model, specifically, assumes that participants of the cartel will stablish a random rotation scheme to determine the winning bidders. Analyzing data from wholesale markets for wheat in Northern India, Banerjee e Meenakshi (2004) conclude the observed behavior is more consistent with a model of collusion.

Throughout this chapter, we presented a set of methods available for the detection of cartels. We divided the presentation into two parts. In the first part, we introduced methods designed to evaluate if market characteristics are favorable to the formation and success of cartels - the market structure methods. In the second part, we introduced behavioral methods. Behavioral methods detect cartel through the analysis of firm conduct. Methods of both type can be useful tools for effective cartel enforcement, reducing costs, optimizing the allocation of resources and producing additional evidence.

3. Quantification of Overcharges

In the previous chapters, we introduced the economic theory of cartels and explained the mechanisms that determine the formation of cartels and their success. This discussion explained how cartels can affect consumer`s utility and welfare, highlighting the importance of effective antitrust frameworks for cartel enforcement.

Cartels impose costs on society mainly through two mechanisms. First, cartels cause a loss of utility that is not transferred to cartel`s participant. This loss of welfare is the deadweight loss of the cartel. Second, there is a transfer of utility from consumers and other market participants to the cartel. This redistribution of utility has no impact over aggregate welfare. Nevertheless, it has a negative impact in terms of equity and social justice. Both mechanisms harm society and must be considered in the definition of a suitable deterrence strategy and in the definition of due compensation. Ideally, compensation would be proportional to harm imposed on society. Thus, it would be determined considering several factors, such as duration, scope , impact over prices and quantity sold.

Compensation for the harm imposed on society does not restitute victims of cartel. An effective antitrust enforcement framework must involve a complementary mechanism that entitles victims to demand compensation for damage. These two types of compensation serve two different goals. Reparation for the costs imposed on society aim to discourage the formation of cartels. Reparation for victims aim to compensate victims for losses incurred.

This chapter and the next introduce methods that are useful to the quantification of damages imposed on victims. In this chapter, we focus on estimating the overcharge borne by final consumers. In the next, we introduce methods for the evaluation of the passing on of overcharges.

In general, compensation for damages are a result of private actions. In the next section, we present a brief review of international experience. One of the main obstacles

for the success of such actions is credibly proving and quantifying damages. The general principle is that compensation must restitute victims to their original position, i.e., restitute victims any loss imposed by the cartel. Thus, proper quantification of damages depends on evaluating the difference between the observed scenario and a hypothetical scenario with no restrictions to competition – the counterfactual.

In an ideal scenario, victims would be entitled to compensation for actual loss (damnum emergens) and for loss of profit (lucrum cessans). This compensation would also include adjustments designed to compensate for the time value of money. The loss of profit represents the profit that victims otherwise would have made. The quantification of this sum is challenging and seldom done in practice. The actual loss is the damage caused by cartel overcharges. We define overcharge as difference between observed price and the price that would prevail in a scenario with no restrictions to competition – the counterfactual. Actual loss is given by the multiplication between overcharge and units bought. In what follows, we introduce methods for the estimation of overcharges.

Our intention is to show that it is possible to obtain a credible approximation of damage relying on quantitative methods. These methods have academic backing and their use is growing in popularity. We have no intention to give the impression that quantifying is always uncomplicated and feasible. This quantification is only trustworthy for cases in which we can credibly isolate the impact of cartel behavior from the influence of every other relevant factor. This is not always an easy task. This task depends on the specific features of each case and on data availability.

It is worth mentioning that we are not presenting an exhaustive list of available methods. We introduce the methods most widely used in real world analysis. We classify the methods into two categories: comparison-based methods and market/firm structure-based methods. In general, in the first category, we have reduced form methods and, in the second category, structural form methods. In a structural form method, the analysis is designed to closely follow concepts defined by the economic theory. With this approach, we can analyze the mechanisms that determine the relationship between different variables. In a reduced form method, the intention is to explore the existence and size of a causal relationship between variables. In this case, there is no intention to understand mechanism that determine the relationship. The choice between different methods must rely on the specific features of each case and on data availability.

3.1. International Experience

We begin with a brief presentation of the international experience with the use of quantitative tools for the estimation of overcharges.

The process of obtaining compensation for personal damage from cartels depends on specific requirements determined by the legal framework of each country. Nevertheless, some features are common across a large set of countries. First, this process is not usually delegated to the antitrust authority. Instead, it is the result of private actions taken to court. Antitrust authorities are usually focused on imposing sanction that intended to compensate for the harm cartels cause on society. Brazil's legal framework also admit the possibly of public actions intended to compensate collective damages (Lei de Ação Civil Pública).

There is great variability in the ways the antitrust authority can or must participate in the process of determining private damages. This participation can involve sharing of information, production of technical material or the definition of an optimal deterrence strategy. There is also great variability in the approaches available to determine damage. In the last few decades, we have seen an increase in the use of quantitative techniques to estimate damages.

In the United States, private actions intended to obtain compensation for damage caused by cartels are especially popular. The country legal framework allows any individual that incur in damage from cartel to sue. In the first case of this type – dating back more than a hundred years – compensation was proportional to the multiplication between an estimate of overcharge and units bought. Approximately 90 % of the complaints against cartels in the United States today are private actions and thus not related to the administrative actions of the antitrust authority. American jurisprudence conditions cartel damage actions on the submission – by the plaintiff - of a quantitative estimate for damage. The estimation does not have to be precise. It needs only to be a good enough approximation of damage.

The European Union legal framework determines that any individual that suffers damage from a cartel is entitled to compensation. There is great heterogeneity across member states on rules and on the popularity of private actions for cartel damage. In some countries, like Germany and United Kingdom, private actions for cartel damage are

reasonably popular. In others, like Spain, such actions are still rare. In 2008, the European Commission launched a study intended to (i) diagnose the main obstacles to private actions for cartel damage; (ii) suggest reforms capable of removing these obstacles. In 2009, another study was launched. This second study presented several quantitate methods that can be used for the estimation of damage.

In 2014, the European Union adopted a directive establishing a set of principles that intended to reduce the obstacles to private damage actions. These principles included: (i) simplify the access to data and relevant information; (ii) bind the effects of antitrust authorities decision before the courts; (iii) establish clear rules for limitation period and (iv) empower national courts to estimate harm.

In Latin America, private actions for cartel damage are uncommon. Nevertheless, there are projects that intend to change this scenario. Mexico, for instance, recently altered its antitrust legislation to remove obstacles to private action. Before the reform, such actions could only begin after a final decision from the competition authority. In 2011, that obstacle was removed.

The situation in Brazil is not significantly different from the situation in the rest of Latin American. Private actions for cartel damage are still rare in the country. Our hope is that these guidelines help change this scenario while serving as an official and simplified reference for overcharge quantification.

3.2. Comparison-Based Methods

In this section we present the most widely used comparison-based methods for overcharge estimation. We focus on reduced form methods. That is, methods that evaluate and measure the relationship between variables with no intention to uncover the mechanisms that determine this relationship.

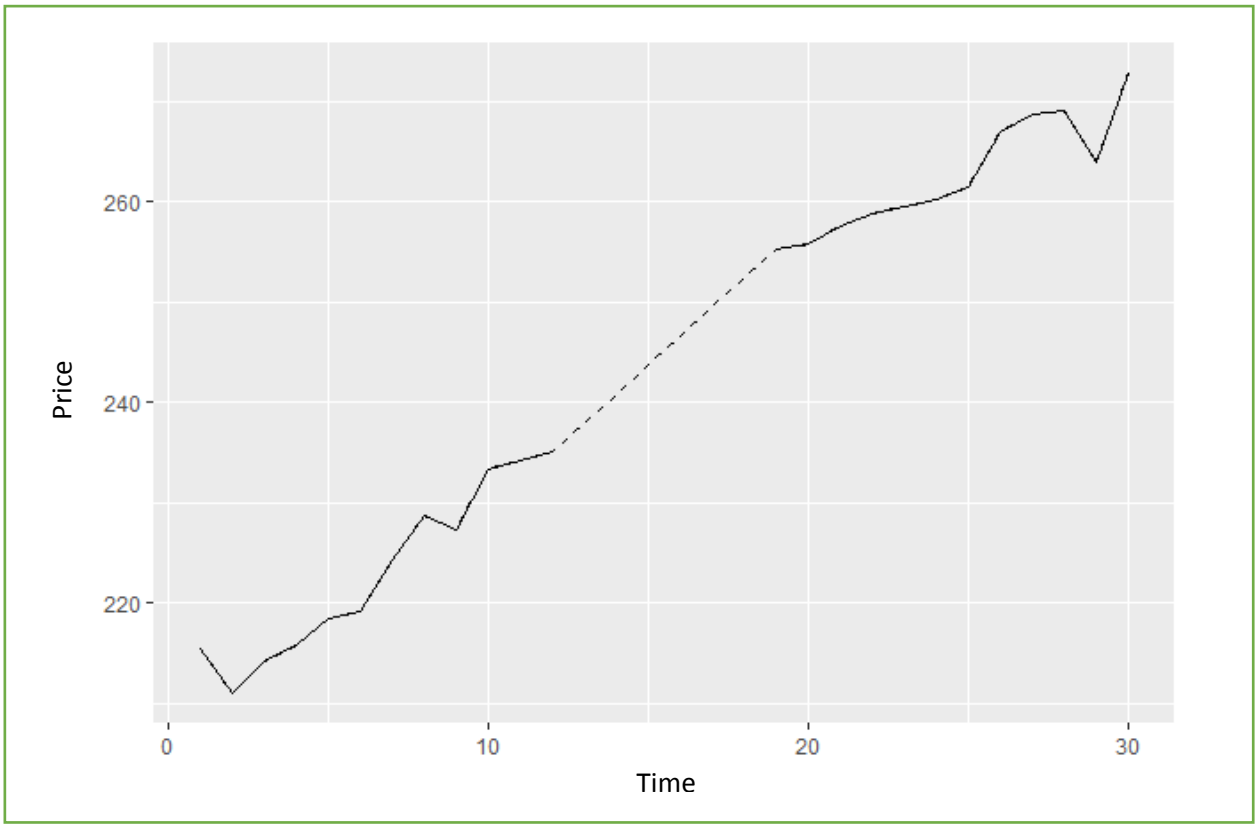
We present method with varying degree of complexity. From simple comparison based on strong assumptions to complex econometric approaches. The choice between different methods depends on the availability and quality of data. It also depends on market characteristics.

Several papers review the available literature and present a measure of median overcharge. This measure is often based on cartel cases spanning industries and countries. One approach is to assume that the cartel under analysis is a good approximation of the median cartel. Under this – very strong - assumption, a good enough approximation for cartel overcharge is the median overcharge defined by the literature[14].

If we have evidence that restrictions to competition were active for only a specific period, one simple alternative is to estimate overcharge comparing price behavior over time. Under this approach, we compare the behavior of firms in periods with evidence of collusion against periods with no evidence of collusion. There are a number of ways to implement this strategy. We can rely on simple comparisons – prices before and/or during and/or after. We can also implement comparisons over time using advanced econometric techniques. The choice between different methods – as usual – relies on data availability and on the assumptions needed to define the counterfactual scenario – in this case, periods with no evidence of collusion.

We begin assuming that prices are transparent and data on prices is readily available. Thus, we have information on prices set before the formation of the cartel, during the period in which the cartel imposed restrictions to competition and after the dissolution of the cartel. In this case, we can estimate the price that would be set in a competitive scenario – the counterfactual price – under the assumption that in the absence of restrictions to competition prices would have followed a constant trend. A technique available for analysis under this assumption is the linear interpolation. With this technique, we join price points before cartel formation and after its dissolution to estimate counterfactual price. The following figure illustrates this approach. In this case, we have evidence of collusion for every period between t=12 and t=19. Joining the price points before and after the cartel gives us the counterfactual prices. In the following figure, the dotted line represents counterfactual price. The overcharge is given by the difference between actual price and counterfactual price.

[14] Posner (2001) finds a median overcharge of 28%. Werden (2003) finds a median overcharge of 15 %. Connor e Lande (2008) find a median overcharge of 20%.



In some cases, we do not have information on the exact moment in time the cartel began its activities. Also, data on prices before the cartel are not frequently available. "During versus after" comparisons are one alternative to deal with restrictions of this type. Occasionally, information on prices set after the dissolution of the cartel are not available. In this case, we can implement "before versus during" comparisons.

We can implement "before versus during" or "during versus after" comparisons with a simple comparison between prices. That is, we can accept that counterfactual price is equivalent to average[15] price before the formation of the cartel or after its dissolution. The overcharge is given by the difference between average and actual price. Depending on the quality of available data, we can use statistical test to investigate if there is significant differences between actual and counterfactual prices[16]. Analysis of this type rely on the very strong assumption that the formation of the cartel is the only factor influencing price differences between two periods.

We can also implement graphical analysis for "before versus during" and "during versus after" comparisons. Under the hypothesis that in the absence of restrictions to

[15] Depending on the specificities of the case, we can use other first moment statistics, such as median or mode price.
[16] For instance, t test for difference of means.

competition price trends would be constant, we can estimate counterfactual price using a linear extrapolation technique.

With comparisons over time, we compare the behavior of firms in a cartel with their own behavior in different periods. Thus, with this type of comparison we can control for characteristics of firms and markets that are immutable over time. That is the main advantage of these methods. Nevertheless, comparisons over time have some disadvantages. Particularly, such comparisons may be blind to the fact that several factors outside the sphere of influence of the cartel – such as cost, demand, outside competitors - can determine price differences over time. One alternative is to employ econometric tools that can control for the influence of external factors. We introduce, next, two econometric specification that can include controls for external factor and that are often useful for cross-time comparisons.

With the first specification, we can estimate overcharge including an indicator variable, i.e., a variable that indicates periods of cartel activity. We define – for every market and every period - price as a function of every external factor that influences price. When restrictions to competition are imposed, price will also be influenced by cartel's behavior. Thus, price is also a function of the presence of cartel. In this scenario, we can estimate overcharge investigating price changes in periods of cartel activity. Specifically, we can compute overcharge estimating – usually by ordinary linear regression (OLS) – the following specification:

$$p_{it} = \alpha + \beta_j x_{jt} + \delta_l y_{lit} + \omega I_{it} + \varepsilon_{it}$$

Here, p_{it} represents price of firm i at period t, x_{jt} represents market characteristic j at period t, y_{lit} represents characteristic l of firm i at period t and ε_{it} represents the error term. The variable I_{it} represents the indicator variable. This variable equals one if firm i is part of a cartel at period t. If firm i is not part of a cartel at period t, I_{it} equal zero. In this specification, the parameter ω is our parameter of interest. This parameter represents the portion of price that is explained by cartel presence once we control for every other relevant factor, i.e., the cartel overcharge

In the previous specification, we assumed that the presence of the cartel does not systematically change the relationship between prices and external factors. If this assumption is not reasonable, we have to adapt the analysis. One option is to include

interactions, i.e., variables that can capture the possible influence of the cartel over the relationship between external factors and prices.

A second specification – known as predictive approach - is built under the assumption that the relationship between prices and external factor is consistent across competitive periods. Under this assumption, we can quantify overcharges through a two-step approach. In the first step, we estimate the relationship between prices and external factors using information on every period without known restrictions to competition. This first step results in a set of estimated parameters that indicate how every external factor influence price under competition. In a second step, we use these parameters to estimate counterfactual prices for every period with known restrictions to competition.

Specifically, we estimate the following specification considering only periods with no evidence of collusion:

$$p_{itnc} = \alpha + \beta_j x_{jtnc} + \delta_l y_{litnc} + \varepsilon_{itnc}$$

In which tnc indicates period t with no evidence of collusion (nc), p_i indicates price of firm i, x_j indicates market characteristic j, y_{li} indicates characteristic l of firm i and ε_{itnc} is the error term

With the previous specification, we can estimate a set of parameters that represent the relationship between external factors and price, i.e., we obtain the following estimated values $\hat{\alpha}, \widehat{\beta_j}$ and $\widehat{\lambda_l}$. We can then use these estimates to predict counterfactual prices. If we have information on the characteristics of markets and firms at any period t with evidence of collusion (c), we can estimate counterfactual price at that period ($\hat{p}_{itc}$) as follows:

$$\hat{p}_{itc} = \hat{\alpha} + \widehat{\beta_j} x_{jtc} + \widehat{\delta_l} y_{litc}$$

With this approach, we can obtain estimates that vary in time in response to changes in market and firm characteristics.

Comparisons over time are often useful for the analysis of cases in which information on the identity of cartel's participants and on the moment the cartel began or ceased its operations is available. Information on the moment a cartel begins its activities is not always available. The dissolution of a cartel, on the other hand, usually coincides with the beginning of an administrative investigation by the antitrust authority. If the beginning of an administrative investigation is considered reference for a comparison-

based method, some details must be taken to attention. First, prices may take a while to reach a competitive equilibrium after the dissolution of the cartel. Medium and long-term contracts and price wars can delay competitive conditions. Second, cartel participants may have an incentive to manipulate prices right after cartel dissolution. If the difference between prices set by the cartel and equilibrium prices right after the dissolution determines sanctions, participants can manipulate prices for a period with the intention to reduce due compensation.

One alternative are methods based on comparisons across groups. If we have two groups similar in every pertinent characteristic except for the fact that for one group we have evidence of non-competitive behavior, we can estimate overcharge through a comparison between these two groups.

Firms selling similar products in similar markets located in different regions are one alternative for comparison. For instance, if we have evidence of collusion for a group of gas stations in a given county we can estimate overcharge comparing the price behavior of these firms against the price behavior of gas station in neighboring counties. Similar products sold by firms not involved in collusion are another possible alternative for comparison. For instance, we can estimate overcharge in engineering projects for the government by comparing it with price set for engineering projects for private hirers.

The greatest challenge for implementing comparison across groups is choosing a suitable group for comparison. Results are only trustworthy if the groups being compared are reasonably similar in every pertinent aspect. In what follows, we refer to the group with evidence of restrictions to competition as treatment group and to the group with no evidence of restrictions to competition as control group.

The use of these terms relates with the incorporation of some elements of experimental methods into the study of economics. In an experimental study, the researcher can define – based on random criteria – a group that will suffer the influence of the event of interest or the treatment – the treatment group - and a group that will not suffer that influence – the control group. The impact of the event – or treatment effect - is measured by the difference between treatment and control groups after treatment. In theory, the use of experimental techniques increases the robustness and reliability of results.

In several cases, the use of purely experimental methods is not a feasible or appropriate alternative. That does not mean we cannot incorporate the rationale of experimental methods to the analysis of cases in which the researcher has no control over who receives treatment. There is an extensive literature dedicated to the mission of developing methods of this type – the so-called quasi-experimental methods[17]. If we are able to identify groups that are similar in every relevant criteria except exposure to treatment, we can estimate treatment effect.

The main factor determining the quality and trustworthiness of the results obtained from quasi-experimental methods is the choice of control group. The choice of control group must follow a set of principles. First, the assumption that the only significant difference between control and treatment group is exposure to treatment must be reasonable. In what follows, we introduce quasi-experimental methods that are useful for the estimation of overcharges. We compare a group of firms that take part on collusion – the treatment group – against a group of competitive firms – the control group. In this scenario, firms in the treatment and control group must be reasonably similar in terms of demand, cost, market structure and every other relevant factor. Second, we must be confident on the assumption that firms in the control group are not exposed to treatment, i.e., their behavior is not influenced – directly or indirectly – by anticompetitive behavior. Thus, we must evaluate not only if firms in the control take part on collusion but also if their behavior is somehow influenced by the behavior of firms taking part on collusion.

Once we define a suitable control group, the methods we can use for cross group comparison are quite similar to the methods used for comparisons over time. We can obtain an estimate of overcharge through simple comparisons. Specifically, we can quantify the overcharge as the average difference between prices set by firms in the treatment group and prices set by firms in the control group,

We can also use econometric tools to control for the influence of external factors. The two econometric specifications for comparison over time previously introduced can be adjusted to serve as tool for comparison across groups. If we plan to estimate overcharge defining price as a function of external factors and of cartel influence, we must adjust the definition of indicator variable. In the specification below, firm are acting simultaneously and the indicator variable indicates firms that take part on collusion:

[17] See Angrist and Pischke (2009) *Mostly Harmless Econometrics.*

$$p_{ig} = \alpha + \beta_j x_{jg} + \delta_l y_{lig} + \omega I_{ig} + \varepsilon_{ig}$$

Specifically, g represents group and I_{ig}represents a dummy variable that equals one if firm i of group g takes part on collusion and zero otherwise, i.e., I_{ig}equals one for every firm part of the treatment group.

If we plan to estimate overcharges using a predictive approach we also need to adjust the analysis. In this case, the competitive parameters – parameter valid under a scenario with no restrictions to competition – have to be estimated using information on the behavior of firms in the control group. These estimated parameters can then be used, in combination with information on external factors, to quantify counterfactual prices

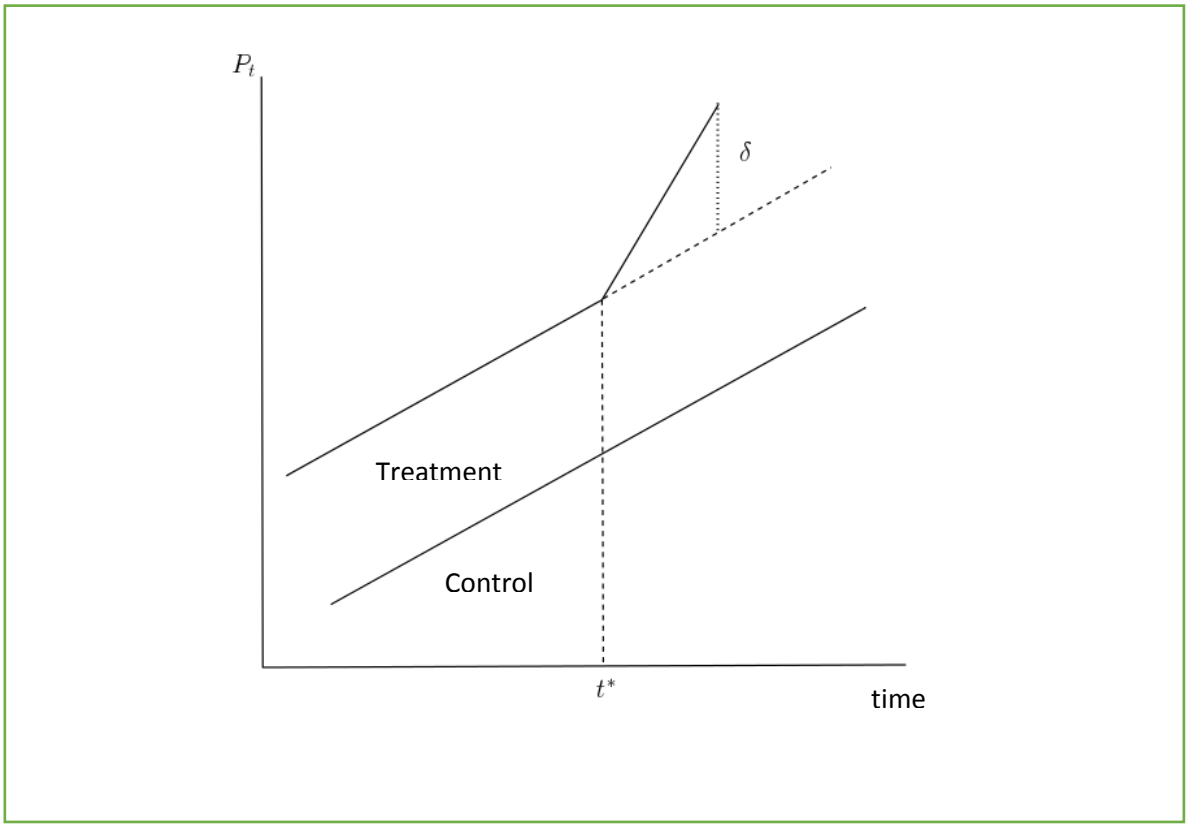
We conclude introducing a method that incorporates features of the two previous approaches to the estimation of overcharges. Whit this method, we can estimate overcharges comparing through time the behavior of a group of firms that take part in collusion (treatment group) against a group of firms that take no part in collusion (control group).

If there is a structural difference in price level between treatment and control groups, comparisons across group can be unreliable. Thus, if prices are higher for one group due to a market-specific factor, a price comparison produces inadequate estimates for overcharge. If unobserved external factors that influence price vary through time, comparisons over time are also likely to result in inadequate estimates. We can improve our analysis and obtain results that are more reliable by the incorporation of features of these two approaches. That is the rationale that induced the development of the difference-in-differences method.

The difference-in-differences method is useful for the analysis of cases in which: (i) we can identify treatment and control groups - here, firms that take part on collusion and firms that do not; (ii) we can identify the moment the group of treatment received treatment – here the moment the cartel began its activities; (iii) we can collect data on observed behavior before and after treatment . The general idea of the difference-in-differences methods is that, under certain conditions, we can identify the treatment effect – in this case, the overcharge - by comparing through time the behavior of firm exposed to treatment against the behavior of firms not exposed to treatment. With this method, we estimate the differential time trends caused by exposure to treatment.

If there are structural difference in price level between treatment and control groups, these structural differences are likely to be consistent through time and will be taken in consideration once time becomes a relevant aspect of analysis. Likewise, if time-varying unobservable affect both treatment and control groups, we can control for the influence of these unobservable variables implementing a comparison across groups.

The following figure illustrates the difference-in-differences method. The figure shows the behavior of a certain variable over time for the treatment group and for the control group. The figure also show the exact moment - t^* - in which the treatment group is exposed to treatment. The treatment effect is the difference in behavior between treatment and control group that is caused by exposure to treatment. Thus, is the difference behavior that persist once we control for every relevant factor not related to treatment. In the following figure, the symbols δ represents the treatment effect.



The difference-in-differences method is frequently used for the estimation of overcharges. There are two main approaches available to calculate treatment effect (δ). First, we can calculate the treatment effect through a simple ratio. Specifically, let A represents price set by the treatment group before treatment - i.e., before the formation of

the cartel - and B represents price set by the treatment group after treatment. Let C represents price set by the control group before treatment and D represents price set by the control group after treatment. In this case, the treatment effect is given by the difference between two differences. Specifically,

$$\delta = (B - A) - (D - C)$$

We can also implement a difference-in-differences through regression analysis. Specifically, we can estimate the treatment effect – the overcharge – by regressing the following specification:

$$p_{it} = \alpha + \beta Dt + \omega Treatment_i + \delta D_t \times Treatment_{\text{i}} + \rho_j X_{jit} + \varepsilon_{it}$$

Here p_{it} the price set by firm i at period t; D_t represents a dummy variable that equals zero for every period t before treatment – before the formation of the cartel – and equals one for every period t after treatment; $Treatment_{\text{i}}$ represents a dummy variable that equals one if firm i takes part on collusion and thus is included on the treatment group and zero if firm i is on the control group; and X_{ijt} represents an external factor j that influences the price set by firm i at period t. The treatment effect – or overcharge – is given by the estimate of the parameter δ.

3.3. Firm/ Market Structure Based Methods

In the previous section, we introduced comparison-based methods for the estimation of overcharges. Under certain conditions, these methods serve as a simple and reliable alternative for estimating overcharges. It is important to highlight that these conditions play a crucial role in the quality of results. Each method relies on a set of implicit and explicit assumption. Results will be only be trustworthy if these assumptions are reasonable.

In this section, we introduce a set of methods that serve as a good alternative for cases in which the use of comparison-based methods is not suitable or feasible. We focus on methods that explore characteristics of market and/or firm structure to estimate overcharges. These methods often rely on the use of economic models for empirical analysis. An economic model is a simplified and systematic representation of reality, a

theoretical construct that replicates aspects of reality defining a pattern for the relationship between different variables. In the characterization of an economic model, the researcher faces a basic trade-off. If a model is too simple, it might overlook import aspects of reality. If it is too complex, it may not be a useful tool for analysis. Economic models play a central role in empirical structural analysis. In a structural approach, the analysis is designed to closely follow concepts defined by the economic theory. The goal is to reveal the mechanisms that determine the relationship between different variables. Most methods to be introduced throughout this section follow a structural approach.

One first alternative is to explore information on costs of production to analyze the behavior of cartels. According to this approach, we can estimate counterfactual prices through a two-step procedure. In the first step, we estimate costs of production. In a second step, we determine a reasonable profit margin given the characteristics of markets and firms. To estimate counterfactual prices we adjust the estimated cost of production to encompass the appropriate profit margin.

This approach is challenging for two reasons. First, the estimation of costs of production is not straightforward. Every firm register accounting costs of production. Nevertheless, access to such information is often restricted under confidentiality clauses. The analysis is not straightforward even when information on accounting costs is available. Economic costs take into consideration opportunity or implicit costs. Thus, there is no automatic relationship between accounting costs and economic costs. The estimation of overcharges is only appropriate when based on economic concepts. Accounting costs can also offer inadequate information if we do not take into consideration the standard used for registering fixed and depreciation costs.

Second, estimating the appropriate profit margin can also be a difficult task. As previously stated, the economic theory is consistent with scenarios in which prices are not equivalent to costs of production. Several factors – such as market structure, availability of close substitutes and product homogeneity – can establish a wedge between prices and costs of production. Often, an estimate for the difference between prices and costs – a measure closely related to profit margins – is not readily available. One option is to estimate a likely margin given the structure of firms and market. Another alternative is to use an estimate of profit margins obtained from a counterfactual scenario, i.e., a similar market and/or group of firms for which there is no evidence of collusion.

We can also estimate counterfactual prices exploring economic models of market structure. In a previous section, we introduced some basic models of market structure analysis. These models are often useful for the analysis of real world scenarios. We can explore the available information – number of firms, price-elasticity of demand, product homogeneity, availability of close substitutes – and evaluate how firms would behave under different models of market structure. Then we can evaluate if actual behavior is consistent with predicted behavior. We can also evaluate how firms would respond to changes in market conditions, such as an increase in costs of production or entrance of a new competitor.

For each different model of market structure, we can represent behavior defining a systematic relationship between variables. That usually means defining explained variables as a function of explanatory variables. This relationship relays on a given functional form and on a set of –usually unknown - parameters. We can quantify behavior by obtaining a good enough approximation of the unknown parameters. There are mainly two methods for quantifying unknown parameters in a structural empirical analysis. We can quantify parameters through calibration, i.e., quantify parameter relying on specificities of the model, previous information or unrelated studies. We can also estimate parameters, i.e., explore available data to obtain the best possible approximation of actual behavior.

To quantify overcharges, we must identify, once again, behavior under a counterfactual scenario, i.e., a scenario with no influence of anticompetitive behavior. In this case, the quantification process relies on yet another methodological choice. Specifically we must choose one between two approaches. In the first, we only define a model of market structure and quantify parameters for the counterfactual scenario. The overcharge is then given by the difference between actual price and estimated counterfactual price. In a second approach, we quantify parameters for actual behavior and for counterfactual behavior. In this case, the overcharge is given by the difference between estimated collusion price and estimated competitive price.

We will not present a thorough introduction to the use of structural method for quantification of overcharges, since these methods can be reasonably complex and rely on advanced economic concepts. Nevertheless, we will introduce set of general recommendations.

In a previous section, we introduced five classical models of market structure: perfect competition, monopolistic competition, Bertrand oligopoly with homogeneous products, Cournot oligopoly and monopoly.

In a model of perfect competition, a large number of firms with similar cost structure compete in a market offering a homogeneous product. Under this framework, any firm that increases prices above marginal costs will lose market share. Firms in perfect competition are price takers and market price equals marginal cost of production.

In monopolistic competition, a large number of firms compete in a market offering differentiated products. Thus, firms compete in terms of price and product characteristics. If consumers value certain characteristics more, firms selling products with these characteristics can set prices above marginal cost of production.

In a Bertrand oligopoly with homogeneous products, a small number of firms compete in a market offering a homogeneous product. In a Betrand model, firms compete in terms of price and market price equals marginal cost of production. This conclusion relies on a set of assumption. Specifically, there is no heterogeneity in costs between firms, firms do not face capacity constraints and firms offer a homogeneous good. The results are different if the model is adapted to incorporate different aspects of reality – product differentiation, for instance.

In Cornout oligopoly, a small number of firms compete in terms of quantity. Each firm defines a pricing strategy under the assumption that its behavior does not influence the pricing strategy of its competitors. The equilibrium price, in a Cournot framework, is usually set above marginal cost. The difference between price and marginal cost depends on the number of firms competing for the market. The fewer firms competing, the larger is the difference.

Monopolistic markets are markets in which a single firm offers a good. When defining its pricing strategy, the monopolist does not have to consider the share of market it would lose to other firms as result of an increase in prices (cross elasticity of demand). The monopolist only has to consider the reduction in total demand (price elasticity of demand). Since the monopolist faces no competition, it has the power to determine market price. In a monopolistic market, price will be set to maximize monopolist's profit. A perfect cartel, i.e. a cartel that faces no constraints to its behavior, will behave like a monopolist.

Results from structural empirical analysis are usually not robust to the choice of counterfactual market structure. The counterfactual price is closely related to the level of competitiveness in the counterfactual market. In general, estimates of overcharge will be higher for counterfactual markets that are more competitive. Thus, the choice of counterfactual market structure is a crucial one. In only a few cases, it is reasonable to infer that market structure would be perfectly competitive in the absence of restrictions to competition. Usually, we need to justify the choice of counterfactual market structure with a careful analysis of market and firm characteristics.

Choosing an adequate structure for the actual market, i.e. a market structure that best represents the behavior of the cartel, is also crucial. The estimates of overcharge are not robust to different assumptions on cartel behavior. In a perfect cartel, participants would always act to replicate the behavior of a monopolist. In the real world, this is not always a possibility. In several cases, firms in a cartel are not able to restrict competition fully. In these cases, a monopolist market structure is not an adequate choice for actual market structure.

The choice of adequate structure for actual and counterfactual market is not straightforward. This choice depends on a thorough analysis of market and firm characteristics that is specific to each case. . There is no general rule or set of objective criteria to guide this choice Nevertheless, a set of general of principles can be outlined.

We have to consider the pricing strategy of firms. If firms compete in terms of price, the models of perfect competition, monopolistic competition and Bertrand can be accurate representations of market structure. If competition is in terms of quantity, a Cournot model might be a more adequate choice.

Product differentiation is an important factor. The perfect competition model is consistent with a scenario in which products are perfectly homogeneous. The Bertrand model can be adapted to consider the possibility of product differentiation.

Another important factor is number of firms in a market. Each model of market structures is based on a different assumption over the number of firms competing for a market. In general, markets with a large number of firms are more consistent with a more competitive representation of market structure.

The degree of market power and the number of firms on market are closely related to the presence of barriers to entry. If we can identify significant barriers to entry, we can assume a less competitive market structure.

The cost structure of firms is another relevant factor. If costs are homogeneous across firms and production decision depends mostly on variable costs a model of monopolistic competition, perfect competition or a Bertrand model with homogeneous costs can be accurate representations of market structure. If costs are heterogeneous across firms and/ or fixed costs are significant, we can choose between a model of Cournot or a Bertrand model with heterogeneous costs.

We conclude this section emphasizing that the result of any empirical analysis depends on the validity of a set of implicit and explicit assumptions. For structural empirical analysis, the choice between different economic models is the most crucial assumption. For some cases, that choice can be straightforward. In other cases, the choice depends on subjective criteria. Therefore, it is advisable to test the robustness of results. One alternative is to replicate the analysis considering a different set of assumptions. A comparison between these results and original results can inform on how sensible results are to the validity of certain assumptions.

4. Quantifying the Passing-on of Overcharges

In previous sections, we introduced method that can be used to quantify cartel damage. We focused on cases in which damage is imposed directly on final consumers. For these cases, the quantification of damage is closely related to the quantification of the cartel overcharge. The overcharge is the difference between the price set by the cartel and the price that would prevail in a scenario with no restrictions to competition. The equivalence between overcharge and damage imposed on final consumers in only valid for cases in which the overcharge is fully transferred to consumers. This is not always the case.

If the product sold by the cartel is an input to the production process of other firms, the overcharge may not be fully transferred to final consumers. When the product sold by the cartel is an input to the production of other products, the overcharge represents an increase in production costs. To understand how that increase affects final consumers, we must understand how firms react to changes in production costs in different scenarios.

Firms determine behavior with the goal to maximize profits. That is, firms choose price and output aiming to maximize the difference between revenue and costs. Thus, price and output levels depend on costs of production. Other things equal, an increase in production costs reduces profits. Firms respond to an increase in costs by evaluating the trade-off between price and demand. Firms may choose to increase price and maintain price-costs margins. Nevertheless, an increase in price will probably result in a contraction of demand. The sensibility of demand to price changes determine the size of this contraction. Thus, the final impact over revenue depends not only on price changes but also on the response of demand to price changes. Firms react to increase in costs trying to answer the following question: what is the price and output level that maximizes profits given the increase in production costs? The answer to this question depends on several factors.

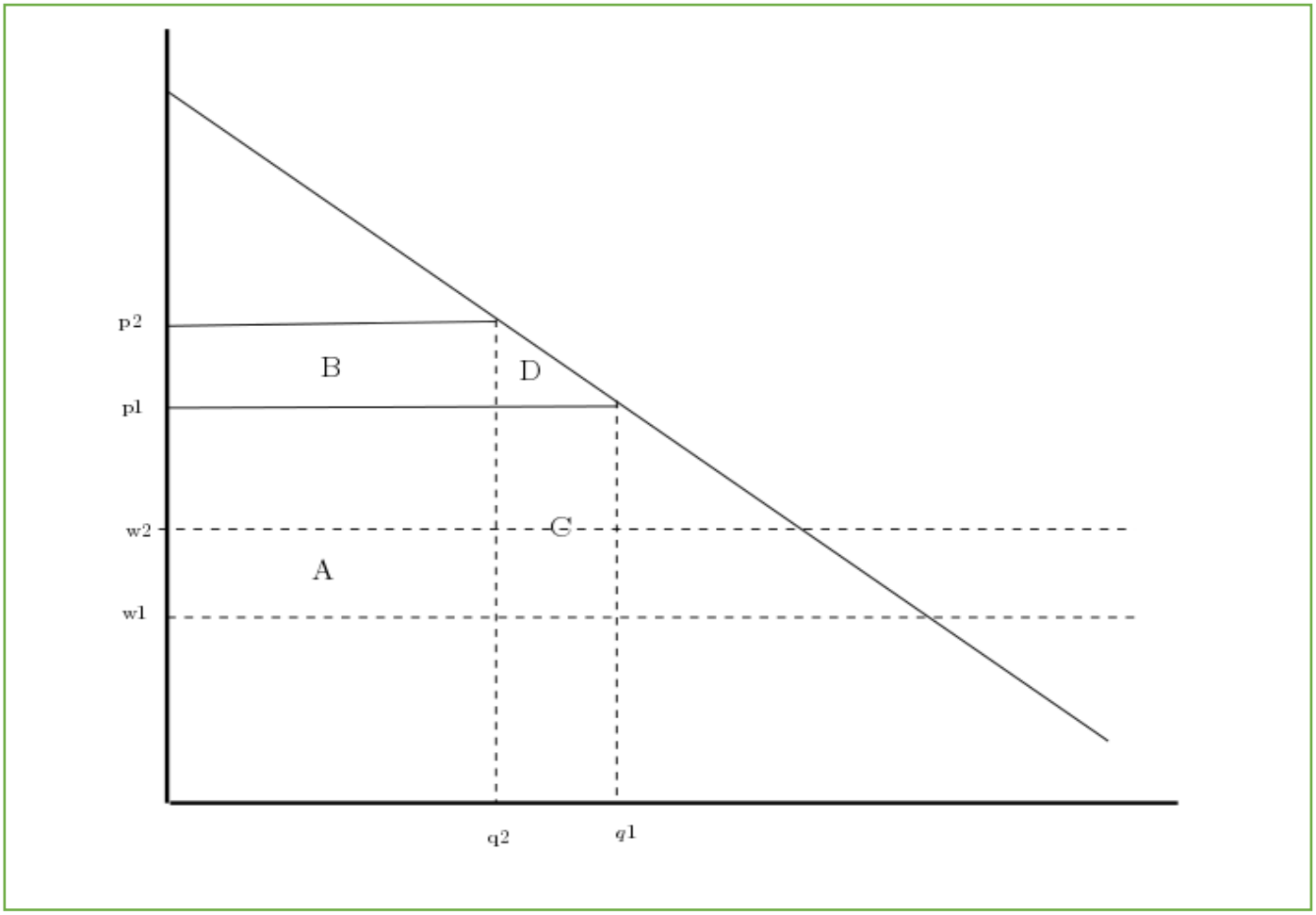
When a firm is deciding by how much to increase prices in response to an increase in costs of production, that firm is deciding how much of the cost increase will be

transferred to its consumers. When costs increase because a cartel sets an overcharge over inputs, the firm that uses these inputs must decide how much of the overcharge will be transferred across the production chain. We refer to that decision as the passing on of overcharges. The damage imposed by the cartel over intermediate and final consumers depends on the passing on of overcharges. If the intermediate consumer – here, the firm that uses the product sold by the cartel in its production process – decides not to transfer the overcharge to its consumers – that is, decides to not increase the price of the final good - the intermediate consumer fully absorbs the damage imposed by the cartel. If the intermediate consumer decides to increase prices in order to compensate completely the increase in production costs, the final consumer absorbs the overcharge cost fully. Finally, if the intermediate consumer transfers only part of the cost increase to final consumers, final and intermediate consumers absorb part the overcharge cost.

In what follows, we focus on a simple production chain. That is, we focus on a scenario in which a cartel sells a product that is used as an input in the production process of another firm – the intermediate consumer. The second firm – the intermediate consumer – sells all its production to final consumers. That is, its production is not used as an input in the production process of any other firm. In this scenario, the cartel can impose costs of three types. First, the cartel imposes a cost over the intermediate consumer, i.e. the consumer that directly buys the product with overcharge. This cost is given by the multiplication between overcharge and units bought. As previously stated, at least part of this cost can be transferred to final consumers in the form of higher prices. The size of this transfer determines the size of the damage imposed on final consumers. Finally, we have a third type of cost. When part of the overcharge is transferred to final consumers in the form of higher prices, we have a reduction in demand and thus a contraction in output. This contraction in output is a cost imposed on final and intermediate consumers.

The following figure illustrates this case. The figure represents the demand function for a final consumption good sold by a given firm. For a scenario in which inputs costs w_1, the final consumption good is sold at price p_1. In this scenario, the firm sells q_1 units of this product. In an alternative scenario, we have an increase in production costs due to cartel overcharges. Inputs are now sold at a cost of w_2. The firm decides to pass part of this overcharge to its consumers. Thus, it sets a higher price - p_2 – for the final

consumption good. As a result of the increase in price, we have a contraction of demand. At price p_2 only q_2 units of the final good are sold.



This figure is also a useful representation of the costs cartel impose on intermediate and final consumers. With the overcharge, the production costs of the intermediate consumer increases. Other things equal, this increase in production costs leads to a loss in revenue. That loss can be represented by area A. When part of the overcharge is passed on to final consumers, part of the initial loss is transferred to final consumers. Area B represents this transfer. The loss suffered by intermediate consumers is then given by A – B. The loss suffered by final consumer is given by area B. We have also have a loss that is a direct result of the contraction of demand. That loss is represented by area C. The loss from overcharge is transferred to the cartel – area A – and to intermediate consumers – area B. The loss from demand contraction is not transferred as a gain to any market participant and thus is a net loss for society.

Table 3: Loss from Overcharge

	Overcharge	Pass-on	Lost Sales	Lost Utility
Intermediate Consumer	A	-B	C	A-B+C
Intermediate Consumer/ Final Consumer		B		B
Loss to Consumer (Total)	A		C	A+C
Welfare Loss			C	C

Source: Baseado em van Dijk e Verboven (2010)

In what follows, we ignore the loss that results from lost sales. We focus on the loss that is a result of the overcharge and the passing on of overcharge.

From the previous discussion, we conclude that the intermediate consumer does not necessarily absorbs the damage imposed by the cartel fully. Part of the damage may be transferred to final consumers. This increase the challenge of quantifying damage. We have two options. First, we can just ignore the passing on of overcharges. According to this approach: (i) only the intermediate consumer can request compensation for damage; (ii) the quantification of damage must overlook the passing on of overcharges. That is the approach backed by the antitrust regulation in the United States. In 1977, a decision from the Supreme Court[18] established the interpretation[19] that only the consumers directly harmed by cartel behavior – here, intermediate consumers – were entitled to compensation. This approach intends to eliminate possible barriers to private enforcement. It is worth mentioning that, in the last few decades, several states – including California[20] – adopted the interpretation that final consumers should also be entitled to compensation.

A second approach is to explicitly consider the passing-on of overcharges. According to this approach: (i) the passing on of overcharges must be deducted from the compensation that must be paid to intermediate consumers; (ii) the final consumer is

[18] Illinois Brick Co. v. Illinois, 431 U.S. 720 (U.S. 1977)
[19] Illinois Brick Doctrine Law
[20] California v. ARC America Corp., 490 U.S. 93 (U.S. 1989),

entitled to compensation. That is the approach backed by antitrust legislation in the European Union and in Brazil.

The challenge of quantifying damage is higher if we need to consider the passing on of overcharges. In what follows, we introduce methods that can be used to quantify the passing on of overcharges across the production chain.

As previously stated, firms perceive an increase input prices due to an overcharge as an increase in costs of production. To understand how firms react to the overcharge, we must understand how firms respond to higher production costs in different scenarios.

The economic theory offers some insights on how firms would react to higher production costs. The passing on of overcharges depends on characteristics of firms and markets. It depends on the relevance of the input with overcharge as a share of total costs. It also depends on how the overcharge affects the production cost of competitor firms.

First, firms react differently to changes in different types of costs. Prices are determined as a function of the marginal cost or the cost of producing on more unit. Usually, changes in variable costs – costs that vary with the level of output – are promptly transferred to consumers. Changes in fixed costs, on the other hand, are likely to affect prices only after some period of time. In the presence of menu costs – or costs resulting from price changes – even an increase in variable costs can take a while to be transferred to consumers in the form of higher prices.

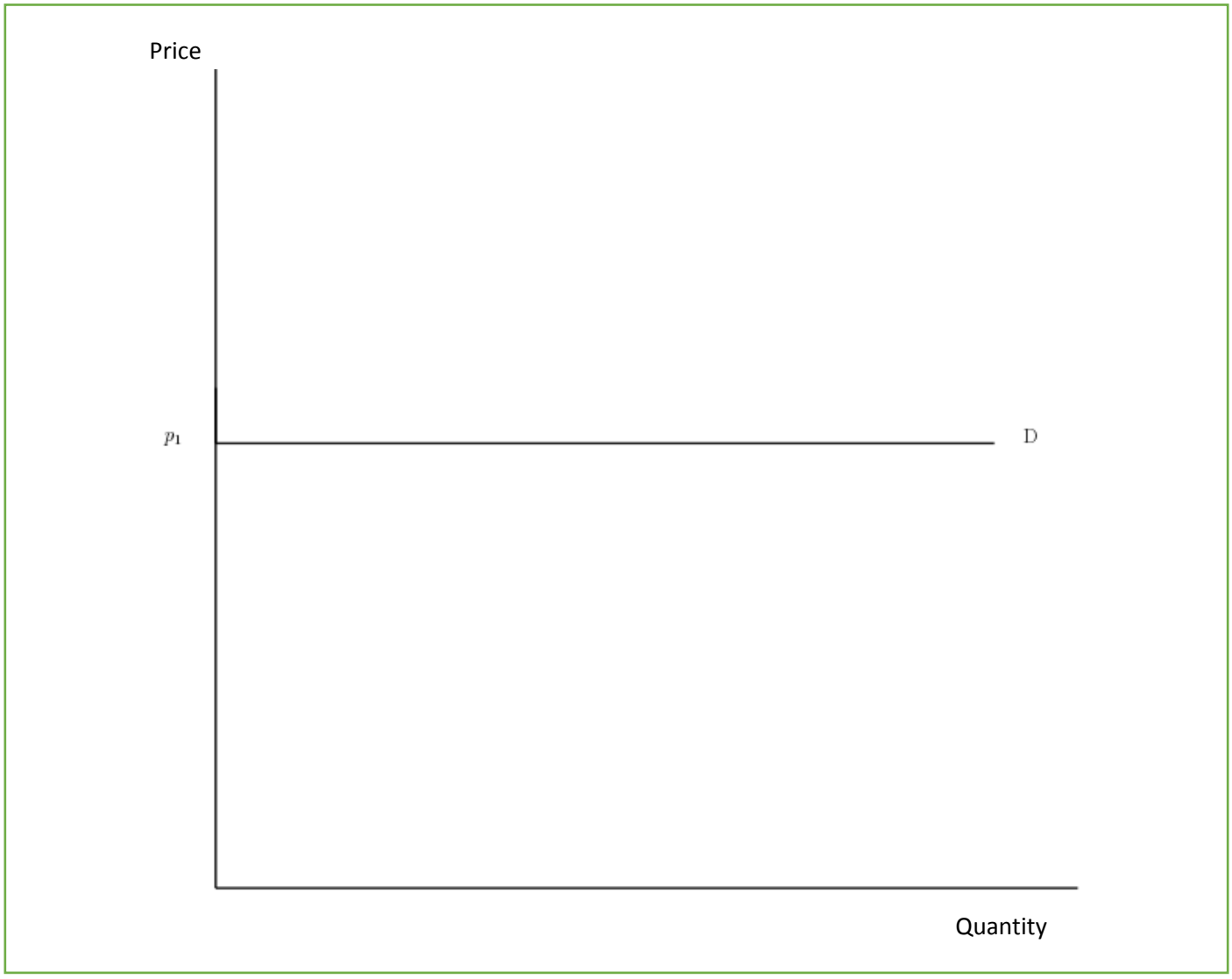
Firms decide how much of the cost increase will be transferred to final prices evaluating the trade-off between higher revenue due to higher prices and lower revenue due to a contraction of demand. Thus, the impact of a cost increase over prices depends on how demand will react to higher prices. Consider, first, a firm specific cost increase. That is, a cartel sets an overcharge on a product that is used as an input by a single firm competing for a market. In this case, the firm has to consider the fact that its competitors are not affected by the cost increase when deciding if it will pass-on the overcharge. An increase in prices in this scenario will likely lead to a loss of market share. In this case, we have a low probability that the overcharge will be passed on to final consumers. Consider an alternative scenario in which a cartel sets an overcharge on a product that is used as input by all firms competing for a market, i.e, a market specific cost increase. Here, every firm has to evaluate how to better adjust prices in order to compensate for the

higher costs. In this case, the likelihood that the cost increase will be passed on to final consumers increases.

We can also evaluate how demand will react to price increases by measuring the price elasticity of demand. The price elasticity of demand is a measure of the sensibility of demand to price increases[21]. To understand this concept, consider two extreme theoretical constructs. In the first, demand is unresponsive to price changes. The following figure illustrate this case. Here, demand is not altered by price changes and thus price elasticity of demand is null. That is, demand decreases by zero in response to a price change.

[21] The price elasticity of demand measures how much demand will contract (in percentage) to a 1% increase in prices. If price elasticity of demand equals two, an increase of 1% in price will lead to a reduction of demand of 2%.

In a second scenario, any small change in price reduces demand to zero as illustrated by the following figure:



In this case, price-elasticity of demand is infinite. That is, there is no limit to reduction on demand in response to a price change.

In the real world, demand responds somewhat to price increases. Thus, the price-elasticity of demand is usually a number between zero and infinite. The price elasticity of demand is high if demand is very sensible to price changes. If a product has close substitutes, the price elasticity for that product will usually be high. For instance, if the price of butter increases, part of consumers will choose to buy margarine reducing significantly the demand for butter. The price elasticity of demand is low if demand

responds slightly to price increases. The price elasticity of demand of essential goods is usually low. An increase in the price of an indispensable medicine is likely to have a limited impact over demand

It is the price elasticity of demand that determines the impact that the passing on of overcharges will have over output. If price elasticity of demand is high, the passing on of overcharges is likely to have a significant impact on demand. In this case, firms are less likely to fully transfer an increase in production costs to consumers. If price elasticity of demand is low, the passing on of overcharges is not likely to have a significant impact on demand. Here, the probability of passing on any increase in costs is higher.

Another factor that significantly influences the passing on of overcharges is market structure. The passing on of overcharge is likely to be more intense under specific market structures. If the overcharge is firm specific, firms are less likely to pass on the overcharges in more competitive markets. In a more competitive market, a firm that unilaterally increases prices is more likely to lose market share.

If the overcharge is market specific, we have a result somehow counterintuitive. Specifically, firms are more likely to pass on the overcharge in more competitive markets. Firms set price-cost margins considering the reaction of competitors. In a competitive market, if there is a large difference between market price and costs of production, a firm that reduces price will absorb a greater share of market demand. As long as prices are above costs, firms will have an incentive to reduce prices. In equilibrium, the difference between price and costs is close to zero. In a competitive market, prices are closely related to production costs. Thus, an increase in costs affects prices and the overcharge is likely to be passed on to final consumers. On the other hand, in less competitive markets, firms are more likely to enjoy some market power. Thus, the difference between price and costs can be different from zero. In this scenario, firms may choose not to transfer at least part of the overcharge to final consumers.

Until now, we introduced some insights on how firms would react to higher production costs. In what follows, we introduce tools that can be useful for the empirical analysis of the passing on of overcharges. We can classify the approaches in two types: sequential and holistic. With a sequential approach, we analyze every step independently and in a systematic order. We first estimate overcharge and then the passing on of

overcharges. In a holistic approach, we simultaneously estimate overcharge and the passing on of overcharges.

We also classify the approaches in direct and pass-on rate approaches. With a direct approach, we directly estimate the passing on of overcharges. We evaluate the increase in price of the final good due to the overcharge. With a pass on rate approach, we estimate at which rate higher production costs are transferred to final consumers.

In a direct approach, we evaluate the passing on of overcharges estimating the difference between the actual price of the final good and the price that would have prevailed in a counterfactual scenario – a scenario with no overcharge. We can estimate that difference using the methods introduced in the previous section. Another alternative is to evaluate the difference between actual price-cost margin and counterfactual price-cost margin. We can also use the methods previously introduced. If we find evidence that price-cost margins were unaffected by the overcharge, we can conclude that the firm transferred the damage to final consumers fully. If we find evidence that price-cost margins decreased, we can conclude that only part of the overcharge was transferred to consumers. If we find that price-cost margins decreased and the price of the final good was not altered, we can conclude that the firm opted to not transfer the overcharge to final consumers.

In a pass-on rate approach, we estimate the rate at which cost increases are transferred to final consumers. Once we have an estimate for the pass on rate, we can estimated damage imposed on final consumers by applying that rate on an estimate of overcharge. Suppose we he have an overcharge of 10$ and a pass on rate of 70%. Here, intermediate consumers suffer a damage of 3$ and final consumers suffer a damage of 7$.

In the previous chapter, we introduced methods that are useful for the estimation of overcharges. In what follows, we focus on methods useful for the estimation of pass-on rates.

If information is available, we can use quantitative tools to estimate pass-on rates. If we have data on final price and on cost structure – such as data on price of the input provided by the cartel and other inputs – we can estimate a correlation between price of inputs and final price. We can also estimate a pricing function using regression techniques.

Another option is to estimate pass-on rates using indirect evidence on pricing strategy. If firms determine price following a systematic rule or algorithm we can explore that behavior to compute pass on rate.

Another approach – especially useful for cases with restricted access to information - is to obtain a pass on rate of reference. The pass on rate of similar firms competing for similar markets is good candidate for reference rate.

We can also explore insights from the economic theory to obtain a good enough approximation of the pass-on rate. Previously, we presented some findings of the economic theory on how firms are likely to react in response to an increase in costs. We can analyze market and firm characteristics and evaluate the behavior predicted by economic theory to determine pass-on rates

Finally, it is worth mentioning that the passing on overcharges can affect complex supply chains. We focused on a simple case, in which a cartel impose an overcharge over an input that is used for the production of a final good. In the real world, the cartel can increase production costs for firms that are linked to extensive and complex supply chains. The methods previously introduced can be adjusted for the analysis of such scenario.

5. Final remarks

We introduced, throughout these guidelines, the methods most widely used for the quantification of cartel behavior. We designed the guidelines to serve as practical tool readily available for real world analysis. We focused on the methods and models more likely to be useful in the process of: (i) detecting cartels; (ii) quantifying overcharge; (ii) quantifying the passing on of overcharge.

Private actions for cartel damage are still rare in Brazil. Our hope is that these guidelines help change this scenario while serving as an official and simplified reference for overcharge quantification.

6. References

Abrantes-Metz, R.M.; Froeb, L.,; Geweke, J.; e Taylor, C. (2006). "A variance screen for collusion" . International Journal of Industrial Organization, vol. 24, 3, 467-486.

Abrantes-Metz, R.M.; Bajari, P. (2009). Screens for Conspiracies and Their Multiple Applications. Antitrust 24(1), pp. 66-71.

Abrantes-Metz, R. M. (2011), "Design and Implementation of Screens and Their Use by Defendants". Competition Policy International (CPI) Antitrust Chronicle, Vol. 2, September 2011. Disponível em SSRN: https://ssrn.com/abstract=1943223.

Athey, S e Bagwel, K. (2001), "Optimal Collusion with Private Information." The RAND Journal of Economics. Vol 32.3, 428-65.

Baldwin, L.; Marshall R.; e Richard, J. (1997) "Bidder Collusion at Forest Service Timber Sales," Journal of Political Economy 105, no. 4, 657-699

Bajari, P.; Ye, L. (2001). "Competition Versus Collusion in Procurement Auctions: Identification and Testing". Working Papers, Stanford University, Department of Economics.

Bajari, P.; Ye, L. (2003). "Deciding Between Competition and Collusion". Review of Economics and Statistics, Volume 85, Issue 4, p.971-989.

Banerjee, A. and Meenakshi, J. V. (2004). "Buyer Collusion and Efficiency of Government Intervention in Wheat Markets in Northern India: An Asymmetric Structural Auctions Analysis". American Journal of Agricultural Economics, Vol. 86, No. 1, pp. 236-253. Available at SSRN: https://ssrn.com/abstract=513313

Becker, G. S. (1968). "Crime and Punishment: An Economic Approach, Journal of Political Economy", março/abril (número 76), PP. 169-217.

Bolotova, Y.; Connor, J. e Miller, D. (2008). "The impact of collusion on price behavior: Empirical results from two recent cases". International Journal of Industrial Organization, vol. 26, issue 6, 1290-1307.

Boshoff, W. e van Jaarsveld, R. (2017). "Recurrent collusion: Cartel episodes and overcharge in the South African cement market". CCLE Working paper WPS03

Calabresi, G., and A. Douglas Melamed, "Property Rules, Liability Rules and Inalienability: One View of the Cathedral", 85 Harvard Law Review 1089 (1972).

Carrasco, V; de Mello, J e Rigato, R. "O Cartel dos Gases Medicinais: Análise Econômica e Cômputo de Sobrepreço".

Centre for European Policy Studies; Erasmus University Rotterdam; Luiss Guido Carli (2007). "Making antitrust damages actions more effective in the EU: welfare impact and potential scenarios" Final Report. Report for the European Commission. DG COMP/2006/A3/012.

Clark, E.; Hughes, M.; Wirth, D. (2004). "Analysis of Economic Models for the Calculation of Damages". Study on the conditions of claims for damages in case of infringement of EC competition rules.

DOJ Primer (2017). "Price Fixing, Bid Rigging, and Market Allocation Schemes: What They Are and What to Look For".

European Commission (2008). Commission Staff Working Document Accompanying document to the WHITE PAPER on Damages actions for breach of the EC antitrust rules. SEC(2008) 405.

European Commission (2008). WHITE PAPER on Damages actions for breach of the EC antitrust rules. COM(2008) 165 final

European Commission (2013). "Practical Guide: Quantifying Harm in Actions for Damages Based on Breaches of Article 101 or 102 of the Treaty on the Functioning of the European Union". Commission Staff Working Document. SWD(2013) 205.

European Commission (2016). "Study on the Passing-on of Overcharges". Final Report. Disponível em: http://ec.europa.eu/competition/publications/reports/KD0216916ENN.pdf

Esposito, F.; e Ferrero, M. (2006). "Variance screens for detecting collusion: an application to two cartel cases in Italy". Paper presented to the 2nd ACLE Workshop on Forensic Economics in Competition Law Enforcement, Amsterdam, The Netherlands

Frias, M. C.. Ações movidas por lesados por cartéis crescem e criam conflito com leniência. In Folha de São Paulo (20/6/2017). Disponível em <http://m.folha.uol.com.br/colunas/mercadoaberto/2017/06/1894220-acoes-movidas-por-lesados-por-carteis-crescem-e-criam-conflito-com-leniencia.shtml>. Acesso em 21 de junho de 2017.

Froeb, L.; Sibley, D.; Doane, M.; Pinto, B. (2014). "Screening for Collusion as a Problem of Inference". The Oxford Handbook of International Antitrust Economics, Volume 2.

Green, E.J. and R.H. Porter (1984), "Noncooperative Collusion Under Imperfect Price Information", Econometrica 52(1):87-100.

Harrington, J. (2005). "Detecting Cartels". Disponível em http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.143.5837&rep=rep1&type=pdf

Harrington, J., e Chen, J. (2006) "Cartel Pricing dynamics with cost variability and endogenous buyer detection". International Journal of Industrial Organization. 25 1185-1212

Hatzitaskos, K.; Card, D.; Howell,V. (2014). "Guidelines on Quantitative Techniques for Competition Analysis"; diponível em https://www.cornerstone.com/Publications/Articles/Guidelines-Quantitative-Techniques-for-Competition

Heijnen, P.; Haan, M.; e Soetvent, A. "Screening for Collusion: A Spatial Statistics Approach". Journal of Economic Geography 15(2).

Hovenkamp, Herbert J. (2011), "Quantification of Harm in Private Antitrust Actions in the United States" Faculty Scholarship. 1860. Disponível em: http://scholarship.law.upenn.edu/faculty_scholarship/1860

Maier-Rigaud, F.; Schwalbe, U. (2013). "Quantification of Antitrust Damages".: Competition Damages Actions in the EU: Law and Practice.

Kaplow, L.; Shapiro, C. (2007). "Antitrust," Handbook of Law and Economics, Elsevier.

Lande, R. H. and Connor, J. M. (2005), "How High Do Cartels Raise Prices? Implications for Reform of the Antitrust Sentencing Guidelines". ; American Antitrust Institute Working Paper No. 01-04. Disponível SSRN: https://ssrn.com/abstract=787907 or http://dx.doi.org/10.2139/ssrn.787907

Laitenberger, U. e Smuda, F. (2013) "Estimating Consumer Damages in Cartel Cases". ZEW Discussion Paper No. 13-069

OECD (2011). "Quantification of Harm to Competition by National Courts and Competition Agencies". DAF/COMP(2011)25.

OECD (2013). Ex officio cartel investigations and the use of screens to detect cartels. DAF/COMP(2013)27

OECD (2013). "The Role and Measurement of Quality in Competition Analysis". DAF/COMP(2013)17.

OECD (2015). "Relationship Between Public and Private Antitrust Enforcement". DAF/COMP/WP3(2015)14.

Oxera/Komninos et al. (2009). "Quantifying antitrust damages. Towards non-binding guidance for courts", Study prepared for the European Commission, disponível online em http://ec.europa.eu/competition/antitrust/actionsdamages/ quantification_study.pdf.

Polinsky, M.. "An Introduction to Law and Economics", 4ª edition. Wolters Kluwer: 2011, P. 83

Posner, R. (2001). "Antitrust Law". 2ª edição. The University of Chicago Press.

Porter, R.H. (1983), "A Study of Cartel Stability: The Joint Executive Committee, 1880-1886", Bell Journal of Economics 14(2): 301-314.

Porter, R. e Zona, J. (1993), "Detection of Bid Rigging in Procurement Auctions", Journal of Political Economy, vol. 101, no. 18, 518-538.

Porter, R. e Zona, J. (1999), "Ohio School Milk Markets: An Analysis of Bidding", RAND Journal of Economics, Vol 30, no.2, p. 263-288.

Reiss e Wolak (2005). "Structural Econometric Modeling: Rationales and Examples from Industrial Organization". Prepared for the Handbook of Econometrics, Volume 6.

Shavell, S.. "Foundations of Economic Analysis of Law", Harvard University Press. 2004. Ebook

Squillante, F. (2014). "A Brief Overview of the Directive on Antitrust Damages Actions". Revista Italiana di Antritrust. Disponível em: http://iar.agcm.it/article/viewFile/10206/9497

U.S. Department of Justice; Federal Trade Comission (2017). "Antitrust Guidelines for International Enforcement and Cooperation". Disponível em: https://www.justice.gov/atr/internationalguidelines/download

Verboven, F.; Dijk, T. (2009). "Cartel Damages Claims and the Passing-On Defense". The Journal of Industrial Economics. Volume 57, Issue 3. pp 457–491.

Werden, G. (2003). "The Effect of Antitrust Policy on Consumer Welfare: What Crandall and Winston Overlook". Economic Analysis Group Discussion Paper.