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COLLUSION AND ANTITRUST: THE DARK SIDE OF PRICING ALGORITHMS

Tesi di laurea in EUROPEAN COMPETITION LAW

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Table of contents

Introduction 7

I. Tacit collusion in the oligopoly: an EU perspective 11

1. The economics of tacit collusion 12

1.1. Explicit collusion and tacit collusion 12

1.2. Factors influencing the tendency to collude in an oligopoly 14

1.3. Game theory and the prisoner's dilemma 17

1.4. The "oligopoly problem" in literature 22

2. Tacit collusion under EU competition law 27

2.1. *Ex ante* intervention: tacit collusion as "coordinated effects" 28

2.2. *Ex post* intervention: tacit collusion as a cartel 31

2.2.1. Tacit collusion as a concerted practice and the oligopoly defense 32

2.2.2. Application of Article 101 to facilitating practices 35

2.3. *Ex post* intervention: tacit collusion as an abuse of collective dominance 39

3. Conclusion 43

II. Algorithms implementing collusion scenarios 47

1. Possible pro-competitive effects of algorithms 48

1.1. Supply-side efficiencies 48

1.2. Demand-side efficiencies 50

2. The impact of algorithms on the likelihood of collusion 51

3. How algorithms may promote collusion 55

3.1. Messenger algorithms: implementing pre-existing explicit collusion 56

3.1.1. Signalling algorithms 56

3.1.2. Monitoring algorithms 58

3.1.3. Competition law enforcement of algorithmic explicit collusion 60

3.2. The algorithm-enhanced Hub-and-Spoke 62

3.2.1. Uber's Hub-and-Spoke: a case study 68
3.3. Parallel algorithms: algorithm-fueled tacit collusion 72
3.3.1. Competition law enforcement of algorithmic tacit collusion 75
3.4. Self-learning algorithms: tacit collusion of the future 80
4. Conclusion 85

III. Intervention and possible avenues for enforcers against algorithmic collusion 89
1. Main arising challenges for competition law enforcement 90
1.1. The "to regulate or not to regulate" dilemma 90
1.2. Liability: the role of humans on algorithmic collusion 92
1.2.1. Predictable Agent *algorithms as employees* 93
1.2.2. Self-learning *algorithms as agents* 94
1.2.3. Algorithm's suppliers as cartel facilitators 96
1.3. Detection: how to uncover algorithmic anticompetitive dynamics 97
1.3.1. Auditing the algorithm 98
1.3.2. Market studies and investigations 99
1.4. Burden of proof: the *public distancing* requirement in an algorithmic environment 101
2. Possible regulatory intervention on collusive algorithms 104
2.1. Revisiting existing competition regulation 105
2.1.1. Ex ante *intervention: merger control over algorithmic markets* 105
2.1.2. Ex post *intervention: extending the notion of "agreement" and "concerted practice"* 106
2.2. Enforcing innovative regulatory countermeasures 110
2.2.1. Regulation over algorithms: the "compliance by design" 110
2.2.2. Regulation over markets: policies making tacit collusion unstable 114
2.2.3. Algorithmic countermeasures: the use of technology by policymakers and consumers 116
3. Conclusion 119

Conclusion 123

Bibliography 127
Cases 138
European Union 138
United States 141
United Kingdom 143
Italy 143
Legislation 143
European Union 143
United States 145

Tables

Table 1. Tacit collusion under EU competition law 45
Table 2. Impact of algorithms on relevant factors for collusion 53
Table 3. Four categories of algorithmic collusion 88
Table 4. Innovative countermeasures to algorithmic collusion and potential risks 122

Figures

Figure 1. The prisoner's dilemma game 19
Figure 2. The prisoner's dilemma applied to a duopoly 20
Figure 3. A non-cooperative game with cooperation as the dominant strategy 22
Figure 4. Signalling algorithm 57
Figure 5. Monitoring algorithm 59
Figure 6. Traditional Hub-and-Spoke 63
Figure 7. Algorithm-fueled Hub-and-Spoke 64
Figure 8. Algorithm- and data-fueled Hub-and-Spoke 66
Figure 9. Parallel algorithms 73
Figure 10. Deep learning algorithm 81
Figure 11. Tacit collusion between two Q-learning algorithms 83
Figure 12. Decision-making process of algorithmic consumer 119

Introduction

> *We do need to be alert. Because automated systems could be used to make price-fixing more effective. That may be good news for cartelists. But it's very bad news for the rest of us.*[1]
>
> Margrethe Vestager

The importance of algorithms and technology in today's society cannot be underestimated. The advent of Internet has made markets smaller and easier to explore. With few taps on smartphones, tablets, or computers, Internet-provided shoppers can discover a universe of products through price comparison websites and algorithmic systems. Alongside with consumers' online purchasing, algorithms assist companies in pricing decisions, planning, trade and logistics; as technology advances, businesses are increasingly relying on big data and big analytics. Among the others, pricing algorithms are employed particularly in the airline, hotel booking and electricity industries to automatically set firms' prices to maximise profits. Given their automated system, such algorithms may implement continuous price changes within milliseconds, in order to react instantaneously to fluctuations in market supply and demand. On its surface, the algorithmic world would generate pro-competitive effects, in terms of improving quality, lowering prices, and hastening innovation. After the initial positive promises, the widespread use of pricing algorithms raises anyhow concerns of possible anti-competitive behaviours. As pricing mechanisms shift to computer pricing algorithms, so too will the different types of unlawful collusion between firms. In the words of Ezrachi and Stucke, «we are shifting from the world where executives expressly collude in smoke-filled hotel rooms to a world where pricing algorithms continually monitor and adjust to each other's prices and market data»[2].

Beyond employing pricing algorithms as tools to monitor competitors' behaviours, automated systems can make it easier for firms to achieve and sustain collusion without any formal interaction. The so-called tacit collusion – or conscious

[1] Margrethe Vestager, "Algorithms and Competition", Speech at the Bundeskatellamt 18th Conference on Competition, Berlin (16 March 2017), available at: https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/bundeskartellamt-18th-conference-competition-berlin-16-march-2017_en

[2] Ariel Ezrachi and Maurice E. Stucke, "Artificial Intelligence & Collusion: When Computers Inhibit Competition", *University of Illinois Law Review* 2017, n. 5 (2017): 1775.

parallelism – traditionally affects oligopolistic markets, where undertakings may achieve the ends of an explicit cartel merely by recognizing their interdependence and avoiding to adopt a competitive behaviour. Antitrust agencies, anyhow, always failed to address the "oligopoly problem" through the competition law toolbox; besides the *ex ante* intervention through Merger Regulation, which prevents the rise of collusive oligopolistic markets, tacit collusion cannot be held unlawful by European Union competition law. On this background, pricing algorithms may make both explicit and tacit collusive outcomes more likely to be observed in today's markets. Given the positive impact of algorithms on market transparency and frequency of interaction, digital scenarios discourage cartelists' distrust, cheating and deviation from the collusive price; as a result, tacit collusion can potentially always be sustained as an equilibrium strategy. The current changes in market conditions thus approach algorithmic markets to the structural features that are usually associated in oligopolies with the risk of tacit collusion. Having regard to the similarities with the classic "oligopoly problem", the thesis focuses precisely on the question whether pricing algorithms can facilitate and stabilize tacit collusion not only in oligopolistic markets, but also in markets where a wider number of competitors is present. Could automated price-settings widen the scope of tacit collusion from oligopolistic to non-oligopolistic market structures? And, if so, how competition authorities can deal with such advanced "computerised trade environments"?

To meet these challenges, this Thesis advances in three interconnected stages. **Chapter I** summarises the background of classic tacit collusion, from both an economic and legal perspective. After having focused on the structural market characteristics that most influence the likelihood of tacit collusion, the first Paragraph will demonstrate through game theory and economic literature the sustainability of conscious parallelism in oligopolistic markets; the Turner-Posner debate over antitrust legality of tacit collusion will be subsequently discussed. Following this, Paragraph 2 outlines the European Union enforcement over tacitly collusive outcomes. Alongside with *ex ante* intervention through merger control, *ex post* approaches by means of Article 101, via the notions of "concerted practice" and "facilitating practice", and 102 TFEU, as abuse of collective dominance, will be deeply examined and consequently excluded.
In light of the previous analysis over the "oligopoly problem", **Chapter II** considers the role played by pricing algorithms in facilitating cartels and tacit collusion. Without disregarding the pro-competitive benefits of automated system to the digital

society, Paragraph 2 will emphasise the impact of algorithms over structural, supply-side and demand-side market characteristics, which may virtually make collusion stable in any marketplace. The focus of the Chapter, at Paragraph 3, will then distinguish the four Ezrachi and Stucke's scenarios in which algorithms may promote collusion. Among them, the *Messenger* scenario, through monitoring and signalling algorithms, and the *Hub-and-Spoke* scenario, via a supplier's algorithms for numerous competitors, will be addressed as explicit collusion under Article 101 TFEU. The Hub-and-Spoke structure of online platforms as Uber only generates competition uncertainties. Conversely, in *Predictable Agent* and *Digital Eye* scenarios, parallel firm's pricing algorithms unilaterally adopt strategies and set prices, sometimes adopting self-learning and deep-learning networks. The result will be algorithm-enhanced tacit collusion, which raises the most challenging enforcement questions.

The collusive risk surrounding the last two scenarios will lead to the discussion of **Chapter III**, which focuses on the need of antitrust enforcement over algorithmic tacit collusion. Following an interventionist approach, Paragraph 1 will outline firstly the meaningful competition law challenges arisen from an algorithmic-based ecosystem. The most remarkable questions concern liability, detection and burden of proof in a digital milieu. Are undertakings liable when pricing decision are taken by algorithms?; Could algorithmic tacit collusion be detected through algorithm's auditions or market investigations?; How can the *public distancing* requirement be satisfied when dealing with autonomous self-learning algorithms? On this background, the Chapter will then outline at Paragraph 2 two different possibilities of regulatory intervention. On one hand, the discussion focuses on the ability of existing EU antitrust tools – i.e. merger control and Article 101 TFEU – to address effectively algorithmic coordination. The shortcomings of such solutions, on the other hand, will drive the regulatory net beyond its classic prohibitions; the analysis identifies specifically plausible regulations over algorithm's design and transparency, market solutions and "smart" and technologic countermeasures. In light of the digital nature of today's markets, the Thesis endorses the need of innovative regulations and prompt intervention; current EU competition law alone would not be sufficient anymore.

I. Tacit collusion in the oligopoly: an EU perspective

1. The economics of tacit collusion. 1.1. Explicit collusion and tacit collusion. 1.2. Factors influencing the tendency to collude in an oligopoly. 1.3. Game theory and the prisoner's dilemma. 1.4. The "oligopoly problem" in literature. **2. Tacit collusion under EU competition law.** 2.1. *Ex ante* intervention: tacit collusion as "coordinated effects". 2.2. *Ex post* intervention: tacit collusion as a cartel. *2.2.1. Tacit collusion as a concerted practice and the oligopoly defense. 2.2.2. Application of Article 101 to facilitating practices.* 2.3. *Ex post* intervention: tacit collusion as an abuse of collective dominance. **3. Conclusion.**

The combination of big data with advanced pricing algorithms is nowadays changing the competitive landscape in which companies operate. Among the others, technological tools may raise concerns of anti-competitive behaviours as they can make it easier for firms to sustain collusion and parallel pricing without any formal communication. Literature has always referred to this type of collusive outcomes lacking an explicit agreement to coordinate as tacit collusion in European Union or conscious parallelism in the United States. In order to evaluate the effective impact of algorithms on the likelihood of pricing coordination, the starting point of this work is the analysis of the concept of classic tacit collusion from the perspective of economics and EU competition law. Particularly, the link between conscious parallelism and oligopolistic market structures will be discussed in the present Chapter. Could the mere existence of an oligopoly encourage the configuration of tacit collusion? If so, how the EU legal framework might tackle the so-called "oligopoly problem"?

After having distinguished tacit collusion from explicit cartels, Paragraph 1 will firstly outline the economic variables which may make oligopolistic markets more prone to tacitly collude; then, the discussion will focus on the large contribution given by game theory and Harvard and Chicago schools literature to the definition of the "oligopoly problem" and to the debate of punishing or not parallel conducts. Paragraph 2, subsequently, will consider the efficiency of the EU competition law toolbox in dealing with tacit collusion. The analysis of Article 101 and Article 102 TFEU, together with the interpretation given by the relevant case law, will help understand how competition agencies have prosecuted tacit collusion – and always failed to do it. The *ex ante* approach through the EU Merger Regulation would probably be the only conceivable solution.

1. The economics of tacit collusion

1.1. Explicit collusion and tacit collusion

In a competitive market, firms act as price-takers and maximize profits by increasing their output until the cost of the last unit sold (i.e. the marginal cost of production) equals the market price[3]. By acting alone, they cannot affect the market price of a commodity. For this reason, the only way for undertakings to set the market price above the marginal cost of production is to collude. As to the main effect resulting from collusion, wealth would be redistributed from consumers to the undertakings involved in the agreement. Indeed, some consumers, facing an higher price, can afford only less desiderable substitute products. These purchasers are thus worse off, since the susbstitute is inferior, while collusive producers are better off, despite the reduction of the quantity of goods supplied, because they will collect higher profits from the cartel. This results in an inefficient utilization of resources, which represents a deadweight loss[4] to society.

Both explicit and tacit collusion can lead to the same outcome. Explicit collusion refers usually to formal arrangements between undertakings, resulting from explicit meeting of minds trough agreements, contracts, concerted practices and decisions by trade associations, joint-ventures and combinations[5]. Formal cartels maximize the profits of their members by reducing total output and imposing a price well above marginal cost, aiming to set a monopoly price[6], i.e. a price much higher than the one that would be set in a competitive market[7]. Nevertheless, cartels are inherently unstable: members have an incentive to cheat on the cartel by pricing below the agreed price and capturing profits at the expense of other members. In order to

[3] Richard A. Posner, *Antitrust law: an economic perspective* (Chicago: University of Chicago Press, 1978), 241.

[4] **Deadweight loss** refers to the loss of economic efficiency when the equilibrium outcome is not achievable or not achieved: it is the cost born by the society due to market inefficiency.

[5] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 2.

[6] The **monopoly price** is determined by finding the point at which the cartel marginal cost curve (the horizontal sum of the marginal cost curves of the individual firms, if input prices do not increase as the cartel is formed) intersects with the market marginal revenue curve. The price along the demand curve at that output level is the monopoly price. Edwin Mansfield, *Microeconomics: Theory and Applications* (New York: W. W. Norton & Company, 1979), 347-48.

[7] Richard A. Posner and Frank H. Easterbrook, *Antitrust: Cases, Economic Notes, and Other Materials*, Second edition (West Group, 1980), 1064-65.

prevent this from happening, enforcement mechanisms of the cartel should be developed[8].

On the other hand, collusion is possible even without explicit communication and meeting of minds between undertakings. Especially in oligopolistic markets, a formal agreement is not necessary for competing firms to set a monopoly price: each undertaking may realize that its business decisions interact with those made by other firms in the market and may achieve the ends of a formal cartel merely by recognizing their interdependence[9]. This phenomenon is generally referred to as tacit collusion or conscious parallelism, whereby few operators act in a parallel manner as a result of the characteristics of the market, without falling in the legal category of concerted practices[10]. A market player simply refrains from adopting a more competitive behaviour in terms of price setting since this would, as a result, trigger a rational reaction or retaliation by rivals in later periods. As Edward Chamberlin observed, "each seller must consider not merely what his competitor is doing now, but also what he will be forced to do in the light of the change which he himself is contemplating"[11].

From an economic point of view, collusion is possible with or without communication between the firms involved. Therefore, the concept not only includes explicit collusion in the form of agreements or concerted actions but also conscious parallelism, through which firms may still coordinate on prices. Economists define collusion in terms of effects, that is "any situation in which market players do not compete 'to the fullest' but instead charge higher prices than they otherwise would, provided other firms in the market do so as well"[12]. Hence, in economic terms, the incentives to adhere to collusive arrangements are the same with and without communication, although explicit communication may help firms to better coordinate and may lead to higher prices[13].

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[8] Michael K. Vaska, "Conscious Parallelism and Price Fixing: Defining the Boundary", *University of Chicago Law Review* 52, n. 2 (1985): 511.
[9] This will be better pointed out in Paragraph 1.2.
[10] Richard Whish and David Bailey, *Competition Law*, Ninth edition (Oxford: Oxford University Press, 2018), 559.
[11] Edward H. Chamberlin, *The Theory of Monopolistic Competition*, Fifth edition (Cambridge, Massachusetts: Harvard University Press, 1947), 59.
[12] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 28.
[13] Miguel A. Fonseca and Hans-Theo Normann, "Explicit vs. tacit collusion: The impact of communication in oligopoly experiments", *Dusseldorf Institute for Competition Economics Discussion Paper*, n. 65 (2012): 1.

The irrelevance of the element of "explicit communication" between firms in order to have a collusion under an economic perspective is in stark contrast to its significance under antitrust law. Evidence that firms explicitly communicated to each other and engaged in formal agreements to fix or control prices usually presents a *per se* violation of competition law in most jurisdictions. However, conscious parallelism is treated in an entirely different way from a legal perspective and usually considered totally legal. Thus, in contrast to the economic terms, communication is absolutely central to the legal definition of collusion, which is usually limited to explicit agreements and concerted practices. Courts have interpreted this "communication" requirement to include, at least, a "unity of purpose or a common design and understanding"[14], in order to have a proper unlawful collusive agreement. Therefore, as Harrington points out, "there is a gap between antitrust practice which distinguishes [between] explicit and tacit collusion and economic theory which (generally) does not."[15]

1.2. Factors influencing the tendency to collude in an oligopoly

Literature[16] has identified various factors that could have an impact on the likelihood of tacit collusion in the market. One way or the other, all these factors have a bearing on the ease with which firms can establish the terms of coordination.

First, some basic structural variables of the market can affect the sustainability of collusion. In the first place, the number of competitors in the market is clearly an important factor: the fewer the undertakings, the easier it is to agree on the terms of collusion and to monitor adherence; on the opposite, when there are more competitors, the incentive to deviate will be greater, given that each company has more market share to gain[17]. Moreover, collusion is much more difficult to sustain if there are low barriers to entry. In fact, in deciding whether to coordinate or to deviate, firms usually make a trade-off between the short-term gains of deviating and the loss in future profits derived from rivals' retaliation against deviations: the prospect of future entry reduces the potential cost of deviation in terms of foregone

[14] *Monsanto Co. v. Spray-Rite Serv. Corp.*, 465 U.S. 752, 764 (1984).
[15] Joseph E. Harrington, "Detecting Cartels", in *Handbook of Antitrust Economics*, ed. Paolo Buccirossi, (MIT Press, 2008), 6.
[16] Marc Ivaldi, Bruno Jullien, Patrick Rey, Paul Seabright and Jean Tirole, "The Economics of Tacit Collusion", *Final Report for DG Competition, European Commission* (2003): 11-57.
[17] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 32.

future profits, since firms have less to lose from future retaliation if entry occurs anyway. The reduction of the scope for retaliation increases the possible profit of deviating and limits in turns the sustainability of collusion. Finally, market transparency and high frequency of interaction between companies in the market make it easier for the colluding firms to detect competitive behaviours and to react more quickly to a deviation by any participant from the collusive practice.

Second, characteristics concerning the demand side of the market must be taken into consideration. In principle, demand growth increases the value of future gains arisen from collusion and thereby the incentive to adhere to the terms of coordination. However, in practice, the prospect of future entry may increase in growing markets and, as pointed out above, this would reduce the incentive to collude[18].

Third, features about the supply side are relevant in influencing the scope for collusion. In particular, collusion on prices may be less easy to sustain when innovation drives the market: indeed, drastic innovation may allow one firm to gain a significant advantage over its rivals, reducing both the value of future collusion and the degree to which rival firms can retaliate against deviations. Furthermore, product differentiation makes tacit collusion more difficult. Indeed, when a firm tries to develop a better product in terms of quality (that is what economists refer to as "vertical product differentiation"), the company would have more to gain from cheating on a collusive path than low-quality firms. Moreover, the higher the disparities in terms of costs, the less likely it is that tacit collusion will take place: hence, cost asymmetries hinder collusion. The unlikeliness of collusion in the latter case is that firms may find it difficult to agree to a common pricing policy; besides, low-cost firms will be much more difficult to discipline, mainly because they would have less to fear from a possible retaliation from high-cost firms[19]. Different cost levels and differences in product characteristics may result in asymmetric market shares in a given industry: hence, lack of symmetry in market shares is usually indication that collusion is difficult to achieve. Finally, the existence of a dominant firm in the market acting as a price leader (the so called "ringmaster"[20]) can be

[18] Marc Ivaldi, Bruno Jullien, Patrick Rey, Paul Seabright and Jean Tirole, "The Economics of Tacit Collusion", *Final Report for DG Competition, European Commission* (2003): 26-28.
[19] Charles Mason, Owen R. Phillips and Clifford Nowell, "Duopoly Behaviour in Asymmetric Markets: An Experimental Evaluation", *The Review of Economics and Statistics* 74, n. 4 (1992): 665.
[20] The term "**ringmaster**" was originally employed by T. Krattenmaker and S. Salop (Thomas G. Krattenmaker and Steven C. Salop, "Anticompetitive Exclusion: Raising Rivals' Costs To Achieve Power over Price", *Yale Law Journal* 96, n. 2 (1986): 238).

materially important in maintaining price discipline in the collusive path, making coordination of prices easier to preserve.

Most of the factors listed above are usually common in oligopolistic markets. Oligopoly is the market structure in which there are a few suppliers, who realize or believe that their individual behaviour concerning output or price has a perceptible influence on the market outcome and may provoke a reaction of other competitors[21]. Few market players in the industry, high market transparency and frequency of interaction are the main features of the oligopoly model, thus creating a fertile ground for the existence of tacit collusion. Indeed, firms in an oligopoly are aware of the so-called "oligopolistic interdependence", which makes them bound to match on the rival undertakings' marketing strategy[22]. The following highly-stylized example will illustrate this point. A small town has very few gasoline stations. If we assume that entry cannot occur, no gasoline station has an incentive to cut prices below the monopoly level. As a matter of fact, each undertaking realizes that it cannot steal customers from its competitors before its competitors can respond and, therefore, that cutting price in the first instance would be pointless[23]. It is exactly this interdependence between undertakings that allows them to charge a price that boosts profits to a supra-competitive level and turns the market static without even entering into an explicit agreement[24]. Hence, through interdependence and mutual self-awareness, prices will rise towards the monopolistic level and tacit collusion may follow.

In today's world, oligopolies crowd most sectors of the economy, from the wholesale level to retail activities. However, real oligopolistic situations are much more complicated than the stylized model described by economists. It is therefore important to analyse the model specifications that best fit the actual market conditions. In particular, tacit collusion in an oligopolistic market could only arise under four cumulative conditions. First, oligopolists must face the coordination problem: market players have to share a common understanding of the price at which

[21] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 25.
[22] Richard Whish and David Bailey, *Competition Law*, Ninth edition (Oxford: Oxford University Press, 2018), 561.
[23] Andrew M. Rosenfield, Dennis W. Carlton and Robert H. Gertner, "Communication among Competitors: Game Theory and Antitrust Application of Game Theory to Antitrust", *George Mason Law Review* 5 (1997): 428.
[24] Jaime Eduardo Castro Maya, "The limitations on the punishability of tacit collusion in EU competition law", *Revista Derecho Competencia* 13, n. 13 (2017): 202.

collusion should unveil, otherwise they will keep raising prices at different levels, since there are many price equilibria above costs (C1)[25]. Second, there must be a credible threat of retaliation against deviating undertakings, to discourage any temptation to divert (C2)[26]. The third condition requires enforcement: oligopolists must be able to monitor each other's price and to detect any significant competitive deviation from the agreed-upon price (C3)[27]. Fourth, tacit collusion in an oligopolistic market is conditioned on the firms' ability to discourage production and entry by external firms (C4)[28].

The so-called facilitating practices usually play an important role in helping to meet the four conditions. Such devices, which do not constitute explicit cartel agreements, have the effect of promoting coordination of price or conduct between companies in the oligopoly through the exchange of information. Information exchange as such is the most common one, but a wide range of other practices are described in the literature: price leadership, collaborative research, cross-licensing of patents and meeting-competition (MC) clauses in sales contracts may all be used to strengthen the factors that support tacit collusion[29]. In particular, this is done by limiting the gains of competing, hence discouraging deviations, and facilitating the possibility to monitor and detect each other's behaviour.

All things considered, when the requirements are fulfilled and many of the factors previously highlighted are observed, the oligopoly works, in terms of effect, as if undertakings had colluded; however, in terms of forms, there is ordinarily no explicit collusion on the market.

1.3. Game theory and the prisoner's dilemma

In the 1950s the rise of game theory[30] opened new perspectives for research on oligopolies, in order to explain the collusive conduct of the market players. Game

[25] Dennis Yao and Susan DeSanti, "Game Theory and the Legal Analysis of Tacit Collusion", *Antitrust Bulletin* 38, n. 1 (1993): 113.
[26] D. K. Osborne, "Cartel Problems", *The American Economic Review* 66, n. 5 (1976): 838.
[27] George J. Stigler, "A Theory of Oligopoly", *The Journal of Political Economy* 72, n. 1 (1964): 46.
[28] D. K. Osborne, "Cartel Problems", *The American Economic Review* 66, n. 5 (1976): 843.
[29] Ray Rees, "Tacit Collusion", *Oxford Review of Economic Policy* 9, n. 2 (1993): 35-37; Organisation for Economic Co-operation and Development, Competition Committee, *Roundtable on Facilitating Practices in Oligopolies*, 2007.
[30] The birth of **game theory** is usually associated with the publication in 1944 of the book *Theory of Games and Economic Behavior* by the mathematician John von Neumann and the economist Oskar

theory is the "study of the ways in which interacting choices of economic agents produce outcomes with respect to the preferences (or utilities) of those agents, where the outcomes in question might have been intended by none of the agents"[31]. It has been traditionally divided into two branches: non-cooperative and cooperative. Cooperative game theory deals with situations where there are institutions that make agreements binding among the players. Non-cooperative game theory, on the other hand, deals with settings where communication is impossible and agreements are illegal [32]. Firms in an oligopoly act in a non-cooperative way: competitors choose the proper strategy according to their rivals' actions without communicating with each other. An equilibrium will therefore only exist when the decisions of companies lead to a set of strategies in which each strategy is the best response to competitors' behaviours and, given the action of its rivals, "a firm cannot increase its own profit by choosing an action other that its equilibrium action"[33]. In game theory, this is named "Nash equilibrium"[34].

Within the non-cooperative game setting, the prisoner's dilemma[35] provides the most insights into the difficulties and possibilities of tacit collusion. Albert Tucker presented the problem for the first time in 1951 in the form of a short detective story. A murder is perpetrated and two suspects (A and B) are arrested and locked in separate cells. The police need them to confess. To this end, each suspect is offered three possibilities and they have to choose without knowing the intention of the other: (1) if both testify against one another, both will be jailed for five years; (2) if only one testifies against the other, he will be freed while the non-confessor will be jailed for ten years; or (3) if neither testifies, both will get a sentence of one year only for illegal possession of firearms[36].

The structure of the game is presented in **Figure 1**, commonly referred to as the pay-off matrix: it illustrates all the possible outcomes or pay-offs for the two suspects A

Morgenstern. Applications of game theory can be found in many fields, most notably biology, computer science, military science, political science, sociology and, as in the case at stake, economics.

[31] Don Ross, "Game Theory", *The Stanford Encyclopedia of Philosophy* (Spring 2019): 1.

[32] Giacomo Bonanno, "Non-Cooperative Game Theory", *The SAGE Handbook of the Philosophy of Social Science* (2008): 2.

[33] Jean Tirole, *The Theory of Industrial Organization* (MIT Press: 1988), 206.

[34] **Nash equilibrium** is a game theory concept that determines the optimal solution in a non-cooperative game in which each player lacks any incentive to change his/her initial strategy. It was discovered by the American mathematician and Nobel Prize in Economics John Nash.

[35] The **prisoner's dilemma game** was originally framed by Merrill Flood and Melvin Dresher, working at RAND Corporation in 1950. The title "prisoner's dilemma" and the original version are due to Albert W. Tucker, who in 1951 wrote the first paper about it.

[36] Làszlò Mèrö, "The Prisoner's Dilemma", in *Moral Calculations* (New York: Springer, 1998): 29.

and B. The first number in each cell of the matrix provides A's jail sentence in years, the second provides B's sentence. Years of imprisonment must be considered a negative gain.

		SUSPECT B	
		testify	does not testify
SUSPECT A	testify	**-5**, -5	**0**, -10
	does not testify	**-10**, 0	**-1**, -1

Figure 1 – The prisoner's dilemma game

It is clear that the rational strategy for both suspects is to testify, in other words to betray the other player. Regardless of what the opponent chooses, each player receives a better pay-off (that is lesser sentence) by testifying. If B does not testify, it is better for A to testify (because he will be free); if B testifies, it is also better for A to testify (because he will be jailed for five years instead of ten). In the terms of game theory, to testify is the dominant strategy for each player (i.e. the optimal strategy regardless of what the opponent does), even though the resulting outcome is not Pareto-optimal[37], since to not testify would have led to a better collective outcome (**-1**; -1)[38]. The result is that both suspects, ending up testifying against one another, go to jail for five years: hence, this is an example of non zero sum game[39].

This form of the game can easily be applied to the study of undertakings in an oligopolistic market. Instead of deciding on the opportunity to testify or not to testify, undertakings' decisions in an oligopoly are respectively whether to defect (i.e. to compete) or to cooperate (i.e. to collude). Assuming that the companies on the market are only two, the pay-off matrix would then have the structure represented in **Figure 2**, which symbolically depicts the firms' profits in millions of euro, instead of negative years of imprisonment. Similarly to the standard prisoner's dilemma, the reward for two firms cooperating with each other (**3**; 3) is higher than the reward

[37] A strategy is **Pareto-optimal** (or Pareto-efficient) if there is no alternative state that would make some people better off without making anyone worse off. The concept was named after the Italian socioligist Vilfredo Pareto, who introduced it in 1896.

[38] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 29.

[39] A **non zero sum game** is a situation where one decision maker's gain (or loss) does not necessarily result in the other decision maker's loss (or gain). Hence, the winnings and losses of all players do not add up to zero and everyone can gain.

derived from both players' defection (**2**; 2). Moreover, if one firm cooperates while the other undertaking is deviating and fixing a lower price, the colluding player will earn 1 whereas the competing one will gain 4.

		FIRM B	
		defects	cooperates
FIRM A	defects	**2**, 2	**4**, 1
	cooperates	**1**, 4	**3**, 3

Figure 2 – The prisoner's dilemma applied to a duopoly

The transposition of the model to oligopolies suggests that independent firms will choose to compete, rather than collude[40]. Indeed, the dominant strategy for both company is to defect, in other words to compete. As a result, the two firms will not cooperate and end up with the equilibrium of (**2**, 2) with the lower collective profit (that is the Nash equilibrium of the prisoner's dilemma game). Such aggressive strategy, applied to prices, usually lead to the downward movement of prices, or price wars, that are beneficial for consumers, disregarding the opponent's interests.

However, competition policy practice shows that a collusive outcome seems to be the dominant or chosen strategy in a not insignificant number of oligopolies. The first factor that makes collusion more likely is that oligopolists usually interact with each other for a huge amount of times in the marketplace: hence, the game is not "one shot", since it is played more than once. Intuitively, this means that competitive behaviour may spoil future profits that could possibly be attained by collusion. In particular, in a prisoner's dilemma setting that is played for an infinite and random number of rounds[41], the incentive to compete will be weighed by each player against the possible punishment the other player may inflict on him in the future as a result of the refusal to cooperate. On the other hand, when the game is iterated a limited number of times and both the players know, it will be always optimal to defect in all rounds. Indeed, both will defect on the last turn, since the opponent will not have a chance to punish the player in the future. Thus, the player might as well defect on the second-to-last turn, since the opponent will defect on the last, and so on.

[40] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 6.
[41] An infinitely repeated single-period game is called **supergame**.

Nevertheless, real players in an oligopoly usually have imperfect information and may not know exactly the number of times the game will be played, making it rational to cooperate. In concrete, the long-term profits achieved with collusion will exceed the short-term profits achieved by competing[42].
The second factor that makes a collusive outcome more likely is that companies may behave more as if they are in a cooperative game setting. Being in theory communication impossible, players find difficult to rely on the opponents, thus preferring an aggressive and competitive strategy over a collusive one[43]. Considering their recurrent interactions, however, oligopolists can in practice subtly communicate, for instance by sending each other signals to cooperate on future prices or output. This type of communication is sometimes described as "cheap talk"[44], as it does not involve binding commitments. Hence, communication may be essential to prevent companies from starting to compete, which would be the rational outcome in a non-cooperative game, and may make collusion and cooperation easier to achieve[45].

In particular, facilitating practices and devices commonly improve cooperation in the oligopoly, allowing communication and exchange of information between the market players. In terms of the prisoner's dilemma, such practices may reduce the pay-offs/profits that can be obtained from competing while the other player is colluding. In extreme cases, the pay-off matrix may change so much that it is no longer a prisoner's dilemma type of game, where the profits gained through cooperation are always the highest ones, irrespective of what the opponent is doing. An example of this extreme case is given by the pay-off matrix represented in **Figure 3**: here, competing is no longer an attractive option and collusion appears to be the dominant and Pareto-optimal strategy (**4**; 4).

[42] Kyle Bagwell and Asher Wolinsky, "Game Theory and Industrial Organization", *Columbia University Department of Economics, Discussion Paper Series* #:0102-36 (2002): 24.
[43] Václav Šmejkal, "Cartels by robots – current antitrust law in search of an answer", *Intereulaweast* 4, n. 2 (2017): 4.
[44] In game theory, **cheap talk** is communication between players that does not directly affect the payoffs of the game.
[45] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 30-31.

		FIRM B	
		defects	cooperates
FIRM A	defects	**1,** 1	**2**, 3
	cooperates	**3,** 2	**4**, 4

Figure 3 – A non-cooperative game with cooperation as the dominant strategy

In conclusion, to start colluding in an oligopolistic market will itself require overcoming the generalized prisoner's dilemma (shown in **Figure 2**), by implementing communications, facilitating practices, monitoring the other market participants' conduct and iterating the game much more than once.

1.4. The "oligopoly problem" in literature

As stated before, the main argument against the oligopoly is that the characteristics of the market in which oligopolists operate are such that they will not compete with one another on price and they will be able to earn supra-competitive profits without entering into an explicit agreement or concerted practice prohibited by competition law. Cooperative pricing is thus a logical outcome of the "game" without any secret meetings or additional communication[46]. Hence, the term "oligopoly problem"[47] was created in an effort to name the effects on the market that the oligopolistic interdependence creates. Moreover, two subsets of problems – a process problem and a remedial problem – can be distinguished by, respectively, economists and lawyers.

According to economists, the "oligopoly problem" relates to the way in which prices are formed and at what level prices and quantities are set in oligopolies[48]. The issue takes its source in the deficiencies of neo-classical economic theory: indeed, the dual model of monopoly and perfect competition is not able to answer the question properly.

[46] Andrew M. Rosenfield, Dennis W. Carlton and Robert H. Gertner, "Communication among Competitors: Game Theory and Antitrust Application of Game Theory to Antitrust", *George Mason Law Review* 5 (1997): 428.
[47] The expression "**oligopoly problem**" was used for the first time in Richard Posner, "Oligopoly and the Antitrust Laws: A Suggested Approach", *Stanford Law Review* 21 (1969): 1563.
[48] Xavier Vives, *Oligopoly Pricing: Old Ideas and New Tools* (The MIT Press, 2001).

In the late 19th and early 20th century, scholars made a first attempt at filling the oligopolistic problem in economic theory, designing stylized models. In 1883, Antoine Augustin Cournot processed a first model of quantity competition in the oligopoly. Assuming the other undertakings' output will remain unchanged, each company chooses in the equilibrium a level of output that is profit-maximizing in view of what the other market players produces. This features an equilibrium market price below the monopoly level but well above the marginal cost[49]. In 1883, Joseph Bertrand reached a distinct result. Assuming that other prices in the market will remain unchanged, the equilibrium of the Bertrand model leads to a market price equal to marginal cost in the case of homogeneous product and a price that is higher in the case of differentiated products[50]. In 1925, Francis Edgeworth invalidated both models, showing that oligopoly prices were essentially indeterminate , oscillating between small and high levels (the so-called "Edgeworth cycles")[51].

Remote from the reality of daily markets, none of those models was of any help for the purpose of answering the oligopoly problem. However, those models enshrined a key finding: rival oligopolists must take account of each other's best reactions when taking commercial decisions[52]. This "oligopolistic interdependence" steered the subsequent economic research of Edward Chamberlin. In 1929, he found that the interaction of two independent sellers may give rise to a complete absence of price competition, without any actual or tacit agreement. Chamberlin's own words are self-explanatory: "the prices of all move together, and from this it follows at once that the equilibrium price will be the monopoly one"[53]. Hence, if oligopolists consider the effects of their policy upon rivals (the so-called "total influence"), conscious parallelism arises. Furthermore, its outcome is to drive prices up to the level of "monopolistic agreement"[54] between them. Despite many elements of uncertainty, his demonstration was endorsed in 1950s by non-cooperative game theory (widely illustrated in Paragraph 1.3.).

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[49] Antoine Augustine Cournot, *Recherches sur les principes mathématiques de la théorie des richesses* (Paris: L. Hachette, 1838).
[50] Joseph Bertrand, "Théorie des richesses: revue de 'Théories mathématiques de la richesse sociale' de L. Walras and 'Recherches sur les principes mathématiques de la théorie des richesses' de A. Cournot", *Journal des Savants* (1883).
[51] Francis Y. Edgeworth, "The Pure Theory of Monopoly", in *Papers relating to political economy*, Volume I (New York: Burt Franklin, 1925), 111-142.
[52] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 3-4.
[53] Edward H. Chamberlin, "Duopoly: Value Where Sellers Are Few", *Quarterly Journal of Economics* 44 (1929): 89.
[54] *Ibid*., 85.

On the other side, from a legal perspective, the oligopoly problem is perceived primarily as a remedial issue. Indeed, there is an area of consciously parallel behaviour in pricing strategies which is beyond the reach of competition law and yet which harms both competitors and consumers. Hence, what rules and remedies are necessary to prevent supra-competitive prices in oligopolistic markets[55]? What solutions might be appropriate to address the failure? The Harvard and Chicago schools in the United States have tried to give a proper answer, based on two different economic theories.

On one hand, the Harvard School, since its emergence in 1960s, began to gather a huge amount of empirical data, founding a link between oligopolistic market concentration and supra-competitive profits (the so-called "SCP model"[56]). In their view, oligopolies achieve supra-competitive profits just because they enjoy an unreasonable degree of market power. Therefore, recognizing previous Chamberlin's theory of oligopolistic interdependence, Harvard scholars likened oligopolies to monopolies, as evidenced by a propagation of expressions such as "shared monopoly" or "group monopoly power"[57].

Embracing the view of the Harvard School, Donald Turner tried to apply the structural approach of the Harvard economists to the antitrust debate. In an article written in 1962, he argued that oligopolists who achieve a monopoly price "without more in the way of 'agreement' than is found in 'conscious parallelism', should not be held unlawful conspirators under the Sherman Act"[58]. Therefore, Section 1 of the Sherman Act[59], which prohibits "every contract, combination in form of trust or otherwise, or conspiracy, in restraint of trade", is not an appropriate and effective weapon to use against non-competitive pricing in oligopolistic industries. In Turner's view, although tacit collusion could in theory be viewed as a type of "agreement", the agreement cannot properly be called unlawful. Indeed, "the rational oligopolist is behaving in exactly the same way as is the rational seller in a competitively structured industry; he is simply taking another factor into account [the reactions of

[55] Richard Posner, "Oligopoly and the Antitrust Laws: A Suggested Approach", *Stanford Law Review* 21 (1969): 1562.
[56] The **Structure-Conduct-Performance model (SCP)** states that performance is determined by firms' conduct, which is in turn determined by the market structure.
[57] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 5.
[58] Donald Turner, "The Definition of Agreement Under the Sherman Act: Conscious Parallelism and Refusals To Deal", *Harvard Law Review* 75 (1962): 671.
[59] Sherman Act, 15 U.S.C. § 1 (1964).

his rivals to any price cut] which he has to take into account because the situation in which he finds himself puts it there."[60]. Nevertheless, Turner left open the possibility of using Section 2 of the Sherman Act[61], which forbids monopolization, or a strong antimerger policy, to dissolute or prevent new and old oligopolies[62].

On the other hand, the Chicago School challenged the Harvard school view that tacit collusion is a matter of market structure. In their view, oligopolistic markets often yield efficiencies: hence, the explanation for achieving supra-competitive profits is due to a superior efficiency. Scholars like George Stigler demonstrated that collusion needs more than the mere concentration of market power: for tacit collusion to occur, oligopolists would have to detect and monitor the adherence to a pre-defined collusive agreement[63]. Differently, Richard Posner expressed faith in the existence of pure tacit collusion, elaborating a checklist of factors necessary for it to be found (such as market concentration, barriers to entry, cost similarity etc.)[64]. However, all Chicago scholars understood tacit collusion as the convergence of several factors, while the Harvard school concluded that tacit collusion emerges by the sole existence of the conditions of an oligopolistic market.

In the light of a legal analysis reflecting Chicago School's economic theory, Richard Posner explicitly expressed his disagreement with Turner's approach in the article *Oligopoly and the Antitrust Laws: A Suggested Approach* of 1969, thus giving rise to the so-called "Turner-Posner debate" over the problem of oligopoly. In particular, Posner considered inadequate the theory of oligopolistic interdependence. Absent agreement, firms, even in an oligopolistic market, will act as rivals and set prices at a competitive level. Hence, he stated that the relationship between the level of concentration in a market and the probability that pricing will be non-competitive can be elucidated in terms of the theory of cartels and not in terms of interdependence[65]. From this premise, Posner argued that "voluntary actions by the sellers are necessary to translate the bare condition of an oligopoly market into a situation of noncompetitive pricing"[66]. In his view, an oligopolistic market cannot

[60] Donald Turner, "The Definition of Agreement Under the Sherman Act: Conscious Parallelism and Refusals To Deal", *Harvard Law Review* 75 (1962): 665-666.
[61] Sherman Act, 15 U.S.C. § 2 (1964).
[62] Donald Turner, "The Scope of Antitrust and Other Economic Regulatory Policies", Harvard *Law Review* 82 (1969): 1232.
[63] George J. Stigler, "A Theory of Oligopoly", *The Journal of Political Economy* 72, n. 1 (1964): 44.
[64] Richard Posner, "Oligopoly and the Antitrust Laws: A Suggested Approach", *Stanford Law Review* 21 (1969): 1575.
[65] *Ibid*., 1569.
[66] *Ibid*., 1575.

lead by itself to collusive pricing; on the opposite, an explicit intervention of the undertakings would be necessary. In particular, proper collusion requires some system of monitoring and enforcement promoted by the oligopolists, especially if there is no concrete agreement[67]. Differently from Turner's view, such voluntary action, whether in the form of express or tacit collusion, constitutes concerted action and thus falls within the ambit of Section 1 of the Sherman Act[68]. Indeed, even in tacit collusion, there is a "meeting of the minds" between firms: the undertaking restricting output is making an "offer" and the "acceptance" is materialized when its rivals adopt the same conduct. Neverthless, in Posner's view, tacit agreements should be condemned only when their effect is to limit output and raise prices above the competitive level.

Posner's approach gave rise to two main problems. Firstly, proving tacit collusion to the degree of certainty required by courts without any proof of acts of agreement or enforcement is extremely difficult[69]; secondly, once the agreement has been proved, a question arises as to how to eliminate the antitrust violation[70]. As to the first issue regarding the demostration of collusion, Posner proposed a two-step approach: first, economic evidence should be examined to identify markets propitious for the emergence of collusion; second, market evidence should be studied to determine whether collusion exists for real. With regard to the problem of remedy, Posner considered the classic punitive and remedial sanctions. In extreme cases, however, dissolution of the leading firms in oligopolies would be the appropriate remedy. Dissolution consists in dissolving an allegedely illegal combination or association of undertakings, which has given rise to the oligopolistic concentration of market power. Even though dissolution is addressed more to the market structure than to the behaviour itself, repetition of tacit collusion is, in Posner's opinion, difficult to prevent by other classic remedies, since the phenomenon is strictly related to the oligopolistic market structure; moreover, the possibility of dissolution should provide an effective deterrent to recidivous non-competitive pricing.

In conclusion, Posner and Turner addressed tacit collusion and the oligopoly problem from two completely opposite perspectives. Nevertheless, they shared some main

[67] Keith Hylton, "Oligopoly Pricing and Richard Posner", *Boston University School of Law, Law and Economics Research Paper* n. 18-10 (2018): 7.
[68] Michael K. Vaska, "Conscious Parallelism and Price Fixing: Defining the Boundary", *University of Chicago Law Review* 52, n. 2 (1985): 514.
[69] Richard Posner, "Oligopoly and the Antitrust Laws: A Suggested Approach", *Stanford Law Review* 21 (1969): 1578-1587.
[70] *Ibid*., 1588-1593.

focal points. In the first place, Section 1 (and competition policy in general) should be more concerned with the effects of parallel conduct than with proving traditional agreements. Furthermore, both believe that it is necessary to examine the market in which parallel conducts occur[71]. As I will illustrate in Paragraph 2, the Posner-Turner view will be taken as a starting point in the approach of the European Union Commission and Court of Justice, searching for remedies for tacit collusion in oligopolistic markets.

2. Tacit collusion under EU competition law

The wording of both the US Sherman Act and the EU Treaty on the Functioning of the European Union[72] reflects the simplistic state of competition economics until the 1950s, before the Turner-Posner debate: the main competition statutes say nothing about oligopoly or tacit collusion.

In the 1960s the "oligopoly gap" in statutory competition rules was uncovered, becoming a real challange for practitioners. In this context, a string of basic principles derived from economics seemed sufficiently consensual to serve as bottom-lines for policy makers searching for remedial action against tacit collusion. The fact that tacit collusion, even if usually infrequent, generates large welfare loss and adverse effects on consumers, like explicit collusion, enphasized the need for remedial intervention. Although tacit collusion involves rational conduct, this was not considered as a cause of exoneration under the competition rules. Stigler underlined, additionally, that "with oligopoly, virtually everytihing is possible"[73]. Given its little predictive accuracy and its variety of causes, a simplistic conventional approach over collusive dynamics might thus not be satisfactory; for this reason, the importance of market definition began to drive the competition law research[74].

Keeping this in mind, European practitioners turned to the existing toolbox in order to find remedies for tacit collusion. In particular, *ex ante* merger control rules and *ex*

[71] Michael K. Vaska, "Conscious Parallelism and Price Fixing: Defining the Boundary", *University of Chicago Law Review* 52, n. 2 (1985): 517.
[72] Consolidated Version of the Treaty on the Functioning of the European Union, 2008 OJ C 115/47 [hereinafter TFEU].
[73] George J. Stigler, "A Theory of Oligopoly", *The Journal of Political Economy* 72, n. 1 (1964): 44.
[74] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 12-25.

post approaches of Article 101 and 102 TFEU have been investigated as potential solutions.

2.1. *Ex ante* intervention: tacit collusion as "coordinated effects"

The preferred legal tool deployed by the Commission to address the oligopoly problem is the European Union Merger Regulation (EUMR)[75]. Instead of *ex post* analysing the past history of the undertakings, a control by the merger office evaluates *ex ante* the future evolution of the industry, in order to determine whether the merger will create a situation where collusion becomes more likely. As a matter of fact, a merger often affects many of the factors that are relevant for the sustainability of collusion. By eliminating a competitor, a merger reduces the number of partecipants in the market and thereby tends to facilitate collusion. Moreover, mergers which are inclined to restore cost or product symmetries between undertakings may make collusion more sustainable. Entry barriers, frequency of interaction and market transparency, additionally, could all be raised by a merger, thus influencing positively the tendency to collude[76]. This is true for both horizontal mergers (mergers between competitors) and vertical and conglomerate mergers (mergers between non-competitors).

Pursuant to Article 2(3) of the EUMR, the Commission can declare incompatible with the common market any "concentration which would significantly impede effective competition[77], in the common market or in a substantial part of it, in particular as a result of the creation or strengthening of a dominant position"[78]. According to the Guidelines on Horizontal Mergers[79], "a merger in a concentrated market may significantly impede effective competition […] because it increases the likelihood that firms are able to coordinate their behaviour in this way and raise

[75] Council Regulation (EC) n. 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EU Merger Regulation), OJ L 24, 29 January 2004 [hereinafter EUMR].
[76] Marc Ivaldi, Bruno Jullien, Patrick Rey, Paul Seabright and Jean Tirole, "The Economics of Tacit Collusion", *Final Report for DG Competition, European Commission* (2003): 63-70.
[77] The concept of "**significant impediment to effective competition**" ("SIEC") has supplemented in 2004 the concept of "dominance", that was central in the first version of the EUMR (Council Regulation n. 4064/89 of 21 December 1989 on the control of concentrations between undertakings, OJ L 395, 30 December 1989).
[78] Article 2(3) of Council Regulation (EC) n. 139/2004 of 20 January 2004 on the control of concentrations between undertakings.
[79] Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings, OJ C 31, 5 February 2004 [hereinafter Guidelines on Horizontal Mergers].

prices, even without entering into an agreement or resorting to a concerted practice within the meaning of Article 81 of the Treaty"[80] (i.e. today Article 101 of TFEU). Hence, horizontal mergers may give rise to anti-competitive "coordinated effects" between firms, which include parallel pricing conducts arising from tacit collusion in higly-concentrated oligopolistic markets. In the terms of the EUMR, however, coordination may take various forms, from keeping prices above the competitive level to limiting production or dividing the market[81].

In order to detect horizontal competition concerns producing coordinated effects, the factor taken as a starting point for competition policy analysis is the number of firms, their market shares and the resulting market concentration. In the Guidelines on Horizontal Mergers, the Commission has formulated negative presumptions using the Herfindahl-Hirschman Index (HHI)[82]. It is stated that it is unlikely to identify horizontal competition concerns in a market with a post-merger HHI below 1000 (hence, a market with at least ten competitors). In a market with a post-merger HHI between 1000 and 2000 (thus, where there will be at least five competitors) competition issues are unlikely if the HHI increase resulting from the merger remains below 250 and in a market with a post-merger HHI above 2000 where the HHI increase remains below 150, except where special circumstances are present[83].
When the HHI is above these thresholds, other factors and conditions that may make collusion easier should be evaluated. Before 2002, the Commission embraced the checklist approach: it verified the existence of a range of positive factors in a proportion superior to negative factors, to reach a proof of collective dominance determined by the merger. Building on the *Airtours* judgment[84], the Guidelines on Horizontal Mergers introduced a demanding test that goes beyond the checklist approach. According to this test, the Commission must verify the existence of four cumulative conditions, necessary for coordination and collective dominance to be sustainable. These are the four conditions C1, C2, C3 and C4, outlined above at Paragraph 1.2. and imported at §41 of the Guidelines: a common understanding on the terms of coordination, detection, punishment and inability of external firms and potential competitors to undermine tacit collusion.[85] Therefore, the Commission

[80] Guidelines on Horizontal Mergers, §39.
[81] Guidelines on Horizontal Mergers, §40.
[82] The **Herfindahl-Hirschman Index (HHI)** is a measure of concentration defined as the sum of the squared market shares of all the firms in the market. The HHI ranges from close to zero (in an atomistic market) to 10000 (in a pure monopoly).
[83] Guidelines on Horizontal Mergers, §19-20.
[84] Case T-342/99, *Airtours plc. v. Commission*, 6 June 2002, ECR [2002], §§60-62.
[85] Guidelines on Horizontal Mergers, §41.

cannot refer anymore to an abstract risk of coordination; on the contrary, it has to take into account the concrete scenarios and the market characteristics. However, the new standard determines an heavy burden of proof: given the cumulative nature of the conditions, if one (or more) minus factors undermine one (or more) of the four conditions, a finding coordinated effects cannot be reached, as illustrated by the formula below:

Coordinated effects scenario [C1 (+ and – factors) + C2 (+ and – factors) + C3 (+ and – factors) + C4 (+ and – factors)][86]

In this context, EU competition policy practice has been cautious and has challenged mergers on the basis of coordinated effects mainly in cases where there are only two or three undertakings on the market[87]. As a result, a marginalization of coordinated effects analysis in merger enforcement can be observed. Since 1989, indeed, the Commission has prohibited concentrations on grounds of coordinated effects concerns in just 38 decisions out of 270 merger decisions[88]. Nevertheless, the number of merger decisions addressing tacit collusion as coordinated effects widely overcomes the cases applying Article 101 or 102 to collusive oligopolies. The EU "merger control-only" policy enjoys a *de facto* jurisdictional monopoly over tacit collusion issues due to two widespread beliefs. First, the EUMR constitutes a preventive remedy against structural market changes likely to create situations of collusion and this preventive approach is perceived as superior to a a corrective one, since it is "always better to put care before cure"[89]. Second, the merger policy could bring a structural solution to tacit collusion, since it addresses excessive market concentration, which constitutes the main cause of collusion. In the view of the Court, structural commitments are preferable, as "they prevent once and for all […] the emergence or strengthening of the dominant position […] and do not, moreover, require medium or long-term monitoring measures"[90].

[86] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 46-47.
[87] See for instance the following merger cases: Case IV/M190 *Nestlé/Perrier*, OJ 1992 L356/1; Case COMP/M3099 *Areva/Urenco/ETCJV*, OJ 2006 L61/11; Case COMP/M.4980 *ABF/GBI Business*, OJ 2009 C145/09.
[88] Nicolas Petit, "Remedies for Coordinated Effects under the EU Merger Regulation", *Competition Law International* 6, n. 2 (September 2010): 2-5.
[89] G. Drauz, "Collective Dominance/Oligopoly Behaviour under Articles 81/82 and the EC Merger Regulation", in B. Hawk (ed.) (Fordham Corporate Law Institute, 2002), 380.
[90] Case T-102/96 *Gencor Ltd. v Commission*, 25 March 1999, ECR [1999] II-753, §319.

2.2. *Ex post* intervention: tacit collusion as a cartel

Despite a substantial exclusive jurisdiction of the EUMR over tacit collusion, an alternative approach might be to regard the collusive conduct as a behavioural problem, which would require an *ex post* case-by-case control. The corrective and punitive instruments enshrined in Articles 101 (prohibiting cartels) and 102 TFEU (voiding abuses of dominant position) could in principle regulate this area of concerns. In order to uphold the hypothesis, three main arguments may be adduced. First, tacit collusion does not only appear as a result of mergers, acquisitions of control and joint ventures, which the EUMR can regulate[91]; rather, it may equally arise as a corollary of other business practices[92], which are covered by the enforcement policy of Articles 101 and 102. Second, since many market characteristics may either facilitate or undermine tacit collusion, it is almost impossible for competition authorities to *ex ante* predict the emergence of collective dominance and "coordinated effects". Hence, *ex post* evidences should be taken into account through Articles 101 and 102. Lastly, the articles under consideration do not aim to punish the natural pricing parallelism in an oligopoly, as usually perceived; on the contrary, their very rationale would be to eliminate only market failures arising from the rational behaviour of market players[93].

Article 101 TFEU, in particular, enshrines a potentially attractive remedy against tacit collusion. Indeed, it outlaws a range of anticompetitive coordinations, which are "agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the common market"[94]. In addition, its primary purpose is to combat collusion, and, as seen at Paragraph 1.1., there is little difference between tacit and explicit collusion, except for a matter of proof[95]. Tacit collusion, however, requires that firms start to act in parallel without express communication. Since for an agreement or decision to exist it is necessary for the undertakings to display "their joint intention

[91] See Article 1 and Article 3 of Council Regulation (EC) n. 139/2004 of 20 January 2004 on the control of concentrations between undertakings.
[92] This is the case of internal growth strategies, "meet and release" clauses, "most favoured customer" clauses, minority shareholdings, interlocking directorates, basic point pricing system and many other facilitating meausures.
[93] Nicolas Petit and David Henry, "Why the EU Merger Regulation Should Not Enjoy a Monopoly Over Tacit Collusion" (2010): 183-190.
[94] Article 101(1) of Treaty on the Functioning of the European Union (TFEU).
[95] Richard Posner, "Oligopoly and the Antitrust Laws: A Suggested Approach", *Stanford Law Review* 21 (1969): 1578.

to conduct themselves on the market in a specific way"[96], faithfully expressed by an implicit or explicit manifestation of a "concurrence of wills"[97], the European Court of Justice has identified tacit collusion as possibly being prohibited under Article 101 as a concerted practice.

2.2.1. Tacit collusion as a concerted practice and the oligopoly defense

A concerted practice is a form of coordination where undertakings, without concluding any sort of agreement or establishing a plan of action, "knowingly substitute practical cooperation between them for the risks of competition"[98]. The category of concerted practices can be applied to anti-competitive collusion in the absence of a formal agreement. However, direct or indirect contact between undertakings, some meeting of minds between the parties to cooperate and a relationship of cause and effect between the practice and the subsequent conduct on the market usually have to be identified, among other factors, to prove a concerted practice occurred[99].

The fact that tacit collusion has often been referred to as a concerted practice in the case-law does not necessarily mean that all oligopolistic parallel behaviours would result in an unlawful concerted practice[100]. Since distinguishing between illegal conducts and rational lawful strategies in oligopolies could be challenging, the application of Article 101 has appeared extremely troublesome; thereby, the European Court of Justice has, since the 1960s, gradually shut out any possibility to apply it directly to tacit collusion.

The first relevant case in this context is *Dyestuffs*[101]. In 1969, the Commission fined ten producers of dyestuffs, considered guilty of three general and uniform price increases through unlawful concerted practices, since evidence that the firms met on

[96] Case T-7/89 *SA Hercules Chemicals v Commission*, 17 December 1991, ECR [1991] II-1711, §2.
[97] Case T-41/96 *Bayer AG v Commission*, 26 October 2000, ECR [2000] II-3383, §69.
[98] Case C-8/08 *T-Mobile Netherlands and Others v Raad van bestuur van de Nederlandse Mededingingsautoriteit*, 4 June 2009, ECR [2009] I-4529, §26.
[99] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 218-220.
[100] George O'Malley, "Tacit Collusion: An Analysis of the EU Legislative Framework", *The Student Journal of European Law* I (2014): 5.
[101] Case 54/69, *SA française des matières colorantes (Francolor) v Commission*, 14 July 1972, ECR [1972] 851 [hereinafter *Dyestuffs*].

several occasion had been found[102]. On appeal, the applicants invoked the so-called "oligopoly defense": they argued that the Commission had erroneously conflated the notion of concerted practice with "conscious parallelism of members of an oligopoly, whereas such conduct is due to independent decisions adopted by each undertaking, determined by objective business needs"[103]. Implicit in the applicants' argument was the idea that a parallel behaviour in an oligopolistic market constitutes a natural market phenomenon. However, the Court of Justice upheld the Commission's decision, finding the evidence of explicit collusion to be conclusive. Nevertheless, in an unclear statement, it stated that parallel behaviour may be identified with a concerted practice only if it leads to conditions of competition which do not correspond to the normal conditions of the market[104]. Moreover, the Court recognised that price competition in oligopolies may be muted and that oligopolists in normal conditions react to one and other conduct, thereby recognizing on one hand the applicant's argument as a matter of principle but leaving the oligopoly defense wholly ineffective on the other.

This was confirmed by the Court of Justice in *Zuchner v Bayerische Vereinsbank AG*, which reapeted that intelligent responses to a competitor's behaviour would not bring firms within the scope of Article 101(1)[105]. However, in the Commission's view in *Peroxygen Products*, an agreement between oligopolists does not fall outside Article 101, since the very fact that firms had entered into an agreement indicates that pure competition between rivals might have led to a different market behaviour[106].

But it is the *Woodpulp* case that marked the culmination of the case-law on the oligopoly defense. In 1985 the Commission held that fourty producers of wood pulp and three of their trade associations were guilty of a concerted practice to announce future prices and to charge similar prices to customers. Absent evidence of explicit agreements, the Commission based its findings demonstrating *a contrario* that the conduct could not be regarded as lawful oligopolistic parallel pricing, as the wood

[102] Commission Decision 69/243/CEE of 24 July 1969 (IV/26.267 - *Matières colorantes*), OJ [1969] L 195/11.
[103] Case 54/69, *SA française des matières colorantes (Francolor) v Commission*, ECR [1972] 851, §39-45.
[104] *Ibid*., §53.
[105] Case 172/80, *Zuchner v Bayerische Vereinsbank AG*, 14 July 1981, ECR [1981] 2021, §14.
[106] Commission Decision 85/74/EEC of 23 November 1984 (IV/30.907 - *Peroxygen products*), OJ [1985] L 35/1, §50.

pulp market was not a narrow oligopoly[107]. On appeal, the Court of Justice substantially annulled the Commission's decision[108]. First, in the opinion of the Court, the fact that producers announced price rises to users in advance did not eliminate the producers' uncertainty as to what each other would do, hence this did not in itself cause an infringement of Article 101. Moreover, the simultaneity of price announcements could be explained by the high degree of market transparency. Lastly, the Court found that the pulp sector was more oligopolistic than the Commission had supposed, since it was in reality composed of a "group of oligopolies", prone to price parallelism[109]. Here, the Court applied the oligopoly defense, stating that the parallelism of prices "may be satisfactorily explained by the oligopolistic tendencies of the market[110]".

More recently, the General Court followed the jurisprudence of *Woodpulp* in striking down the Commission's ruling in *CISAC*[111], which had identified a concerted practice between twenty-four collecting society. Knowing that parallel behaviour could be evidence of a concerted practice only where there is no plausible alternative explanation, the Court held that the fight against unauthorised use of musical works was an explanation of price parallelism other than collusion, thus annulling the decision of the Commission[112].

Since 1993 the *Woodpulp* case has therefore made crystal clear that Article 101 TFEU does not directly outlaw tacit collusion and that the oligopoly defense would overcome any attempt to apply the notion of concerted practice to parallel pricing. As a matter of fact, parallelism would serve as proof of a concerted practice only when alternative explanations different from collusion are not convincing; however, it is extremely unlikely that concerted practice would be the only possible explanation in oligopolies. This solution has been remarkably stable over years, pravailing even in the US antitrust law[113]. Nevertheless, the Commission and the General Court have continued to claim that where competition in a market is already

[107] Commission Decision 85/202/EEC of 19 December 1984 (IV/29.725 - *Wood pulp*), OJ [1985] L 85, §82.
[108] Joined Cases C-89, 104, 114, 116-117, 125-129/85, *A Åhlström Osakeyhtiö v Commission*, 31 March 1993, ECR [1993] I-1307 [hereinafter *Woodpulp*].
[109] *Ibid.*, §102-120.
[110] *Ibid*., §127.
[111] Case T-442/08 *International Confederation of Societies of Authors and Composers v European Commission*, 12 April 2013, EU [2013] T:2013:188.
[112] *Ibid*., §96-102, 134-139 and 182.
[113] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 30.

restricted, like in an oligopolistic one, antitrust authorities should be particularly vigilant to ensure that existing competition is not restricted anymore[114].

2.2.2. Application of Article 101 to facilitating practices

Notwithstanding the difficulties in proving that parallel behaviour is attributable to collusion between firms as opposed to the oligopolistic structure of the market, Article 101(1) TFEU can be deployed in other ways to deal with tacit collusion. For this purpose, the "parallelism plus rule", which consists of finding illegal behaviour whenever a facilitating factor accompanies parallelism, has been suggested[115]. In other words, Article 101 can be applied to what are often referred to as facilitating practices, which, as explained in Paragraph 1.2., make it easier for firms to achieve the benefits of tacit coordination[116]. Implicit in *Woodpulp*, indeed, was the idea that if tacit collusion cannot be forbidden when arising as a result of oligopolistic interdependence, Article 101 ought however to catch practices which "artificially" favour tacit collusion: in this way, tacit collusion has progressively become indirectly relevant in many areas of Article 101 TFEU enforcement.

The assessment of facilitating practices under Article 101 TFEU consists generally of two steps[117]. The first step, under Article 101(1), is to asses whether an agreement between undertakings has an anti-competitive object or potential restrictive effects on competition. The second step, under the block exemption of Article 101(3)[118],

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[114] Case T-202/98, *Tate & Lyle plc, British Sugar plc and Napier Brown & Co. Ltd v Commission of the European Communities*,12 July 2001 [2001] EU:T:2001:185; Case C-194/99 P, *Thyssen Stahl AG v Commission*, 2 October 2003 [2003] EU:C:2003:527.

[115] Massimo Motta, *Competition Policy: Theory and Practice* (Cambridge: Cambridge University Press, 2004), 50.

[116] Richard Whish and David Bailey, *Competition Law*, Ninth edition (Oxford: Oxford University Press, 2018), 581.

[117] Communication from the Commission - Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, OJ C 11, 14 January 2011, § 20.

[118] Article 101(3) of Treaty on the Functioning of the European Union (TFEU): "*The provisions of paragraph 1 may, however, be declared inapplicable in the case of:*
- any agreement or category of agreements between undertakings,
- any decision or category of decisions by associations of undertakings,
- any concerted practice or category of concerted practices,
which contributes to improving the production or distribution of goods or to promoting technical or economic progress, while allowing consumers a fair share of the resulting benefit, and which does not:
(a) impose on the undertakings concerned restrictions which are not indispensable to the attainment of these objectives;

which only becomes relevant when the first step has been overtaken, is to determine the pro-competitive benefits produced by that agreement and to asses whether they outweigh the restrictive effects on competition. During the second step, the structure of the market is relevant to the analysis of agreements. According to the Commission, when the market configuration is oligopolistic, the alleged restriction of competition must be seen in the light of the peculiar market dynamics; thereby, an agreement might be found to satisfy Article 101(3) only where it would have the effect of introducing economic advantages into the market (e.g. improving production and distribution)[119].

In essence, Article 101 TFEU catches four types of facilitating practices[120]. First, horizontal cooperation agreements amongst oligopolists could facilitate tacit collusion. As held by the 2011 Guidelines on horizontal cooperation agreements, information exchange agreements, R&D agreements, production agreements, joint purchasing agreements and standardization agreements may all "decrease the parties' decision-making independence and as a result increase the likelihood that they will coordinate their behaviour in order to reach a collusive outcome"[121]. In particular, the limited number of firms in the market has played a role in cases where exchange of information is used as a facilitating device for tacit collusion. In *Fatty Acids*[122], for instance, exchange of information was the sole competition infringement and parties tried to motivate their behaviour claiming elements of a typical non-cooperative game in an oligopoly: they were afraid of provoking price-cutting which would make retaliation necessary and monitoring of respective market positions was essential to allow orderly marketing. Again, it was the oligopolistic structure of the market in the *UK Tractors*[123] decision that led to conclude that Article 101(1) had been infringed through an information exchange agreement. In particular, the Commission emphasized that such agreement had promoted the creation of market transparency

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(b) afford such undertakings the possibility of eliminating competition in respect of a substantial part of the products in question."

[119] Commission Decision 84/381/EEC of 12 July 1984 relating to a proceeding under Article 85 of the EEC Treaty (IV/30.129 - *Carlsberg*), OJ [1984] L 207/26, p. 9.

[120] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 31.3

[121] Communication from the Commission - Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, OJ C 11, 14/01/2011, § 37.

[122] Commission Decision of 2 December 1986 relating to a proceeding under Article 85 of the EEC Treaty (*Fatty Acids*), OJ [1987] L 3/17.

[123] Commission Decision of 17 February 1992 relating to a proceeding pursuant to Article 85 of the EEC Treaty (*UK Agricultural Tractor Registration Exchange*), OJ [1992] L 68/19.

and the elimination of uncertainty about competitors' actions, which are likely to destroy the hidden competition left in an oligopolistic market and to facilitate collusive outcomes. Hence, the characteristics of the market must be taken into account: where the structure of the market is oligopolistic, it is necessary, in the General Court's view, to ensure the effectiveness of residual competition on the market; therefore, some horizontal cooperation agreements, which are not anti-competitive in competitive markets, may be found to infringe Article 101(1) only in oligopolies[124].

Second, Article 101 could outlaw vertical agreements which facilitate tacit collusion, at either supplier and distributor level. The 2010 Guidelines on vertical restraints[125] provides guidance on the collusion facilitating effect of exclusive distribution agreements, exclusive customer allocation agreements, selective distribution agreements, recommended prices agreements, resale price maintenance agreements, etc. For instance, an agency agreement could ease collusion on the market, in the Commission's view, if a number of principals used the same agents whilst collectively preventing others from doing so, or where they used agents to exchange sensitive information between themselves[126].

Third, agreements that create financial links amongst oligopolists, generally labeled passive investments, are alike covered by Article 101 TFEU. These include agreements giving rise to the acquisition of minority shareholdings in a rival oligopolist, cross-shareholdings, interlocking directorates etc. Indeed, when a firm invests in a rival in an oligopolistic industry, the investing firm may become less eager to price-cut on a collusive price, since it would absorb a portion of the rival's losses from the price-cut. Moreover, passive investment by an efficient firm in a less efficient one may cause higher collusive prices[127]. As the Court of Justice stated in the *Philip Morris*[128] case, the acquisition by one company of an equity interest in a competitor does not in itself constitute conduct restricting competition; nevertheless, such an acquisition may serve in an oligopolistic market as an instrument for

[124] Communication from the Commission - Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, § 39-47.
[125] Communication from the Commission - Guidelines on Vertical Restraints, OJ C 130/01, 19 May 2010.
[126] *Ibid*., § 20.
[127] Ariel Ezrachi and David Gilo, "EC Competition Law and the Regulation of Passive Investments Among Competitors", *Oxford Journal of Legal Studies* 26, n. 2 (2006): 332.
[128] Cases 142/84 and 156/84, *British American Tobacco Company Limited and R. J. Reynolds Industries Inc. v Commission* (Philip Morris Inc. and Rembrandt Group Limited intervening), 17 November 1987, ECR [1987] 4487, § 37-45.

influencing the commercial conduct of the companies, facilitating tacit collusion and falling foul of Article 101(1), together with the EUMR.

Fourth, even technology transfer agreements between owners of competing technologies may lead to a facilitation of both explicit and tacit collusion. According to the 2014 Guidelines on Technology Transfer Agreements, collusion can be facilitated by licensing agreements, non-compete obligations and patent pools, that lead to a high degree of commonality of costs between undertakings, this conducting to similar views on the terms of coordination[129]. Hence, outside the scope of the Technology Transfer Block Exemption Regulation (TTBER)[130], technology transfer agreements are subject to individual assessment under Article 101(1) TFEU: when the number of competitors is rather small, they may more likely promote collusion and reduce intra-technology competition, that is to say competition between undertakings that produce on the basis of the same technology[131].

Similarly, the Supreme Court of the United States held that conscious parallelism itself does not constitute an offense to Section 1 of the Sherman Act[132]. In its view, parallel conduct is sufficient evidence of an illegal agreement only when "plus factors" are present: additional evidence must be highlighted in order to have the parallel behaviour prohibited[133]. The most consistently used plus factor in the United States case law is the proof that the parallel practices are contrary to the firm's self-interest when acting alone, since what is needed in a cartel is group action contrary to each firm's independent profit-maximizing conduct. Other plus factors may include high-level interfirm communication, artificial standardization of products and price increases during times of low demand[134]. The latters, in particular, can be proved by evidences of facilitating agreements between undertakings, thus constituting the

[129] Communication from the Commission - Guidelines on the application of Article 101 of the Treaty on the Functioning of the European Union to technology transfer agreements, OJ C 89/3, 28 March 2014, § 171.
[130] Commission Regulation (EU) n. 316/2014 of 21 March 2014 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of technology transfer agreements (TTBER), OJ L 93, 28 March 2014.
[131] Communication from the Commission - Guidelines on the application of Article 101 of the Treaty on the Functioning of the European Union to technology transfer agreements, § 173.
[132] *Theatre Enterprises, Inc. v. Paramount Film Distributing Corp.*, 346 U.S. 537 [1954], p. 540-541.
[133] *Delaware Valley Marine Supply Co. v. American Tobacco Co*., 297 F.2d 199, 3d Cir. [1961], p. 202-203.
[134] Michael K. Vaska, "Conscious Parallelism and Price Fixing: Defining the Boundary", *University of Chicago Law Review* 52, n. 2 (1985): 519-522.

"plus" in the "conscious parallelism plus something else" requirement in the US antitrust practice[135].

In both EU and US competition law, therefore, it does appear to be theoretically possible for tacit collusion to be captured as a concerted practice under, respectively, Article 101 TFEU and Section 1 of the Sherman Act. In order to do so, courts require the existence of certain factors or facilitating practices: the nature of the market and the conduct of the parties, among the others, must be examined thoroughly. Nevertheless, it remains to be seen whether Article 101 will be an effective instrument in contrasting tacit collusion. In recent years, in fact, the Commission brought very few Article 101 cases against facilitating agreements in oligopolies, especially in areas where Guidelines are not available. Moreover, the four conditions of tacit collusion of Paragraph 1.2., whose existence is indispensable to identify a facilitating effect on collusion, are not systematically mentioned in the case law[136]. However, an opinion by the Advocate General Paolo Mengozzi in the *MasterCard* case appears to pave the way for Article 101 being used in the facilitating practices scenarios: Mengozzi observed, indeed, that the concepts of "agreement" or "concerted practice" are intended to catch all typologies of collusion between undertakings, irrespective of their form, even when coordination is achieved through a joint structure or an independent body[137].

2.3. *Ex post* intervention: tacit collusion as an abuse of collective dominance

Considering the ambiguities surrounding the applicability of Article 101 TFEU to tacit collusion, European scholars have tried to turn to Article 102 TFEU. Although Article 102 does not encompass agreements between undertakings explicitly, it prohibits, however, any abuse of a dominant position "by one or *more undertakings*"[138] (emphasis added), thus providing a textual basis to the concept of collective dominance.

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[135] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 36.
[136] Nicolas Petit, "The Oligopoly Problem in EU Competition Law", *Research Handbook in European Competition Law*, I. Liannos and D. Geradin eds., Edward Elgar (2013): 33.
[137] Case C-382/12 P, *MasterCard and Others v European Commission*, Opinion of Advocate General Mengozzi, 30 January 2014, § 33.
[138] Article 102(1) of Treaty on the Functioning of the European Union (TFEU).

In order to apply Article 102's provision to a conscious parallelism context, the concept of collective dominance must be firstly expounded and interrelated to oligopolistic markets. European case law has been split over a narrow and a broader interpretation of the reference to more than one undertaking. The narrow view of the provision states that the market power and behaviour of undertakings could be aggregated and dealt with under Article 102 only if all the firms belong to the same corporate group[139]. However, it should be noticed that if the legal entities within the same group are to be regarded as *one* undertaking, the narrow approach fails to explain the significance of an abuse by *more than one* undertaking. On the other hand, according to the alternative and wider interpretation of Article 102, legally and economically independent firms might be considered to hold a "collective dominant position"[140]. Although initially rejected by the European Court of Justice in *Hoffman-La Roche*[141], the broader interpretation was upheld in *Italian Flat Glass,* where the General Court stated that "there is nothing in principle, to prevent two or more independent economic entities from being, on a specific market, united by such economic links that, by virtue of the fact, together they hold a dominant position vis-á-vis the other operators in the same market"[142].

In the opinion of the Court in *Compagnie Maritime Belge Transports*, moreover, it is necessary to examine "the economic links or factors which give rise to a connection between the undertakings concerned"[143]. Depending on which economic links enable them to act independently of their competitors, collective dominance could cover two different legal and economic concepts: explicit collusion, which may be described as "non-oligopolistic collective dominance", and tacit collusion, portrayed by "oligopolistic collective dominance"[144]. Non-oligopolistic collective dominance arises when two or more undertakings act as a single entity on the market because of

[139] Case 6/72, *Europemballage Corporation and Continental Can Company Inc v Commission of the European Communities*, 21 February 1973, ECR [1973] 251; Case 6 & 7-73, *Istituto Chemioterapico Italiano S.p.A. and Commercial Solvents Corporation v Commission of the European Communities*, 6 March 1974, ECR [1974] 223.

[140] Richard Whish and David Bailey, *Competition Law*, Ninth edition (Oxford: Oxford University Press, 2018), 585.

[141] Case 85/76, *Hoffmann-La Roche & Co AG v Commission of the European Communities,* 13 February 1979, ECR [1979] 461.

[142] Joined cases T-68/89, T-77/89 and T-78/89, *Società Italiana Vetro SpA, Fabbrica Pisana SpA and PPG Vernante Pennitalia SpA v Commission of the European Communities*, 10 March 1992, ECR [1992] II-1403, § 358 [hereinafter *Italian Flat Glass*].

[143] Joined cases 395/96 P and 396/96 P, *Compagnie Maritime Belge Transports SA, Compagnie Maritime Belge and Dafra-Lines A/S v Commission of the European Communities,* 16 March 2000, ECR [2000] I-1365, § 41 [hereinafter *Compagine Maritime Belge Transports*].

[144] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 378.

structural or commercial links or direct or indirect contacts between them, which give rise to explicit collusion. In *Almelo*[145], for instance, the adoption of the same general terms and conditions for the supply of electric power by the regional energy distributors in the Netherlands was considered by the Court an agreement between undertakings, constituting the commercial link necessary for a collective dominant position to exist. However, the existence of an agreement is not indispensable; a finding of a collective dominant position may be based on other connecting factors and may depend, in particular, on an assessment of the structure of the market[146]. For this reason, the case law has consistently accepted that the economic links giving rise to collective dominance include the relationship of interdependence between the members of a tight oligopoly, producing the suitable conditions for tacit collusion. Thus, oligopolistic collective dominance is the equivalent of oligopolistic coordination, resulting from market interactions and not from commercial links or direct or indirect communications between the oligopolists. The European Court in *France v Commission* tried to capture implicitly tacit collusion under the notion of collective dominance, ruling that parties may hold a collective dominant position "because of correlative factors which exist between them"[147]. However, the first meaningful attempt to set out a test for oligopolistic collective dominance was *Airtours* in 2002. Paragraph 62 of the judgement, in particular, subordinates the proof of oligopolistic collective dominance to the satisfaction of three conditions, i.e. detection, punishment and inability of competitors to undermine tacit collusion[148]. Enriched by the *Impala* case[149] with a fourth requirement (i.e. the shared understanding of the terms of coordination), these conditions have become the four cumulative conditions C1, C2, C3 and C4 of the EUMR, outlined above in Paragraph 2.1.

Having established that Article 102 is in principle applicable to oligopolistic collective dominance, it is necessary secondly to consider what kind of oligopolistic conduct would constitute an abuse of a collective dominant position: indeed, a collective dominant position is not in itself unlawful under Article 102; for there to be an infringement there must be an abuse of the collective dominance.

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[145] Case C-393/92, *Municipality of Almelo and others v NV Energiebedrijf Ijsselmij*, 27 April 1994, ECR [1994] I-1477.
[146] *Compagnie Maritime Belge Transports*, § 45.
[147] Case C-68/94, *République française et Société commerciale des potasses et de l'azote (SCPA) et entreprise minière et chimique (EMC) v. Commission*, 31 March 1998, ECR [1998] I-1375, § 211.
[148] Case T-342/99, *Airtours plc. v Commission*, 6 June 2002, ECR [2002] II-2585, § 62.
[149] Case T-464/04, *Independant Music Publishers and Labels Association (Impala, association internationale) v Commission of the European Communities*, 13 July 2006, ECR [2006] II-02289.

Commentators identify two main categories of abuse of dominant position, namely exploitative and exclusionary abuse; the classification may anyhow be straightforwardly broadened to the collective dominant position scenario[150]. Through exploitative abuses competition is harmed by the dominant undertakings, generally charging prices which are higher than the prices of a competitive market[151]. According to this, it could be argued that tacit coordination by collectively dominant oligopolistic undertakings is exploitative, since in an oligopolistic market prices are higher, albeit without the need of an explicit agreement. However, the Commission has not attempted to condemn rational conscious parallelism as an exploitative abuse under Article 102, as competition law should not require firms to behave irrationally and unnaturally. Since price parallelism cannot be considered as exploitative abuse, a distinct issue would be whether collectively dominant firms may abuse their position by charging excessively high prices. Here the abuse would lie not in the parallelism, but rather in the level of unfairly high prices, which are explicitly condemned by Article 102(2)(a)[152], making legal actions against excessive pricing in an oligopoly possible[153]. Such actions, however, are likely to be rare: the Commission avoid usually to act as a price regulator. Exclusionary abuses, on the other hand, harm competition by conducts that hinders the competitive opportunities of rivals. Given that tacit coordination is likely to arise where a few oligopolistic firms are able to set prices above the competitive level, the entry of new competitors may make tacit collusion less easy to achieve, hence it is likely to be welcomed by competition authorities. For this reason, the Commission may investigate exclusionary conducts by collectively dominant firms where the alleged victims of the anti-competitive

[150] Richard Whish and David Bailey, *Competition Law*, Ninth edition (Oxford: Oxford University Press, 2018), 592-594.
[151] Jonathan Faull and Ali Nikpay, *The EU Law of Competition*, Third edition (Oxford: Oxford University Press, 2014), 387.
[152] Article 102(2) of Treaty on the Functioning of the European Union (TFEU): "*Such abuse may, in particular, consist in:*
(a) directly or indirectly imposing unfair purchase or selling prices or other unfair trading conditions;
(b) limiting production, markets or technical development to the prejudice of consumers;
(c) applying dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage;
(d) making the conclusion of contracts subject to acceptance by the other parties of supplementary obligations which, by their nature or according to commercial usage, have no connection with the subject of such contracts."
[153] See, for instance, *Telefónica, Vodafone and Orange*, Spanish National Competition Authority decision of 19 December 2012.

behaviour are actual or potential competitors which might be able to subvert tacit collusion on the market[154].

Although the theoretical applicability of the concept of collective dominance to oligopolistic conscious parallelism, there has so far been no cases under Article 102 TFEU where tacit collusion was held to constitute directly a sufficient connecting element required for a collective dominant position[155]. Since the adoption of the EUMR in 2004, in addition, the Commission has shown disinterest in the enforcement of Article 102 in tacitly collusive oligopoly, expressed clearly in the Guidance Paper[156] of 2009 as well.

3. Conclusion

As outlined throughout the present Chapter, tacit collusion has been a doubtful issue for both economic literature and competition law authorities. By identifying it as any situtuation in which market players charge higher prices recognizing their interdependence, economists equalize tacit collusion to explicit cartels in terms of effects. In order to tackle the phenomenon, the literature has identified various factors wich may make market more prone to collusive conducts. Among the others, low number of competitors, market transparency and frequency of interaction are positively relevant in influencing the scope for collusion. With few marketplayers, high degree of communication and control of rivals' prices, oligopolistic markets set the most appropriate conditions for the existence of tacit collusion. In the 1950s, non-cooperative game theory provided explanations to the so-called "oligopoly problem": by applying the "prisoner's dilemma" game to the study of undertakings in oligopolistic markets, collusive outcomes emerged frequently as the dominant strategy for each oligopolist, specifically when implemented by facilitating practices.

Having regard to the foregoing economic considerations, legal practioners have begun perceiving the "oligopoly problem" as a challenging remedial issue. In this

[154] See, for instance, Commission decision 93/82/EEC of 23 December 1992 in Cases *Cewal, Cowac and Ukwal*, OJ [1993] L 34/20, where the members of a liner conference have been found to infringe Article 102 through various practices with the intention of eliminating competitors from the market, such as selective price cutting.
[155] Heiko Haupt, "Collective Dominance under Article 82 EC and EC Merger Control in the Light of the Airtours Judgment", *European Competition Law Review* 9 (2002): 438.
[156] Guidance on the Commission's enforcement priorities in applying Article 82 of the EC Treaty to abusive exclusionary conduct by dominant undertakings, OJ C 45, December 2008.

context, the Turner-Posner debate over the necessity of prompt antitrust intervention is symptomatic: the Harvard School (i.e. Donald Turner), on one hand, viewed tacit collusion as a matter of oligopolistic market structure and claimed for the inadequacy of Section 1 of the Sherman Act; on the other hand, Richard Posner and the Chicago School argued that "voluntary actions" by undertakings are necessary to lead the oligopoly to collusive pricing and that such explicit intervention would fall within the notion of "concerted practice" of Section 1. Taking into account the Turner-Posner discussion, the European Union explored different remedies to tacit collusion. The table below (**Table 1**) displays the potential application of Article 101 TFEU, Article 102 TFEU and Merger Regulation (EUMR) to oligopolistic pricing interdependence, together with their relevant case law and their practical efficacy. Since *ex post* intervention has usually demonstrated ineffective, the *ex ante* control through EUMR, which prevent oligopolies from arising in the first place, may work as an appropriate solution regarding tacit collusion; employing Article 101 to address "facilitating practices" would be the other effective alternative.

	Intervention	Legal notions	Efficacy	Relevant case-law and documents
EX ANTE	**European Union Merger Regulation (EUMR) n. 139/2004**	"Coordinated effects"	Preventive effective remedy **against** structural **market changes** likely to create tacit collusion → **Preferred legal tool** in EU	⇨ *Airtours plc. v Commission* [2002] ⇨ **Guidelines on Horizontal Mergers** (2004)
EX POST	**Article 101 TFEU**	"Concerted practice"	Price parallelism would serve as a proof of "concerted practice" only when alternative explanations different from collusion are not convincing → Through "**oligopoly defense**", Article 101 **can not directly outlaw** tacit collusion	⇨ *Dyestuffs* [1972] ⇨ *Zuchner v Bayerische Vereinsbank AG* [1981] ⇨ *Peroxygen Products* [1985] ⇨ *Woodpulp* [1993] ⇨ *CISAC* [2013]
		"Facilitating practices"	Article 101 **can tackle facilitating agreements**, which make it easier for firms to achieve the benefits of tacit collusion	⇨ **Guidelines on Horizontal Co-operation Agreements** (2011)

			(e. g. Information exchange, exclusive distribution agreements, licensing agreements)	⇨ *Fatty Acids* [1987] ⇨ *UK Tractors* [1992] ⇨ **Guidelines on Vertical Restraints** (2010) ⇨ *Philip Morris* [1987] ⇨ **Guidelines on Technology Transfer Agreements** (2014)
EX POST	**Article 102 TFEU**	"Abuse of collective dominant position"	Article 102 can in principle be applied to **oligopolistic collective dominance**; exploitative abuse can tackle oligopolistic excessive pricing and **exclusionary abuse** can reach tacit collusion → Nevertheless, **no direct cases under Article 102** of tacit collusion	⇨ *Italian Flat Glass* [1992] ⇨ *Compagnie Maritime Belge Transports* [2000] ⇨ *France v Commission* [1998] ⇨ *Airtours* [2002] ⇨ *Impala* [2006]

Table 1 – Tacit collusion under EU competition law

II. Algorithms implementing collusion scenarios

1. Possible pro-competitive effects of algorithms. 1.1. Supply-side efficiencies. 1.2. Demand-side efficiencies. **2. The impact of algorithms on the likelihood of collusion. 3. How algorithms may promote collusion.** 3.1. Messenger algorithms: implementing pre-existing explicit collusion. *3.1.1. Signalling algorithms. 3.1.2. Monitoring algorithms. 3.1.3. Competition law enforcement of algorithmic explicit collusion.* 3.2. The algorithm-enhanced Hub-and-Spoke. *3.2.1. Uber's Hub-and-Spoke: a case study.* 3.3. Parallel algorithms: algorithm-fueled tacit collusion. *3.3.1. Competition law enforcement of algorithmic tacit collusion.* 3.4. Self-learning algorithms: tacit collusion of the future. **4. Conclusion.**

The increased automation of computerized protocols and the rapid developments in technology have changed the way undertakings interact, communicate and trade. These processes have accelerated the birth of digitilized markets, covering nowadays a wide spectrum of commercial activities, from stock trading to the offer and purchase of online products and services.

With the rise of data-driven business models and e-commerce, companies are increasingly turning to computer algorithms that learn from the data they process. Algorithms can be defined informally as "any well-defined computational procedure that takes some value, or set of values, as input and produces some value, or set of values as output"[157]. E-commerce, in particular, has unlocked practical applications for algorithmic pricing (also called dynamic pricing algorithms): both well-known e-retailers and small-scale sellers have started to assess and adjust prices using computer algorithms, which monitor market activity and determine within milliseconds whether, and by how much, to raise or lower prices.

In 2011, an unintended hike in the price of two second-hand copies of Peter Lawrence's book, *The Making of a Fly*, being sold on Amazon, notably became the most well-known anecdote on this issue[158]. The book reached, from April 8 to 18, the astonishing price of $23.7 million, set through the interaction of two different sellers' programmed algorithms: the first fixed the price of the first book (x) for 1.27059 times the price of the second book (y); the second set the price of the second book (y) at 0.9983 times the price of the first book (x). Being the two equations

$$x = 1.27059 * y$$
$$y = 0.9983 * x,$$

[157] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, *Introduction to Algorithms*, Second edition (Cambridge, Massachussetts: The MIT Press, 2001), 5.

[158] John D. Sutter, "Amazon Seller Lists Book at $23,698,655.93 - - Plus Shipping", *CNN*, April 25, 2011, http://edition.cnn.com/2011/TECH/web/04/25/amazon.price.algorithm/index.html.

the result was un upcoming spiral in which each algorithm's price hike was subsequently responded to by a price hike from the other, and vice versa. Although the example appears to have been the product of mistake, it illustrates perfectly how algorithms can raise "endless possibilities for both chaos and mischief"[159]. If, on one hand, they could create a more transparent marketplace, in which resources are allocated more efficiently, on the other hand pricing algorithms could facilitate anticompetitive practices, such as both tacit and explicit collusion. Thus, an important question arises: what dangers the market has to face when algorithms are left unchecked or, worse, used to actively distort competition?

1. Possible pro-competitive effects of algorithms

When correctly used and supervised, algorithms and data-driven marketplaces are generally associated with significant efficiencies both on the supply and on the demand side.

1.1. Supply-side efficiencies

On the supply side, algorithms can find patterns and create data trends in order to determine undertakings' business decisions, optimising their commercial strategies instantaneously. This can promote static efficiencies: firms become able to lower their production costs and, thus, products' prices to consumers by matching more efficiently buyers and sellers and improving the allocation of resources[160]. For instance, algorithms can help reducing costs by optimising inventory levels, which permits to have the right amount of stock in the right place at the right time[161].
Furthermore, online and algorithmic markets are characterised by lower entry barriers: potential sellers can rapidly enter and exit the market without incurring significant costs that they cannot recover elsewhere[162]. Market entry, in particular, has been promoted by the abilty of firms to develop new offerings based on

[159] Michael Eisen, "Amazon's $23,698,655.93 Book About Flies", *it is NOT junk*, April 22, 2011, http://www.michaeleisen.org/blog/?p=358.
[160] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 15.
[161] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 7.
[162] *Ibid*., 6.

algorithms. Companies are thus under costant pressure to innovate, promoting in this way dynamic efficiencies, improving existing products or developing new ones. Customers generally benefit from these conditions, since as entry barriers decrease, concerns about likely anticompetitive effects would lessen as well[163].

Pricing algorithms, in particular, have been recognised to improve both static and dynamic market efficiency. Commonly understood as the computational codes run by sellers to automatically set prices to maximise profits, they are nowadays particularly common in the airline, hotel booking, road transports, electricity and retail industries[164]. *Inter alia*, dynamic pricing algorithms, which implement continuous price changes over time, allow companies to react instantaneously to changes in supply and demand conditions, preventing the rise of unsatisfied demand and excess of supply, thus raising revenues and lowering costs[165].

The reason why firms might be able to achieve higher profits through pricing algorithms can differ from one industry to another. The airlines companies' commercial challenge, for instance, is to fill the planes at the best price they can, taking into account the perishable nature of the goods: as a matter of fact, if a ticket has not been sold and the plane has flown, the potential revenues are lost forever. To tackle this issue, airlines sell tickets long before the flight date and use algorithms to dynamically adjust prices on fluctuations in demand up to the flight date, in order to maximise revenue. Car rental companies and hotels use similar approaches, thus achieving higher profits by managing through algorithms their perishable goods. Yet, Amazon sellers on Marketplace can maximise their profits using price-matching algorithms, which match the lowest or second-lowest price offered on the platform for the same product[166]; differently, Airbnb recommends prices to hosts according to an algorithm which is based on criteria such as location, time of the year, competitors' prices and availability, in this way maximising the number of

[163] Organisation for Economic Co-operation and Development (OECD), *Protecting and Promoting Competition in Response to "Disruptive" Innovations in Legal Services* (13 June 2016).
[164] Shuchi Chawla, Jason D. Hartline and Robert Kleinberg, "Algorithmic Pricing via Virtual Valuations", *arXiv e-prints* (August 2008): 1.
[165] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 16.
[166] Oxera, *When algorithms set prices: winners and losers. Discussion paper* (19 June 2017), 10-11.

transactions and ensuring the participation on the platform by both hosts and guests[167].

1.2. Demand-side efficiencies

On the demand side, algorithms might lead, by reducing costs, to lower prices for consumers and might help to match supply and demand in the most efficient way. Beside that, faster price changes could also increase search costs, since consumers become less sure about when and where they can expect to find the best price for the product.

In this context, algorithms can however assist consumers in their purchasing decisions. The development of algorithms has improved, in particular, the ability to offer price comparison services trough search engines or comparison platoforms. Price comparison websites (PCWs) make it easier for consumers to compare through algorithms the available offers and find the best alternative. In this way, PCWs can facilitate market transparency, collecting and aggregating information on products and services. A more transparent market environment increases efficiency by allowing suppliers to benchmark their performance with that of their competitors, which constitutes a key requirement in promoting a competitive market.
Furthermore, online platforms help to reduce search costs for buyers, enabling users to quickly compare relevant prices and facilitating information flow. By reducing search costs, these websites make multiple searches on multiple platforms possible, further enhancing the competitive pressure on suppliers to the benefit of consumers: the reduction of the asysimmetry of information between sellers and buyers, indeed, can make it harder for suppliers to take advantage of ill-informed customers, which were more likely to be subjected to higher pricing.
Moreover, PCWs also weaken the market power of sellers and increase consumers' buyer power: by allowing consumers to compare a larger number of offers, algorithms can potentially lead to consumers overcoming manipulative marketing techniques and making more sophisticated and rational choices[168].

[167] Hector Yee and Bar Ifrach, "Aerosolve: Machine learning for humans", *Airbnb Engineering & Data Science* (4 June 2015), available at: https://medium.com/airbnb-engineering/aerosolve-machine-learning-for-humans-55efcf602665.
[168] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 4-9.

By supporting consumer decisions and better organising information, algorithms thus have the potential to create positive effects on consumers and social welfare. In particular, PCWs algorithms are now turning into a new generation, through which consumers could completely outsource to the algorithm their purchasing decisions. The concept of "algorithmic consumers"[169] will be however widely discussed in Chapter III.

2. The impact of algorithms on the likelihood of collusion

There is no doubt that computer algorithms can be a powerful tool to extract value from data collected in the digital economy, potentially fostering demand and supply side efficiency, innovation and competition. In spite of the benefits of algorithms outlined above, however, a growing competition policy literature is raising concerns about the possibility that undertakings' pricing algorithms might lead to collusive outcomes, with consumers paying higher prices than in a competitive market. Algorithms may, indeed, work as facilitating factors for both explicit and tacit collusion and may enable a new form of coordination that was not even possible before, which is referred to as "algorithmic collusion"[170].

Firstly, the use of computer algorithms is changing structural, supply-side and demand-side market characteristics[171]. As outlined by Paragraph 1.2. of Chapter 1, economists have identified the most relevant market factors that may increase the likelihood of collusion: by influencing positively those characteristics, algorithms may potentially make digital markets more prone to collusive outcomes. However, pricing algorithms do not affect all facilitating factors in the same way.
A rather large positive influence of algorithms can be expected on two structural factors, namely market transparency and frequency of interaction, both of which enhance the likelihood of collusion in the market. Focusing first on market transparency, the effective implementation of algorithms requires the collection of detailed real-time data through automated methods. In order to benefit from an "algorithmic competitive advantage", market players have therefore an enormous incentive to gather market information and to make investments in technology. The

[169] Michal Gal and Niva Elkin-Koren, "Algorithmic Consumers", *Harvard Journal of Law and Technology* 30, n. 2 (2017).
[170] Competition and Markets Authority (CMA), *Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing* (2018), 22.
[171] Monopolkommission, *Algorithms and collusion* (2018), 6-7.

result is a transparent environment that is prone to collusion, where market partecipants can constantly observe through algorithms rivals' actions, consumers' choices and market changes, making them able to find a sustainable supra-competitive price equilibrium and to monitor and detect deviations from the collusive price. Furthermore, complex algorithms are able to distinguish between intentional deviations from collusion and natural reactions to changes in market conditions (e.g. fluctuations in demand), which may prevent unnecessary retaliations[172].
With respect to frequency of interaction, algorithms has revolutionised the speed at which firms can make business decisions and adjust prices to the respective market conditions. Frequent algorithmic price adjustments enable undertakings to react immediately to possible deviations or even to discourage and anticipate them. The relatively high speed of retaliation, indeed, prevents deviations from being profitable, at least in the short term, as they can be identified quickly[173].

It is currently less clear how the use of algorithms may affect the number of firms and barriers to entry, traditionally identified as two of the main structural characteristics that affect the risk of collusion. It is generally known that collusion may more easily be sustained over time where the market is characterized by high entry barriers and few players. Algorithms could, on one hand, reduce barriers to entry and make new entries more likely, since they can provide useful market information to potential entrants and improve certainty. On the other hand, algorithms will also make market entries more difficult, as new entrants can be fended off more quickly by established providers with the help of computerized systems[174].
With respect to the number of firms, one peculiar aspect still has to be outlined. Algorithms make, indeed, the number of competitors in the market a less relevant factor for collusion: their ability and speed in collecting and analysing data make it easier to coordinate the behaviour of a large number of firms. Therefore, oligopolistic and highly-concentrated markets are not a necessary precondition anymore for algorithmic collusion to take place[175].

[172] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 22.
[173] Autorité de la Concurrence and Bundeskartellamt, *Competition Law and Data* (10 May 2016), 14.
[174] Monopolkommission, *Algorithms and collusion* (2018), 7.
[175] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 21.

The likelihood of collusion in a given industry can be also affected by demand factors, such as demand growth, demand stagnation and demand fluctuations through business cycles. However, the use of algorithms by firms, which is the focus of the present chapter, should not directly affect market demand and his factors.
Supply variables, on the other hand, can be deeply influenced by algorithmic pricing. Algorithms are, indeed, an important source of innovation, which constitutes one of the most relevant supply-side characteristics. In particular, in the case of search engines, navigation apps and online platforms, where algorithms are a source of competitive advantage, companies may face a greater competitive pressure to develop the best-performing algorithm, thus reducing the present value of collusive agreements, as well as the incentive to collude. Similarly, algorithms can allow companies to differentiate their services or production costs, leading to cost asymmetry between market players. In this way, collusion might be harder to sustain, due to difficulties of finding a common focal point to coordinate. Hence, some supply variables of digital markets may potentially counterbalance the enhanced risk of collusion resulting in particular from a more transparent market environment[176].

The table below (**Table 2**) summarizes the main relevant factors for collusion and the expected impact of algorithms on them.

Relevant factors for collusion		Impact of algorithms
Structural characteristics	Market transparency	+
	Frequency of interaction	+
	Number of firms	±
	Barriers to entry	±
Demand variables	Demand growth/decline	0
	Demand fluctuations	0
Supply variables	Innovation	-
	Cost asymmetry	-

Note: **+** positive impact; **-** negative impact; **0** neutral impact; **±** ambiguous impact

Table 2 - Impact of algorithms on relevant factors for collusion

[176] *Ibid*., 22-23.

Despite the apparently ambiguous effects on some factors, however, the standard modelling of collusion in the economic literature has mathematically demonstrated that in a perfectly transparent market where firms interact repeatedly (as in the case of an algorithmic market) collusion is always sustainable as an equilibrium strategy, since deviations can be easily identified and immediately retaliated[177]. Moreover, at least three main algorithms' features can positively influence the likelihood of explicit and tacit collusion in digital markets, making the collusive outcome stable[178]. First, when business decisions are taken by rule-based, "rational" algorithms, their patterns can be detected by competitors' algorithms more easily than the "irrational" and unpredictable decisions taken by human beings. Second, the use of algorithms reduces the risk that firms make mistakes when trying to meet the collusive equilibrium, thus preventing involuntary destabilization. Third, algorithms are unlikely to succumb to the so-called "agency slack", i.e. the human tendency to favour personal or short-term gains, obtained by violating the collusive equilibrium, over company or long-term gains from maintaining tacit collusion.

Naturally, the fact that collusion can be facilitated by algorithms does not necessarily imply that it will: especially in non-oligopolistic markets, with a high number of firms, each player has indeed an incentive to stay out of the cartel and benefit from the so-called "cartel umbrella", resulting in failure to coordinate[179]. In addition, perfect market transparency and instantaneous retaliation may be quite difficult to observe in reality. Nevertheless, there is a clear risk that the intensive use of algorithms may facilitate the implementation of both explicit and tacit collusion. By changing market factors, algorithms completely transform traditional brick-and-mortar markets, for which low transparency, slow transactions and non-digitalized decision-making were characteristics. But it is on tacit collusion that digital markets may have the strongest impact: by constantly reapeting the Prisoners's Dilemma through high-speed and transparent transactions (as explained by Paragraph 1.3. of Chapter I), algorithmic oligopolists may choose a collusive outcome as dominant strategy; moreover, by removing the relevance of traditional conditions for tacit

[177] *Ibid*., 65-67.
[178] Peter Georg Picht and Benedikt Freund, "Competition (Law) in the Era of Algorithms", *Max Planck Institute for Innovation & Competition Research Paper* n. 18-10 (2018): 7.
[179] Reinhard Selten, "A Simple Model of Imperfect Competition, Where 4 Are Few and 6 Are Many", *International Journal of Game Theory* 2, n.1 (1973).

collusion to exist, such as the low number of firms, even non-oligopolistic markets could replace explicit collusion with tacit coordination[180].

3. How algorithms may promote collusion

Once it is asserted that collusion might be easier to sustain in digital markets characterised by high transparency and frequent interactions, the question that follows is how undertakings can actually establish collusion through pricing algorithms. Following the Ezrachi and Stucke research in *Virtual Competition: The Promise and Perils of the Algorithm-driven Economy*[181], three nonexclusive categories of algorithmic collusion will be identified: the *Messanger* scenario, in which the pricing algorithm is implementing an already made explicit agreement between colluding parties; the *Hub and Spoke* scenario, in which a single parallel pricing algorithm may determine the market price charged by numerous users on the same platform; and *The Predictable Agent* scenario, where unrelated undertakings in the same market use algorithms to monitor prices and adjust them to each other's prices. Finally, a fourth challenging category will be taken into account: through trial-and-error and experiments, self-learning algorithms could give rise in the future to the *Digital Eye* scenario, where algorithms may autonomously determine the means to optimise profit and execute whichever strategy they deem optimal, collusive practices included[182].

While, on one hand, messenger and (partially) hub-and-spoke algorithms may be used as a technical tool to assist in implementing explicit collusion or hub-and-spoke cospiracies and may be quite easily found as competition law infringements, parallel and (ipothetically) self-learning algorithms, on the other hand, may facilitate tacit coordination. The last two scenarios, therefore, raises the most challenging legal issues for competition authorities: conscious parallelism concerns, as explained at Paragraph 2, may be widely enhanced in an algorithmic environment, making the

[180] Salil K. Mehra, "Antitrust and the Robo-Seller: Competition in the Time of Algorithms", *Minnesota Law Review* 100 (2016): 1339-1351.
[181] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016).
[182] Ariel Ezrachi and Maurice E. Stucke, "Artificial Intelligence & Collusion: When Computers Inhibit Competition", *University of Illinois Law Review* 2017, n. 5 (2017): 1782-1784.

discrimen between unlawful explicit collusion and lawful tacit collusion completely blurred[183].

3.1. Messenger algorithms: implementing pre-existing explicit collusion

The most simple role of algorithms as facilitators of collusion is in monitoring competitors' actions in order to enforce a previously existiting collusive agreement. Under the *Messenger* scenario, undertakings explicitly agree to collude and map out the cartel; computer algorithms, which cartel members program to align their behaviour and punish any deviation from the agreement, help as messengers in executing the collusion[184]. Two are the main types of algorithms which can facilitate explicit collusive agreements during two different phases of the cartel's life: signalling algorithms, under the "development" phase of the collusive agreement, and monitoring algorithms, under the "live" phase.

3.1.1. Signalling algorithms

During the opening phase of the collusive agreement, companies, in order to avoid explicit and evident communication, may attempt to reveal an intention to collude, to negotiate and to find focal points around which to align their prices through signalling – for instance, by raising prices in the expectation its competitors will do likewise – and unilateral price announcements. Although signalling may be observed both in digital and traditional environments, it usually does not come without a cost in brick-and-mortar markets. Whenever most competitors do not receive the signal or intentionally decide not to react, indeed, the signalling firm loses sales and profits, thus leading to failure to coordinate[185]. On the opposite, algorithms might reduce or even eliminate the cost of signalling in digital markets, by enabling companies to automatically set very fast actions which can be easily read by rivals possessing good analytical algorithms.

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[183] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 25.

[184] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 39.

[185] Joseph E. Harrington Jr. and Wei Zhao, "Signaling and Tacit Collusion in an Infinitely Repeated Prisoners' Dilemma", *Mathematical Social Sciences* 64, n. 3 (November 2012): 279.

In this context, signalling algorithms can be very effective as messengers in supporting negotiation of the terms of collusion between companies, before actually engaging in price coordination. **Figure 4** portays the functioning of a typical signalling algorithm: each firm continuously sends new signals ($\bar{s}$) and monitors through the algorithm the signals sent by the other competitors (s_n); then, when all players finally send the same signal, firms can fix the agreed price until a new successful negotiation takes place[186].

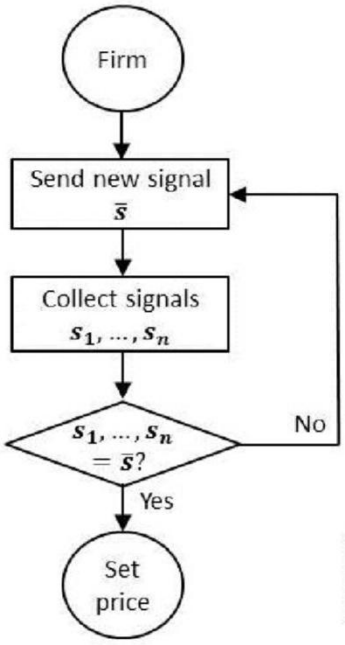

Figure 4 – Signalling algorithm (**Source**: Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 31)

One effective way to employ signalling algorithms to facilitate collusion could be to publicly disclose through the algorithm detailed data which is used as a code to propose and negotiate price increases. This was the situation of the *Airline Tariff Publishing* case[187]. In 1992, the United States alleged that the defendant airlines used the Airline Tariff Publishing Company (ATPCO)[188] fare dissemination system to

[186] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 29-31.
[187] *United States v. Airline Tariff Publishing Co*., 836 F. Supp. 9 (D.D.C. 1993).
[188] The **Airline Tariff Publishing Company (ATPCO)** is a central clearinghouse that compiles all the data received from airline companies (which includes price, travel dates, origin and destination

exchange information, communicate, and agree upon supracompetitive fares. In the ATPCO database, each airline could attach up to two footnotes to any fare, using them to identify the relevant ticketing and travel dates. Among these footnotes, the First Ticket Dates, which indicated a future date at which a fare was currently scheduled to become available for purchase, and Last Ticket Dates, which indicated a future date at which a fare might no longer be available, were used by the airlines to communicate proposals to raise fares or eliminate discounted fares[189]. Essentially, the defendants employed the computerized fare dissemination system to monitor competitors' responses to their signals and, thanks to this arrangement, they negotiated for several weeks through fare changes until all the airlines had indicated their commitment to increase fares or eliminate discounts by filing the same fare in the same market with the same First or Last Ticket Date. Once the agreement was established, the computer program also enabled them to verify possible deviations from the agreed fare and to signal retaliatory measures. The algorithm, therefore, simply executed tasks that were previously set by companies and helped enforcing the humans' anticompetitive agreement, which was investigated by the US Department of Justice (DoJ) under Section 1 of the Sherman Act[190]. In deciding the case, the DoJ then reached a settlement agreement with the airline companies, under which the latter agreed to stop announcing most price increases in advance.

3.1.2. Monitoring algorithms

Differently from signalling algorithms, monitoring algorithms simply help to check the right functioning and working of a pre-existing collusive agreement, where the common collusive price have been already set. Monitoring algorithms, indeed, collect information concerning competitors' business decisions and prices, look for any potential deviation from the established collusive price ($\bar{p}$) and eventually program immediate retaliations, such as price wars, as soon as any firm deviates (**Figure 5**)[191].

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airports etc.) and shares it in real time with travel agents, computer reservations systems, consumers and the airline companies themselves.

[189] *United States v. Airline Tariff Publishing Co*., 836 F. Supp. 9 (D.D.C. 1993), 7.

[190] Severin Borenstein, "Rapid Communication and Price Fixing: The Airline Tariff Publishing Company Case", Working paper (1997), http://faculty.haas.berkeley.edu/borenste/download/ATPCASE1.PDF.

[191] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 26-27.

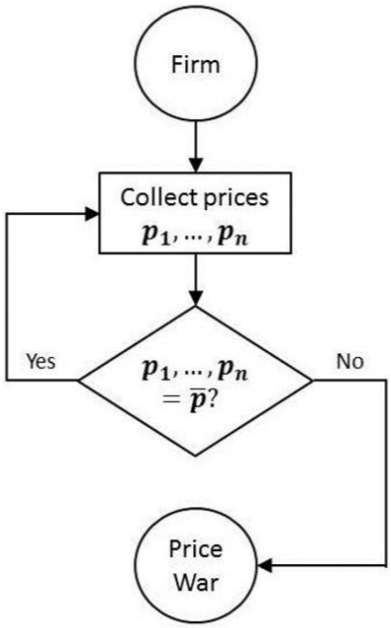

Figure 5 – Monitoring algorithm (**Source**: Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 27)

The most recent – and only one – example of detected monitoring algorithm facilitating an horizontal agreement has been the 2016 proceeding of the US Department of Justice (DoJ) and the UK Competition & Markets Authority (CMA) regarding the so-called *Poster Cartel* case[192]. Here, members of a price-fixing scheme involving posters sold through Amazon Marketplace have been held responsible for breaching Section 1 of the Sherman Act. The posters' sellers involved had initially agreed, by e-mail, that they would no longer underbid each other. After a period of manual adjustment, David Topkins (one of the posters' sellers) and his co-conspirators adopted specific pricing algorithms that collected competitors' prices of posters, in order to coordinate changes to their respective prices and eventually set the same price. The monitoring algorithm was therefore used to facilitate a pre-arranged horizontal price-fixing agreement, thus acting as a simple intermediary[193].

[192] DoJ, Plea Agreement of 30 April 2015, Case *U.S. v. David Topkins*; DoJ, Plea Agreement of 11 August 2016, Case *U.S. v. Daniel William Aston and Trod Limited*; CMA, Case 50223 – *Online sales of posters and frames*, Decision of 12 August 2016.
[193] Monopolkommission, *Algorithms and collusion* (2018), 7.

Besides horizontal agreements, monitoring algorithms may also be employed as facilitators of vertical anticompetitive agreements, specifically *resale price maintenance* (RPM). By means of such contracts, a supplier and a retailer do agree on the retailer's downstream price in the form of a fixed or a minimum sales price; inasmuch as competition is negatively affected, RPM agreements have been prohibited as "restrictions by object" in violation of Article 101 TFEU. On this background, monitoring algorithms could deeply enhance RPM effects and capability to lessen competition. First, they can be extremely helpful in detecting deviations from a fixed resale price, contributing to the effectiveness of the vertical agreement. Second, with regard to recommended prices, increased price transparency through algorithms may allow producers to retaliate against retailers that do not comply with pricing recommendations, thus limiting the incentives to deviate in the first place: the supplier would thus actually turning that recommended price to a fixed resale price (RPM). Third, when retailer A adheres to a fixed resale price (RPM) and is being monitored by retailer B using algorithms, retailer B may match A's price, although he is not engaged in RPM, uniforming in this way prices at an higher level[194]. In this context, the last detected case has been the 2018 European Commission decision to fine €111 million four electronic manufacturers[195]. Asus, Denon & Marantz, Philips and Pioneer engaged in an explicit *resale price maintenance* and used sophisticated monitoring algorithms to effectively track resale price setting in the distribution network and to intervene in case of price decreases, thus making the vertical agreement effective.

3.1.3. Competition law enforcement of algorithmic explicit collusion

From an enforcement perspective, in the *Messenger* scenario an explicit collusive agreement or concerted practice is always previously set by undertakings. Signalling and monitoring algorithms thus simply facilitate collusive outcomes undertakings would have otherwise achieved through other means, e.g. non-automatically setting higher prices, distributing price lists or communicating through trade associations. In this respect, the antitrust infringement occurred at the moment of the explicit meeting of minds, which had taken place in advance. The rationale behind this is that if price-fixing cartels are illegal under Article 101 when implemented in the bricks-and-

[194] Organisation for Economic Co-operation and Development, *Algorithms and Collusion – Note from the European Union* (21-23 June 2017), §12.
[195] European Commission – Press Release, *Antitrust: Commission fines four consumer electronics manufacturers for fixing online resale prices*, Brussels (24 July 2018).

mortar world, they *a fortiori* must be voided when enforced online by algorithms[196]. Hence, once detected, competition enforcers have the tools to challenge explicit algorithmic collusion[197]. First, Article 101 TFEU and Section 1 of the Sherman Act traditional concepts of agreement or concerted practice can be applied straightforwardly. Second, competition authorities can establish violations and impose fines or settlement arrangements on the companies using the classic notions of "restriction by object"[198] or "*per se*" illegality[199].

According to the EU Commision inquiry into the e-commerce sector, about half of the retailers nowadays track online prices of competitors. 67% of those retailers also use automatic software programmes and monitoring algorithms for that purpose[200]. Moreover, other reports suggest that algorithmic pricing is not only limited to online environment: thanks to the use of electronic price tags, it is also used by brick-and-mortar retailers[201]. In this context, it is important to remember that as signalling and monitoring algorithms may be used to facilitate cartels and anticompetitive conducts, they may also be used by individual companies to enhance market transparency and execute a more aggressive competitive behaviour: for instance, a maverick firm may potentially destabilize cartel activity by using sophisticated algorithms. As messengers and intermediaries, algorithms are neither a negative nor a positive force; rather, their effect depends exclusively from human will. It is however undeniable the important psychological impact of intermediary algorithms on prospective collusions: by increasing the distance between the person and the illegal day-to-day

[196] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 12.
[197] Terrell McSweeny and Brian O'Dea, "The Implications of Algorithmic Pricing for Coordinated Effects Analysis and Price Discrimination Markets in Antitrust Enforcement", *Antitrust* 32, n. 1 (2017): 76.
[198] A "**restriction by object**" is a restriction which by his very nature has the potential to restrict competition within the meaning of Article 101(1) TFEU. The European courts and Commission have generally treated price-fixing, market-sharing and bid-rigging agreements as having the object of restricting competition. (Case C-8/08, *T-Mobile Netherlands and Others v Raad van bestuur van de Nederlandse Mededingingsautoriteit*, 4 June 2009, ECR [2009] I-4529, §29).
[199] In US competition law, restraints are ***per se* illegal** when inherently anticompetitive and damaging to the market that they warrant condemnation without further inquiry into their effects on the market or the existence of an objective competitive justification. Agreements among competitors that influence price structure are *per se* illegal. (*United States v. Socony-Vacuum Oil Co.*, 310 U.S. 150, 221 (1940))
[200] European Commission, *Final report on the E-commerce Sector Inquiry*, Brussels (10 May 2017), 175.
[201] Oxera, *When algorithms set prices: winners and losers. Discussion paper* (19 June 2017), 7.

activity, indeed, computers can reduce the guilt of wrongdoing, making collusive conducts easier to bear[202].

In conclusion, both signalling and monitoring algorithms may facilitate and negotiate as intermediaries illegal agreements and make collusion more efficient. Still, they do not eliminate the need for explicit communication during the establishment of the cartel. For this reason, the *Messenger* scenario could be regulated using traditional antitrust tools and does not usually raise enforcement concerns.

3.2. The algorithm-enhanced Hub-and-Spoke

Having considered the relatively simple *Messenger* scenario, the *Hub-and-Spoke* model appears immediately more problematic: here, the same algorithms are used as the central "hub" to coordinate competitors' pricing and activities. Unlike the first scenario, however, the pricing algorithm is not merely a mean to execute a digital cartel; on the opposite, it is the competitors' use of the same pricing algorithm that stabilizes prices and leads to the (sometimes) inadvertent collusive outcome[203].

Firstly, it must be highlighted that the *Hub-and-Spoke* scenario is not unique to the online and algorithmic environment[204]. Courts have indeed long recognised the existence of hub-and-spoke price-fixing conspiracies even in brick-and-mortar markets. As a US court described in 2003, these illegal activities take form when "a central mastermind, or 'hub', controls numerous 'spokes', or secondary co-conspirators"[205]; hence, each spoke participates to independent transactions with the individuals at the 'hub', which collectively further a single illegal enterprise. Although the concept has not yet been precisely defined under EU competition law, UK case law has provided a legal test for finding of traditional hub-and-spoke collusion. The test requires five conditions. First, a company (a "spoke") must disclose to a supplier (the "hub") its future intentions; second, the company may foresee that the supplier will pass the information to other competitor companies; third, the supplier must pass the information to the competitors of the company;

[202] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 42-45.
[203] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 13.
[204] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 42-46.
[205] *United States v. Newton*, 326 F.3d 243, 255 (1st Cir. 2003).

fourth, the competitors may know the circumstances in which the information was disclosed to the supplier by the first company; fifth, competitors must use the information in determining their own future pricing intentions[206]. In order to be held liable of a collusive practice under Article 101 TFEU, each defendent must be therefore aware of the scope of the conspiracy, where the hub-and-spoke system serves as a communication channel between the competitors and thus facilitates the collusive action[207]. **Figure 6** represents the traditional structure described above.

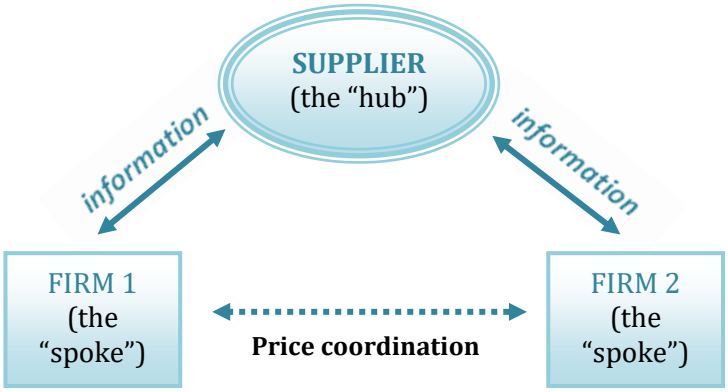

Figure 6 – Traditional Hub-and-Spoke

Translating this model to a digital environment, computer algorithms could execute the "hub" function to facilitate collusion among competitors. Since the creation and improvement of algorithms is expensive, each competitor may outsource its pricing to an algorithm of an upstream supplier (the "hub"). What distinguishes a traditional scenario from an algorithm-driven hub-and-spoke, however, is that under the latter anti-competitive result may be the consequence, but not necessarily the original aim of competitors' action: competition's violations may indeed also occur due to unintentional alignment and use of similar pricing algorithms[208].

[206] *Tesco Stores Ltd, Tesco Holdings Ltd and Tesco Plc v OFT* (2012), Competition Appeal Tribunal (CAT), 1188/1/1/11, [2012] CAT 31, § 57.
[207] European Commission – Press release, *Antitrust: Commission fines broker ICAP €14.9 million for participation in several cartels in Yen interest rate derivatives sector* (Brussels: 4 February 2015), 1.
[208] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 47-48.

In this context, algorithmic hub-and-spoke scenarios may be observed at two levels: the output level (i.e. algorithm) and the input level (i.e. data)[209]. The first scenario, which could be defined as a "de-facto hub-and-spoke structure"[210], entails the use of the same upstream supplier's pricing algorithm (***x***) by competitors; however, no exchange of data input can be noticed (**Figure 7**). Consequently, the industry would face a wide use of identical algorithms, which competitors employ to determine the market price. This may possibly lead to competitors reacting in a similar way to external events, such as changes in input costs or demand: hence, since they all use a similar "brain" to determine their pricing strategy, their market behaviour and prices could easily align. Moreover, if competitors were aware of using the same pricing algorithm, firms would be better able to predict their competitors' price setting behaviour; thereby, reducing strategic uncertainty, algorithms could help sustain a tacitly coordinated outcome[211].

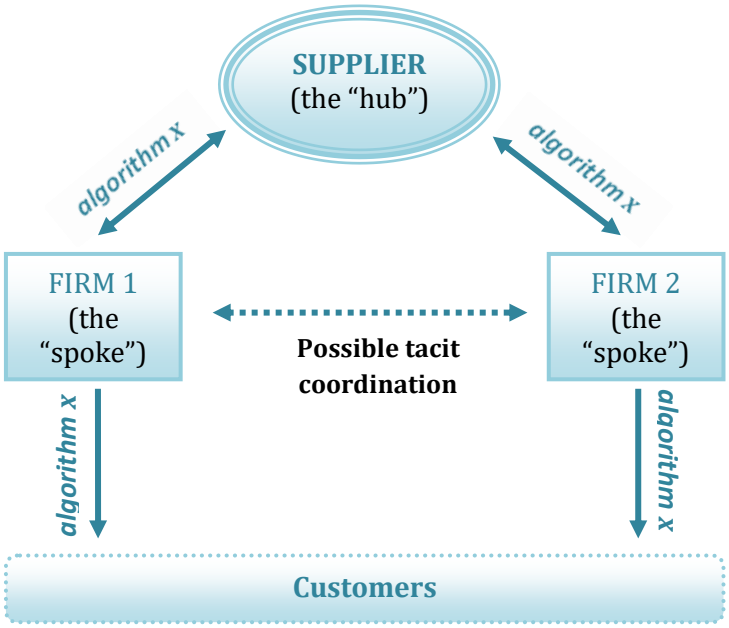

Figure 7 – Algorithm-fueled Hub-and-Spoke

[209] Organisation for Economic Co-operation and Development, *Algorithmic Collusion: Problems and Counter-Measures – Note by A. Ezrachi & M. E. Stucke* (31 May 2017), §32.
[210] *Ibid*., §32.
[211] Competition and Markets Authority (CMA), *Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing* (2018), 25-26.

Nevertheless, the mere fact that firms independently use the same supplier's pricing algorithm is not, by itself, sufficient to establish tacit coordination. As a matter of fact, there must be still the competitors' intention to acquiesce to the tacit collusion, communicating details of their pricing strategies to rivals and resisting to the temptation to undercut the collusive price. Common and parallel algorithms by themselves cannot help firms to overcome the problem of maintaining collusion, which necessarly need explicit announcements or communications between competitors[212]. Hence, an algorithm-fueled hub-and-spoke, similarly to the *Predictable Agent* scenario of Paragraph 3.3., even though raises concerns on plausible prices alignment, cannot be considered as a competition law infringement; on the opposite, when explicit contact or communication between firms is proved, it may be considered unlawful concerted practices under Article 101 TFEU.

The second scenario, on the other hand, resembles more the traditional hub-and-spoke structure. Here, each of the competitors provides the upstream supplier's algorithm with data input, which then the algorithm uses to determine the prices[213]. Competitors are indeed privy to vast volumes of data (especially cost, product and inventory data), usually knowing that their rivals are doing the same; then, the supplier's pricing algorithm uses the market information it collects from each firm in determining the optimal prices for each spokes' product (**Figure 8**). Companies thus use the same provider (the "hub") for their dynamic pricing strategies: when the same supplier's algorithm (***x***) and the same data points and values are employed by multiple market players, the likelihood for prices alignment increases[214].

[212] *Ibid.*, 25-26.
[213] Organisation for Economic Co-operation and Development, *Algorithmic Collusion: Problems and Counter-Measures – Note by A. Ezrachi & M. E. Stucke* (31 May 2017), §32.
[214] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 49.

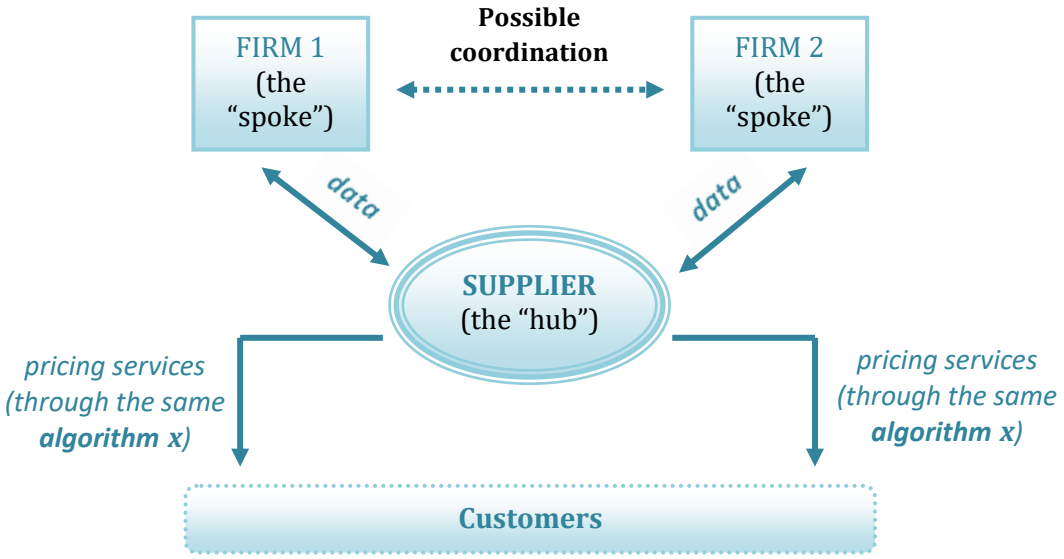

Figure 8 – Algorithm- and data-fueled Hub-and-Spoke

In order to determine antitrust liability in an algorithm- and data-fueled Hub-and-Spoke structure, US courts must prove firms' anticompetitive intent; differently, agencies in European Union should, but are not mandatorily required to, consider the firms' intent in using the same pricing algorithms. In particular, whether the spokes intended a clearly illegal result (such as agreeing to fix prices), or acted with knowledge that illegal results, which actually occurred, were probable, a competition law infringement may emerge[215]. In 2016, the Court of Justice of the European Union applied the requirement in the *Eturas* case, where a possible conspiracy facilitated by an hub-and-spoke system was analysed[216]. In that case, the administrator of a Lithuanian online travel-booking comparison platform (the "hub") dispatched an electronic notice to its travel agents (the "spokes"), announcing a new software that put a 3% cap on discount rates applicable to clients. The practice was considered by the Court as a concerted practice under Article 101 TFEU, since it pursued anticompetitive outcomes. In finding travel agents' liability, however, the Court held that travel agents who knew the content of the message sent via the

[215] *United States v. U.S. Gypsum Co*., 438 U.S. 422, 444-446 (1978); Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 52-53.
[216] Case C-74/14, *Eturas UAB and Others v Lietuvos Respublikos konkurencijos taryba*, 21 January 2016, ECLI:EU:2016:42 [2016].

system could be presumed to have participated in the collusive concerted practice "unless they publicly distanced themselves from that practice, reported it to the administrative authorities or adduce other evidence to rebut that presumption, such as evidence of the systematic application of a discount exceeding the cap in question"[217]. Therefore, beyond the focus on the public distancing requirement (which it will be widely discussed in Chapter III), the ECJ emphasised particularly the significance of establishing travel agents' awareness of the message and, thus, of the anticompetitive aim of the concerted practice. In other words, when firms use the pricing algorithm aware of the illegal and anticompetitive goal, competition law authorities may consider it as a collusion in the form of a concerted practice[218].

No doubts arise when the supplier's algorithm is specifically designed to facilitate collusion among the spokes, as in the above *Eturas* case. On the other hand, algorithms which are not aimed to facilitate collusion but which, nonetheless, undermine competition and lead to higher prices, give rise to more serious concerns. One recent example of the latter situation could be the market for petrol in Rotterdam, where a number of petrol stations used the same "hub" (the Danish company "a2i Systems") for advanced analytics to determine petrol prices. In enlisting "a2i Systems", the approximately 700 petrol stations sought to improve the pricing analysis in order to lower the cost of price wars, or even to avoid them. As *The Wall Street Journal* reported, the complex algorithm was then tested against a control group which did not use the system to determine the prices: as a result, the profits of the group using the software appeared to average 5% higher, which means for the petrol companies millions of Euros more annually[219]. The "a2i" pricing algorithm, however, was not used to coordinate an unlawful cartel between the petrol stations; on the contrary, it aimed to eliminate the costs of price wars. Thus, the creation of the algorithmic Hub-and-Spoke relationship did not theoretically infringe competition law, since it did not aim to facilitate collusion and soften competition.
Although not driven by a cartel agreement, these "incidental hub-and-spokes"[220] may therefore facilitate alignment and increase prices and profits. Hence, the effects on

[217] *Ibid*., §51.
[218] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 13.
[219] Sam Schechner, "Why Do Gas Station Prices Constantly Change? Blame the Algorithm", *The Wall Street Journal* (May 8, 2017), available at https://www.wsj.com/articles/why-do-gas-station-prices-constantly-change-blame-thealgorithm-1494262674.
[220] Ariel Ezrachi and Maurice E. Stucke, "Sustainable and Unchallenged Algorithmic Tacit Collusion", *University of Tennessee Legal Studies Research Paper* n. 366; *Oxford Legal Studies Research Paper* n. 16/2019 (10 November 2018): 30.

the market may equate to a form of unlawful horizontal coordination, while the conditions for establishing a hub-and-spoke conspiracy may be absent. For this reason, the latter Hub-and-Spoke algorithmic structure raises significant competition concerns: the sharing of the same supplier's algorithm, in particular, does differ from the typical tacit collusion issue described in Chapter I and calls for some adequate forms of intervention[221]. As the UK Competition & Markets Authority has observed, however, three main criteria should be satisfied before assessing the "incidental" hub-and spoke as a possible competition law infringement. First, the proportion of the relevant market that has delegated its pricing to a common supplier's algorithm by means of the hub-and-spoke structure should be sufficiently large to make a price increase worthwhile. Second, the hub's pricing algorithm should make use of non-public information or data-input supplied by multiple competitors both in the "training" and the "live" phase of the algorithm. Third, the objective function of the pricing algorithm should be to maximise the total joint profit of all the competitors, since the hub's remuneration is usually calculated as a proportion of all its clients' sales[222].

3.2.1. Uber's Hub-and-Spoke: a case study

In a digital environment, algorithm- and data-fueled hub-and-spoke cospiracies may involve also internet-based platforms, which bring together sellers and purchasers. Online platforms cover a wide range of activities, such as online marketplaces, social media and price comparison websites; nonetheless, they all share key characteristics, including the use of algorithms to facilitate commercial transactions, collection and use of data about suppliers-customers negotiations and network effects[223]. When the platform's algorithm sets the price and many competing operators agree to use the platform's price, the system may dampen horizontal competition.

A meaningful example of the hub setting the price for its spokes is the online platform for car services Uber Technologies Inc. Uber provides a transport service in over 700 cities via an application for mobile phones; through the app, the customer is offered a ride from A to B for a fixed price. In this context, Uber places itself as a mere intermediary, providing the instrument to connect demand with offer, without

[221] *Ibid*.
[222] Competition and Markets Authority (CMA), *Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing* (2018), 26-27.
[223] European Commission, *Policy - Online Platforms* (14 February 2019), available at https://ec.europa.eu/digital-single-market/en/policies/online-platforms

needing to own or directly employ any vehicle or driver. Drivers, indeed, sign contracts with Uber and provide driving services for customers which use the app; the customers pay the ride only via the app, since the drivers are not allowed to accept any payment by other means; finally, Uber receives the payments and proceeds, after having subtracted the fee associated with the use of the platform, to distribute the revenue to each driver[224].

Uber fares are calculated everywhere through an automated price-setting procedure: a base fare (arbitrarily decided by Uber) is added to the additional amount based on the kilometric distance travelled, the duration of the journey and eventual fees incurred by the driver during the service; the resulting sum is then multiplied by a coefficient determined by the "surge pricing algorithm". This automatic system monitors real-time variations in the number of riders requesting transport and drivers offering their service, thus increasing fares when consumer demand in a location exceeds the supply of available drivers. In this way, drivers, which are not bound by working schedules, have a strong monetary incentive to stay longer on the platform[225].

Uber's pricing algorithm (the "hub") therefore determines the fare for the trip for hundreds of competing drivers (the "spokes"), thus representing a possible threat to the effective functioning of competition in the market for urban transport. Obviously, customers can still compare the Uber price to alternatives (such as taxis or other car service platforms), but the more customers and drivers rely on Uber, the more Uber's algorithm can gain market power and opportunities for coordinated prices and hub-and-spoke conspiracies may increase. Moreover, some commentators have referred to Uber ecosystem as an "algorithmic monopoly". According to this view, the market described by Uber's algorithm is not the open market for urban transport; contrariwise, the price-setting algorithm generates an artificial closed market, where Uber has absolute control on all the relavant factors[226]. As a result of its position of

[224] Julian Nowag, "The UBER-Cartel? UBER between Labour and Competition Law", Working Paper, *Lund Student EU Law Review* 3 (2016): 2.
[225] Jonathan Hall, Cory Kendrick and Chris Nosko, "The Effects of Uber's Surge Pricing: A Case Study" (2015), available at: https://drive.google.com/file/d/0B1s08BdVqCgrOHdwaGlEVVMwa1E/view
[226] Matt Stoller, "How Uber Creates an Algorithmic Monopoly to Extract Rents" (April 11, 2014), available at: https://www.nakedcapitalism.com/2014/04/matt-stoller-how-uber-creates-an-algorithmic-monopoly.html

extreme information asymmetry towards consumers, Uber's platform may mimic a perceived competitive price rather than the true market price[227].

Before trying to cover the alleged Uber's hub-and-spoke conspiracy under competition law, a pre-condition is necessary: service providers (the "spokes") should be characterized as separate undertakings. In the opinion of the European Court of Justice, indeed, where the spokes are considered to be workers, they cannot be accounted as undertakings and competition law provisions do not apply[228]: hence, in order to be investigated by competition authorities, Uber's drivers must be qualified as independent contractors.

In this context, the 2017 decision of the ECJ in *Asociación Profesional Élite Taxi*[229] has changed the European Union perception of the Uber's platform. As a matter of fact, Uber has been considered as a "service in the field of transport", responsible for both the intermediation and the transport services, instead of an "information society service", to which Directive 2000/31/EC ("Directive on electronic commerce")[230] refers. One of the main implication of considering Uber as an integrated transport service is that its partner drivers can hardly be qualified as independent undertakings. As described by Odudu and Bailey, "the concept of an economic entity is best understood as the minimum combination of natural and legal persons able to exert a single competitive force on the market"[231]. Taking this into account, a Uber's unlicensed driver could not probably exert a single competitive force on the market for urban transport. Uber and its drivers would therefore constitute a single economic entity (i.e. a single independent undertaking) and would not be subjectable to the scrutiny of competition law, since it would be impossible to identify a competitive relationship among the drivers.

If, on the other hand, the intermediation function of the platform could be separated from the transport service, Uber's drivers could be considered able to compete among themselves. In this context, despite their widespread reluctance to penalize

[227] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 51.
[228] Joined Cases C-159/91 and C-160/91, *Poucet et Pistre*, ECR [1993] I 637; EU:C:1993:63 [1993].
[229] Case C-434/15, *Asociación Profesional Élite Taxi v Uber System Spain SL*, 20 December 2017, ECLI:EU:C:2017:981 [2017].
[230] Directive 2000/31/EC of the European Parliament and of the Council of 8 June 2000 on certain legal aspects of information society services, in particular electronic commerce, in the Internal Market ('Directive on electronic commerce'), OJ L 178, 17 July 2000.
[231] Okeoghene Odudu and David Bailey, "The Single Economic Entity Doctrine in EU Competition Law", *Common Market Law Review* 51 (2014): 1723.

Uber and its challenge to the national monopoly of taxis, competition agencies may invoke an algorithmic hub-and-spoke cartel to asses a violation of Article 101 TFEU. Uber's pricing algorithm, indeed, usually leads to higher prices for consumers[232] and to the elimination of price competition between drivers[233]. Under EU competition law, however, Article 101(3) could be applicable if consumers would benefit from the Uber arrangement; yet, the "non-elimination of competition" criterion would probably not be satisfied. Whether it would be possible to advance the pro-competitive effect on the taxi-market as a whole, i.e. the increased competition with the state organised monopolies, remains extremely questionable[234].
As for potential infringements under Article 102 TFEU, a situation of economic dominance in the relevant market should necessarily be assessed. Especially where, as in the Uber case, the relevant market involves both the intermediation service and the underlying physical service, defining a position of dominance could be extremely difficult. However, strong network effects combined with the accumulation of large quantities of personal data may theoretically enable Uber to consolidate a dominant position in the market for hired transport. Nonetheless, the Ubers' surge pricing algorithm is unlikely to be qualified as an exploitative abuse, since it affects only a small portion of the journeys provided through the platform and for a short period of time: on the contrary, excessive pricing practices should be "significant and persistent" and not merely "temporary or episodic"[235]. On the other hand, an exclusionary abuse may take place whether Uber would decide to forclose the market to competitors through predatory pricing, charging consumers unduly low prices, which anyway does not represents the "surge pricing algorithm" issue.

Although the situation is still unclear, these considerations have already led, in the United States, to a first antitrust class action lawsuit against Uber's ex CEO and founder Travis Kalanick and his drivers. The claim, brought by Spencer Meyer on behalf of every US customer who ever used Uber, alleged that Uber had facilitated a price-fixing cartel in violation of Section 1 of the Sherman Act. In particular, Uber would have conspired with its drivers to generate supra-competitive prices through their agreement to use Uber pricing algorithm. Interestingly, the federal District

[232] Gideon Lichfield, "How Surge Pricing Works", *The Atlantic* (31 October 2015), available at: http://www.theatlantic.com/business/archive/2015/10/how-uber-surge-pricingworks/413335/?utm_source=SFFB.
[233] Differently, for instance, on Airbnb platform users offer their services with competing prices.
[234] Julian Nowag, "The UBER-Cartel? UBER between Labour and Competition Law", Working Paper, *Lund Student EU Law Review* 3 (2016), 5.
[235] Case C-177/16, *Autortiesību un komunicēšanās konsultāciju aģentūra - Latvijas Autoru apvienība v Konkurences padome,* 14 September 2017, EU:C:2017:689 [2017], §56-61.

Court allowed the motion on March 31, 2016, refusing to dismiss the complaint[236]. The Court, indeed, found plausible the existence of an horizontal conspiracy via the Uber terms and app: in the opinion of the Court, the drivers would have obtained supra-competitive prices and would have forgone competition, as Uber's pricing algorithm had guaranteed that the other drivers would not have undercut their prices, thus stabilising the cartel; moreover, this line of arguments was even more convincing given that Uber had organised events for drivers and increased the fares after drivers had demanded an increase. In the Court's decision, furthermore, Judge Rackoff aptly highlighted that "the advancement of technological means for the orchestration of large-scale price-fixing conspiracies need not leave antitrust law behind"[237]. On August 5, 2016, however, Uber appealed, asserting a demand for arbitration: the 2nd US Circuit Court of Appeal confirmed that Uber properly notified in online users agreements that disputes should be arbitrated; for this reason, Meyer appeared to have agreed to arbitrate his claims with Uber[238]. Hence, the Second Circuit remanded the case to the District Court, which finally, on March 5, 2018, reaffirmed the 2nd Circuit Court findings and granted Uber's motion to compel arbitration[239].

Despite its negative ending, what emerges from the *Meyer v. Kalanick* case is the difficult enforcement and legal uncertainty sourronding algorithimic alleged Hub-and-Spokes, when evidence of the anticompetitive intent are absent. Courts have already perceived the sensibility of the theme, as the risk of over-intervention and false positives could damage the development of future internet-based platforms. The new legal challenges therefore demand deeper understanding of the functioning and the competitive dynamics of the market, in order to identify the tipping point from legal use to anticompetitive use of an algorithm.

3.3. Parallel algorithms: algorithm-fueled tacit collusion

Unlike the *Messenger* and *Hub-and-Spoke* scenarios, where computer algorithms help to execute explicit illegal agreements or serve usually as the hub in Hub-and-

[236] *Spencer Meyer v Travis Kalanick*, 15 Civ 9796; 2016 US. Dist. Lexis 43944.
[237] *Ibid*., §15.
[238] *Meyer v. Uber Techs., Inc*., 868 F.3d 66, 80 (2nd Cir. 2017).
[239] *Meyer v. Kalanick*, 291 F. Supp. 3d 526 (S.D.N.Y. 2018).

Spoke conspiracies, the third *Predictable Agent* scenario[240] does not involve any clear or implied anticompetitive agreement or arrangement between undertakings. On the contrary, each market player designs unilaterally and autonomously its pricing algorithm (***a*** and ***b***), which is, among other things, programmed to monitor price changes and react to any competitor's price reduction or increase with a strategy to maximise profits. **Figure 9** seeks to outline the functioning of parallel algorithms described above. In this context, signalling algorithms – previously outlined at Paragraph 3.1.1. – are usually employed: a monitoring of competitors' reactions follows an initial price increase of the firm; when all the competitors' prices are finally aligned, the price is thus confirmed .

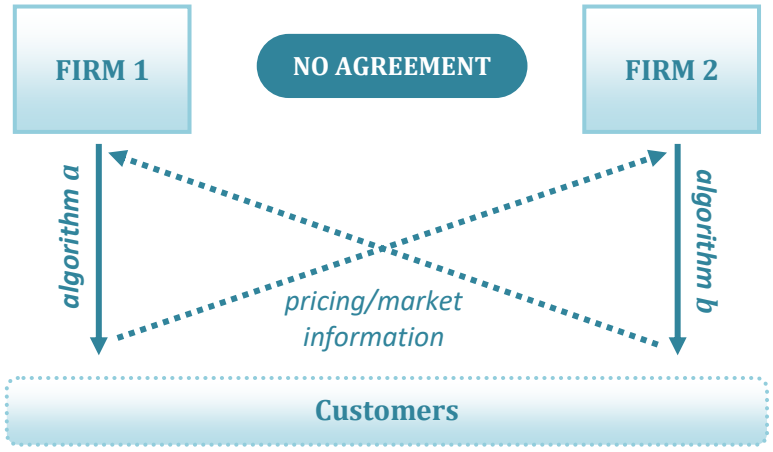

Figure 9 - Parallel algorithms

According to the 2017 E-commerce Sector Inquiry of the European Commission, 78% of the retailers that use algorithms to monitor market prices adjust consequently their own prices to those of their competitors. Some of them (35%) use automatic price adjustments based on monitoring software programmes, together with manual ones[241]. As already underlined in Paragraph 2, three are the main effects on the market when most competitors in an industry adopt their own independent pricing algorithm.

[240] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 56-70.
[241] European Commission, *Final report on the E-commerce Sector Inquiry*, Brussels (10 May 2017), 175-176.

First, both demand and supply of market data (including competitors' pricing and sale terms) increases. The algorithms will indeed engage in "predictive analytics", which enables firms to combine real-time data to build forecasts of pricing and commercial decisions[242]: in order for algorithms to function effectively, computers need quick access to key market data, thus increasing data demand. Moreover, in shifting to pricing algorithms, each market player posts its current prices and decisions, enhancing in this way the supply of market data. The result will thus be a transparent market where all firms collect real-time data on each other and on market characteristics[243]. Second, the speed and frequency of interactions between market players becomes much higher. Being able to asses and adjust prices within milliseconds, pricing algorithms can reprice firms' products many thousands of times per day[244]. Third, taking into account the predicted responses of their competitors, pricing algorithms appear better than humans to calculate the optimal profit-maximising price: since it is ineffective for humans to independently analyse all the underlying market data, firms rely unconditionally on pricing algorithm[245].

As explained in Chapter I, when transparency and speed in responding increase in concentrated markets with homogeneous goods, so too does the risk of tacit collusion. In an environment dominated by similar pricing algorithms, the process may be even faster, more stable and harder to detect, without the need for a preliminary agreement[246]. Once it has been asserted that market conditions are prone to tacit collusion, infact, it is likely that algorithms learning faster than humans are able through high-speed interactions to reach a cooperative equilibrium[247]. In particular, if the algorithm leads firms to adopt very simple and predictable pricing

[242] John Edwards, "What is predictive analytics? Transforming data into future insights", *CIO* (May 16, 2019), available at: https://www.cio.com/article/3273114/what-is-predictive-analytics-transforming-data-into-future-insights.html

[243] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 61.

[244] Analysis from price intelligence firm Profitero has revealed that Amazon.com implements more than 2.5 million price changes every day, compared with just over 50,000 total price changes made by brick-and-mortar retailers BestBuy and Walmart throughout an entire month. (Profitero, "Profitero Price Intelligence: Amazon makes more than 2.5 million daily price changes" (December 10, 2013), available at: https://www.profitero.com/2013/12/profitero-reveals-that-amazon-com-makes-more-than-2-5-million-price-changes-every-day/)

[245] Competition and Markets Authority (CMA), *Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing* (2018), 29-30.

[246] Dylan I. Ballard and Amar S. Naik, "Algorithms, Artificial Intelligence, and Joint Conduct", *Competition Policy International Antitrust Chronicle* (May 2017): 1.

[247] Organisation for Economic Cooperation and Development (OECD), *Algorithms and Collusion – Background Note by the Secretariat* (21-23 June 2017), 30.

behaviour, like price matching or price cycles, which would be easy to decipher by competitors, tacit coordination appears to be more likely. The reduction of strategic uncertainty may indeed help sustain (but not necessarly lead to) a tacitly coordinated outcome and higher prices[248].

In order to illustrate how algorithmic market transparency can lead to price increases and conscious parallelism, the german oligopoly in the fuel sector is analysed as example. In 2011, the government suspected that five companies – BP (Aral), ConocoPhillips (Jet), ExxonMobil (Esso), Shell and Total – dominated the off-motorway petrol station business in Germany[249]. To promote competition, the petrol stations were thus required to report to the government's transparency unit any price changes for gasoline or diesel fuel in real-time, which were then transmitted to consumers. The system, lowering consumers' search costs for finding cheaper gasoline or diesel, appeared at a first glance procompetitive and able to lower prices. On the opposite, an economic study found later that the enhanced market transparency actually increased petrol prices by about 1.2 to 3.3 euro cents and diesel prices by about 2 euro cents[250].

In the case under examination, the increase in pricing was not the likely result of communications between firms; instead, it reflects tacit collusion, where firms, aware of their interdependence through a transparent market, recognise that they will profit by acceding to the higher price. With pricing algorithms the retaliation time is further reduced: given the velocity with which firms can detect price reductions and pricing algorithms can adjust to it, no undertaking would likely profit by discounting; hence, the competitors have less incentive to discount and prices, as a result, will climb[251].

3.3.1. Competition law enforcement of algorithmic tacit collusion

Once explained the possibility for parallel algorithms to enhance tacit collusion, the enforcement perspective must be analysed. Firstly, the *Predictable Agent* scenario

[248] Competition and Markets Authority (CMA), *Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing* (2018), 27-28.
[249] Bundeskartellamt, *Fuel Sector Inquiry – Final Report* (May 2011), 4.
[250] Ralf Dewenter, Ulrich Heimeshoff, and Hendrik Lüth, "The impact of the market transparency unit for fuels on gasoline prices in Germany", *Applied Economics Letters* 24 (May 2016).
[251] Ariel Ezrachi and Maurice E. Stucke, "Sustainable and Unchallenged Algorithmic Tacit Collusion", *University of Tennessee Legal Studies Research Paper* n. 366; *Oxford Legal Studies Research Paper* n. 16/2019 (10 November 2018): 26-27.

does not involve any explicit agreement: the firms, in unilaterally implementing the algorithms, never agree to fix prices. However, each human, when configuring the algorithm independently, recognises that the industry-wide adoption of similar signalling algorithms would likely foster tacit collusion and lead to higher prices and supra-competitive equilibria. As Ezrachi and Stucke outline, "this conscious parallelism at the human level leads to the programming of machines which are aware of possible conscious parallelism at the market level"[252]: hence, there is no evidence of an agreement among the firms but there could be likely evidence of the human's and algorithm's anticompetitive intent.

Absent evidence of an explicit agreement, competition agencies lack enforcement tools, outside the *ex ante* merger control, that could effectively deal with tacit collusion. As a matter of fact, Articles 101 and 102 TFEU usually fail to consider tacit collusion as an infringement under EU competition law. In this context, some have argued that parallel algorithms could represent the "correlative factors" between firms through which - as already outlined in Chapter I – a collective dominant position in the meaning of Article 102 TFEU may arise[253]. The use of pricing algorithms and the subsequent transparency increase in the market may moreover determine the existence of collective dominant positions even in non-oligopolistic markets. Nevertheless, it must be reminded that Article 102 always requires the proof of an abuse of collective dominance, thus making the application of the Article extremely challenging and rare.

Outside the core competition provisions, however, alternative legal instruments may be considered. First, parallel pricing algorithms could be viewed as facilitating practices: while the price monitoring at the heart of traditional tacit collusion is legal under competition law, one may ask whether the creation of conscious parallelism through "artificial" algorthimic means should give rise to antitrust intervention.

In European Union, facilitating practices are labelled as "concerted practices" under Article 101(1) TFEU. In this context, information exchange, considered a concerted practice under established conditions, may show parallels to pricing algorithms

[252] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 65.
[253] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 172-176.

implementing tacit collusion[254]. The central underlying concern in both situations is that the behaviour will affect market characteristics. As a matter of fact, information exchange can constitute an unlawful concerted practice under Article 101(1) if it reduces strategic uncertainty, thus if it "creates conditions of competition which do not correspond to the normal competitive conditions of the market in question"[255]. In particular, exchange of information, similarly to pricing algorithms, can decrease uncertainty increasing transparency in the market, reducing market complexity, buffering instability or compensating for asymmetry[256]. Thus, both information exchange and algorithms may alter the same market conditions to facilitate coordination. Another key aspect of information exchange is the type of data which is provided and the frequency with which it is exchanged. In this context, European Commission defines data which concern prices and quantities and cover future behaviour as the most strategic and high-frequent exchanges of information as the most prone to a collusive outcome[257]. Furthermore, Italian Council of State, among the others, specified that "the presumed public nature of the information exchanged [...] cannot exclude the unlawfulness of a concerted agreement" insofar as the data in question were not easily available on the market in the same form and modality[258]. Since they provide frequent updates on competitor's prices and they monitor public market data, pricing algorithms may raise the same competition concerns.

Therefore, although there is no actual information exchange, the effects of algorithms on possibilities to coordinate would be similar to exchanging data. The independent use of parallel pricing algorithms lacks, however, the "communication or contact between competitors" requirement[259]. Although the ECJ has sometimes recognised that even simple information diffusion to the public could represent a violation of Article 101[260], algorithmic collusion does not fall within the traditional definition of information exchange. Unless the notion of "concerted practice" and "communication" would be officially expanded (whose possibility will be discussed

[254] Luca Calzolari, "La collusione fra algoritmi nell'era dei big data: l'imputabilità alle imprese delle "intese 4.0" ai sensi dell'art. 101 TFUE*"*, *Media Laws* n. 3 (2018): 231-232.

[255] Communication from the Commission - Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, OJ C 11, 14 January 2011, §61.

[256] *Ibid*., §77.

[257] *Ibid*., §86-91.

[258] Council of State, Judgment no. 9565, *Ras-Generali/Iama Consulting* (29 December 2010).

[259] Communication from the Commission - Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, OJ C 11, 14 January 2011, §60.

[260] Case 48/69, *Imperial Chemical Industries Ltd. V Commission of the European Communities*, 14 July 1972, ECLI:EU:C:1972:70 [1972], §100-101.

in Chapter III), the Commission will thus be reluctant to consider algorithmic tacit collusion as information exchange under Article 101 TFEU.

Differently, in the United Stated, facilitiating practices are usually considered as "unfair practices" under Section 5 of the US Federal Trade Commission Act[261], which extends beyond the Sherman Act and other US antitrust laws[262]. In the context of Section 5 "unfair methods of competition", the Federal Trade Commission (FTC) could bring claims against "invitations to collude", i.e. unilateral communications of information to competitors with anti-competitive effects, even without evidence of agreement or communication[263]. Under the current legal standard, the FTC would just need to show that a practice (in this case, the use of an algorithm) is unfair because (1) it causes or is likely to cause substantial injury to consumers; (2) it cannot be reasonably avoided by consumers; and (3) is not outweighed by countervailing benefits to consumers or to competition[264]. However, as evident in *Boise Cascade*[265] and *Ethyl*[266] cases, another harsh requirement has to be met. In *Ethyl*, in particular, the FTC asserted that several specific practices, such as advance notice of price changes or "most-favored-customer" clauses, facilitated the elimination of horizontal competition between four manufacturers of lead-based antiknock gasoline additives[267]. In applying Section 5, the court adopted a strict standard: where evidence that defendants tacitly or expressly agreed to avoid competition are absent, the FTC would have to prove oppressiveness, such as (a) evidence of defendants' anticompetitive intent or purpose or (b) absence of an independent legitimate business reason for the defendents' conduct[268]. The requirement is comparable to the principle that there must be a "plus factor" before conscious parallelism may be found to be conspirational in violation of the Sherman

[261] Section 5 of the Federal Trade Commission Act (FTC Act), Ch. 311, §5, 38 Stat. 719, codified at 15 U.S.C. §45(a) [hereinafter FTC Act]: "*Unfair methods of competition in or affecting commerce, and unfair or deceptive acts or practices in or affecting commerce, are hereby declared unlawful*".
[262] *FTC v. Sperry & Hutchinson Co.*, 405 US 233 (1972); *FTC v. Indiana Federation of Dentists*, 476 US 447 (1986).
[263] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 38.
[264] 15 U.S. Code, Section 45(n) (*Standard of proof; Public policy considerations*); Federal Trade Commission, *Policy Statement on Unfairness* (17 December 1980).
[265] *Boise Cascade Corp. v. Federal Trade Commission*, 837 F.2d 1127, 1148 (D.D.C. 1988).
[266] *E.I. du Pont de Nemours Company. v. Federal Trade Commission*, 729 F.2d 128, 142 (2d Cir. 1984).
[267] Geoge A. Hay, "Facilitating Practices: The Ethyl Case (1984)", in *The Antitrust Revolution: Economics, Competition and Policy*, Third edition (Oxford: Oxford University Press, 1999), 182-201.
[268] *E.I. du Pont de Nemours Company. v. Federal Trade Commission*, 729 F.2d 128, 142 (2d Cir. 1984), §34.

Act. Hence, translating the *Ethyl* standard to the *Predictable Agent* scenario, the defendants may be liable under Section 5 if, when developing the algorithm or in seeing the effects, they were (1) motivated to achieve an anticompetitive outcome, or (2) aware of their actions' natural and probable anticompetitive consequences[269]. Prooving the causal relationship between the company's anticompetitive intention and the negative impact of the algorithm on price competition could be, however, extremely challenging. Moreover, evidence of intent will likely be mixed when each firm has independent business reasons to develop a pricing algorithm: since the first firm to use the algorithm could not be accused of colluding as the market was less transparent, the same may be said for the second or the third firm, which might have legitimate business reasons[270].

Beyond the "facilitating practice" approach, another possible legal instrument may be to consider the use of pricing algorithms as "market manipulation". In this context, the 2014 US Securities and Exchange Commission's (SEC) case against Athena Capital Research is illustrative. The high-frequency trading firm engaged in a practice known as "marking the close": through a sophisticated algorithm called Gravy, stocks were bought or sold in the final two seconds of almost every trading day to manipulate the closing prices of thousands of NASDAQ-listed stocks. Since Athena's employees were aware of the price and market impact of Gravy, as emerged from internal e-mails, the SEC sanctioned the firm 1 million $ of penalty for market manipulation[271]. Hence, clear anticompetitive intent must be proved even when dealing with algorithms manipulating the market. As already been outlined, finding the predominant purpose for using a pricing algorithm and valuing the anticompetitive awareness might not be straightforward in many cases, where e-mails or other evidences are absent[272].

All things considered, existing legal instruments can hardly tackle parallel behaviour, even when implemented by algorithmic means: evidence of anticompetitive intent of the algorithm's developers and users to facilitate conscious parallelism must always be proved. Since algorithm-fueled tacit collusion could lead to higher prices and anti-competitive market dynamics as explicit collusion does, innovative regulatory

[269] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 68.
[270] *Ibid*., 69.
[271] U.S. Securities and Exchange Commission, *Administrative Proceeding File No. 3-16199* (16 October 2014).
[272] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 69.

intervention appears necessary, especially in European Union: the wide range of possibilities will be analysed in Chapter III.

3.4. Self-learning algorithms: tacit collusion of the future

The fourth algorithmic scenario – the *Digital Eye* – represents the next frontier of algorithmic pricing, as well as the most complex and subtle way in which algorithms can achieve collusive outcomes. In particular, two key technological advancements distinguish the scenario from the previous ones. First, computer's and algorithms' ability to process high volume of data in real time is widely improved: using Big Data and Big Analytics, data generated from the online environment, cloud computing and smart sensors can provide to competitors a God-like view[273] of the marketplace at any given moment[274]. Second, sophisticated self-learning algorithms can engage in autonomous decision-making and learning through experience, potentially without the need for any human intervention. Computers are thus set a target such as the maximisation of profit or optimisation of performance; then, self-learning algorithms, using machine learning technologies, execute autonomously whichever strategy they deem optimal to profit on the basis of ongoing feedback collected from market information[275]. Going one step further, companies may implement also deep-learning algorithms, i.e. a subclass of self-learning or machine-learning algorithms. Here, a computerized neural network, simplistically illustrated with the concept of a "black box", processes raw data in a complex and fast way, resembling the human brain, and delivers an optimal output without revealing the decision process: what distinguishes deep-learning algorithms from the others is thus their limited ability to explain their decision making, allowing firms to reach a collusive outcome without even being aware of it[276] (**Figure 10**).

[273] The term "**God View**" has been borrowed from Uber, whose internal tool to track the location of all Uber vehicles and customers is commonly called "God View" by employees. (Maya Kosoff, "Uber's Top New York Executive Is Being Investigated After Using Uber's God View Tool To Track A Journalist's Location", *Business Insider* (19 November 2014) available at: https://www.businessinsider.com/ubers-new-york-manager-investigated-for-using-god-view-2014-11?IR=T)

[274] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 71-72.

[275] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 14.

[276] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 32; Organisation for Economic Co-operation and

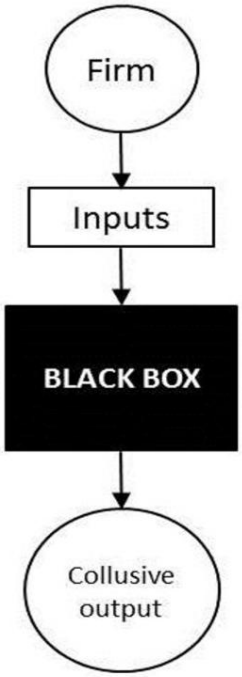

Figure 10 – Deep learning algorithm (**Source**: Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 32)

Given their analogies with oligopolistic interdependence and conscious parallelism, reinforcement learning algorithms (RL) may specifically raise concerns of algorithmic collusion. RL algorithms imply a trial-and-error approach: pricing agents has to try different policies or actions before deciding which one to choose. Moreover, RL pricing algorithms do not know immediately whether they chose the best strategy, in line with the idea that prices in oligopolistic markets do not adjust instantly. Finally, they try to learn the best actions to outperform its competitors or to reach a consensus (i.e. the Nash equilibrium of tacit collusion), as in an oligopolistic market[277]: RL algorithms thus imply the *multi-agent learning problem*, where multiple parties are involved in the learning process and their behaviour directly affects each other[278].

Development (OECD), *It's a Feature, not a Bug: On Learning Algorithms and what they teach us – Note by Avigdor Gal*, Roundtable on Algorithms and Collusion (21-23 June 2017), 5.

[277] Ashwin Ittoo and Nicolas Petit, "Algorithmic Pricing Agents and Tacit Collusion: A Technological Perspective" (2 October 2017): 5-6.

[278] Ai Deng, "An Antitrust Lawyer's Guide to Machine Learning", *Antitrust* 33, n. 2 (Spring 2018): 85.

It is worth noting that RL algorithms are usually based on the more traditional tit-for-tat strategy (TFT): starting with cooperation, each party's algorithm will then just copy exactly what the opponent's algorithm did in the previous period in repeated interaction, hence implementing their continued cooperation. Despite its intuitive functioning, the traditional TFT algorithm has a number of limitations. In particular, firms need to know what the competitors have done and the consequences of future interactions; in the real world, however, firms typically do not possess this information and misperception is usually the commonness[279]. For this reason, TFT algorithms will spend in the long-run half of the time cooperating and half of it defecting[280]. Through RL algorithms, however, the problem is solved: given their trial-and-error mechanism and their God View over competitors' behaviour, Artificial Intelligence reduces uncertainty and succeds in maintainting the collusive outcome[281].

More generally speaking, both machine learning and deep learning algorithms can amplify tacit collusion to a new level of stability. The more often market players are able to observe and know others' strategic behaviour - as happening in the *Digital Eye* scenario - the more likely they are to succeed in finding focal points on which to tacitly coordinate[282]. In enabling a wider and more detailed view of the market, a reduced market uncertainty, a faster reaction time in response to competitive initiatives and dynamic strategies achieved by "learning by doing" and "trial-and-error", artificial intelligence can expand tacit collusion even "beyond oligopolistic markets". The Digital Eye scenario, indeed, does not only support already existing tacit collusion in oligopolies; it also increases the circumstances in which conscious parallelism may be sustained. With the industry-wide use of machine learning algorithms, tacit collusion may thus be seen in markets with many more players, where collusion previously would have been unstable: this algorithms can indeed track more easily the behaviour of numerous rivals to detect cheating, thus

[279] Ai Deng, "What Do We Know About Algorithmic Tacit Collusion?", *Antitrust* 33, n. 1 (Fall 2018): 89.
[280] Avinash Dixit and Barry Nalebuff, *Thinking Strategically: The Competitive Edge in Business, Politics, and Everyday Life* (New York: W.W. Norton, 1991): 111.
[281] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 74-76.
[282] Don Ross, "Game Theory", *The Stanford Encyclopedia of Philosophy* (Spring 2019).

potentially expanding the oligopoly problem of Chapter I to non-oligopolistic market structures[283].

Recent observations of a group of economists have shown that self-learning algorithms (Q-learning algorithms[284] in particular) can have the capacity to achieve coordination on the collusive outcome. In experiments with two Q-learning algorithms, i.e. two market players, collusion emerged in more than 60% of the cases. As illustrated in the graph below (**Figure 11**), forcing a price deviation by one algorithm to the Nash equilibrium price (i.e. the static equilibrium price which would emerge if there is no tacit coordination), the other algorithm reacted. Subsequently, both returned to the pre-existing tacit collusive equilibrium, above the competitive price but below the monopolistic price[285]. In an extension of the experiment, three Q-learning algorithms (that is more than what some argue is possible to coordinate without communication) were then tested: conscious parallelism continued to be observed anyway, thus opening to sustainability of tacit collusion in non-oligopolistic markets[286].

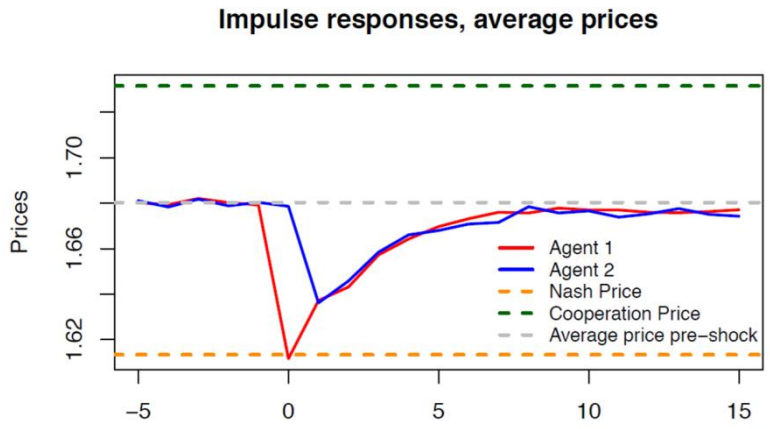

Figure 11 – Tacit collusion between two Q-learning algorithms (**Source**: Ariel Ezrachi and Maurice E. Stucke, "Sustainable and Unchallenged Algorithmic Tacit Collusion", *Oxford Legal Studies Research Paper* n. 16/2019 (10 November 2018): 35.)

[283] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 76-77.

[284] **Q-learning algorithm** is a model-free reinforcement learning algorithm, whose goal is to learn a policy, which tells an agent what action to take under what circumstances. It is commonly employed for dynamic pricing, for instance in the airline or electricity markets.

[285] Emilio Calvano, Giacomo Calzolari, Vincenzo Denicolò and Sergio Pastorello, "Algorithmic Pricing: What Implications for Competition Policy?" (27 June 2018): 7-12.

[286] Ariel Ezrachi and Maurice E. Stucke, "Sustainable and Unchallenged Algorithmic Tacit Collusion", *University of Tennessee Legal Studies Research Paper* n. 366; *Oxford Legal Studies Research Paper* n. 16/2019 (10 November 2018): 34-35.

Nevertheless, some have expressed doubts as to the plausibility of autonomous algorithmic collusion, especially in non-oligopolistic markets. First, it is still not clear how machine learning algorithms may actually reach a collusive outcome. As the U.S. Department of Justice Antitrust Division recently stated, "concerns about price-fixing through algorithms stem from a lack of understanding of the technology"[287]. In particular, doubts as to self-learning algorithms' ability to sustain collusion refer usually to their unknown functioning and their increased sophistication which would make alignment between prices more difficult[288]. Second, the empirical evidence of algorithmic tacit collusion in oligopolistic and non-oligopolistic markets remains often below the threshold of accuracy, consistency and exhaustiveness necessary to drive the point home[289]. In all the cases taken into account as experiments, essential determinants conducive to tacit collusion were already present in the market: the use of algorithmic technology thus simply removed the last obstacle to a pre-existing oligopolistic conscious parallelism. Hence, many authors consider self-learning algorithms as not determinatively, and perhaps not even significantly causal of tacit collusion in markets which are not concentrated. Morover, no empirical evidence has been adduced to prove the humanless nature of tacit collusion derived from artificial intelligence: it still remains a lack of understanding of whether algorithm-driven robo-sellers can autonomously enter into tacitly collusive strategies without human intervention, as Mehra[290] and others stated[291].

While acknowledging current uncertainties, competition agencies have begun looking into the possibility of tacit collusion directly generated from artificial intelligence. If self-learning algorithms are actually uncapable of autonomously reaching tacit collusion, human market players would have to train them to achieve a collusive outcome. In this context, we would return to the enforcement possibilities of the previous *Predictable Agent* scenario, where human-driven tacit collusion is

[287] Pallavi Guniganti, "US DOJ Deputy: Algorithmic Cartel Requires Agreement", *Global Competition Review* (5 February 2018).
[288] Ariel Ezrachi and Maurice E. Stucke, "Sustainable and Unchallenged Algorithmic Tacit Collusion", *University of Tennessee Legal Studies Research Paper* n. 366; *Oxford Legal Studies Research Paper* n. 16/2019 (10 November 2018): 32.
[289] Ashwin Ittoo and Nicolas Petit, "Algorithmic Pricing Agents and Tacit Collusion: A Technological Perspective" (2 October 2017): 2; Competition Bureau Of Canada, *Big Data And Innovation: Key Themes For Competition Policy In Canada* (2017).
[290] Salil K. Mehra, "Antitrust and the Robo-Seller: Competition in the Time of Algorithms", *Minnesota Law Review* 100 (2016).
[291] Ashwin Ittoo and Nicolas Petit, "Algorithmic Pricing Agents and Tacit Collusion: A Technological Perspective" (2 October 2017): 2-3.

enhanced by algorithms. If, on the other hand, self-learning algorithms may autonomously establish conscious parallelism without human intervention, we would face an additional complexity from an enforcement perspective[292]. Algorithm's human developers, indeed, would not be necessarly motivated to achieve tacit collusion, nor could they predict how likely it is that the industry-wide use of AI would yield tacit collusion. Hence, there is no evidence of any anti-competitive intent or attempt to facilitate conscious parallelism, since humans are further detached from the algorithm's own strategic decisions[293].

The lack of anticompetitive intent in the *Digital Eye* scenario has raised two main enforcement issues. First, to what extent are undertakings responsible for their algorithms' actions, where there is not any evidence of anticompetitive agreement or intent? Could algorithms' developers assert that they are not liable for pricing decisions, when taken by autonomous self-learning algorithms? Artificial intelligence thus poses a challenging liability concern, which will be widely discussed in Chapter III. Second, in removing the legal concept of anticompetitive intent, Article 101 TFEU, Section 5 of the FTC Act and the "market manipulation" approach, employed to address the *Predictable Agent* scenario, are now excluded from the available enforcement tool-box. Lacking evidence of the intentional creation of conscious parallelism, prosecutors have few, if any, tools to challenge algorithmic tacit collusion, thus resulting in AI self-learning algorithms escaping legal scrutiny[294]. In order to avoid this, Chapter III will analyse possible new regulatory intervention to protect consumers from alleged algorithmic collusion and subsequent higher prices.

4. Conclusion

In a growing number of markets, goods' and services' prices nowadays are established by dynamic pricing algorithms, which, by monitoring market trends and competitors' behaviours, determine within milliseconds the firm's optimal pricing

[292] Ariel Ezrachi and Maurice E. Stucke, "Sustainable and Unchallenged Algorithmic Tacit Collusion", *University of Tennessee Legal Studies Research Paper* n. 366; *Oxford Legal Studies Research Paper* n. 16/2019 (10 November 2018): 33-34.

[293] Ariel Ezrachi and Maurice E. Stucke, "Artificial Intelligence & Collusion: When Computers Inhibit Competition", *University of Illinois Law Review* 2017, n. 5 (2017): 1795.

[294] *Ibid*., 1795-1796; Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 77-79.

strategy. Without disregarding the significant benefits that automated system have brought to society, both on the supply- and demand-side, Chapter II has focused on the potential impact of algorithms on collusion, as they can make it easier for firms to achieve and sustain coordination without any formal agreement or human interaction. As a matter of fact, pricing algorithms deeply affect market conditions, resulting particularly in high price transparency and high-frequency interactions: these changes in digital markets could make collusive strategies stable in virtually any market structure, thus even in non-oligopolistic markets.

From an enforcement perspective, four different algorithmic collusion scenarios are distinguished. First, the *Messenger* scenario concerns the use of algorithms to implement a pre-existing explicit horizontal agreement: both signalling algorithms, during the cartel's negotiation phase, and monitoring algorithms, during the cartel's executing phase, can help to facilitate the explicit collusion. The legal concepts of "agreement" and "concerted practice" of Article 101 TFEU and Section 1 of the Sherman Act can thus be applied straightforwardly. Second, in the *Hub-and-Spoke* scenario, the use of a single supplier's algorithm (the "hub") may determine the market price charged by numerous firms (the "spokes"). If, on one hand, the single use of the same pricing algorithms without any data exchange may not necessarily generate anticompetive effects, algorithm- and data- fueled Hub-and-Spoke, on the other hand, may give rise to an unlawful traditional hub-and-spoke cospiracy, when firms' anticompetive intent can be proved. In this context, the Hub-and-Spoke structure of online platform, such as Uber, raises new competition concerns. Third, in the *Predictable Agent* scenario, firms unilaterally design parallel algorithms to monitor competitors and react to changing market conditions: the subsequent price increase is thus the natural outcome of tacit collusion arised in a more transparent market. In this context, Article 101 TFEU and Section 5 of the FTC Act could be primarily applied to collusive algorithms as "facilitating practices"; both, however, require some proof of firms' anticompetitive intent. Finally, the *Digital Eye* scenario implies the use of machine-learning and deep-learning algorithms, which autonomously determine the means to optimise profit through experiments and trial-and-error. Lacking completely the human anticompetitive intent, no enforcement tool applies to this category, thus raising debates over possible intervention (that will be discussed in Chapter III).

In conclusion, the following table (**Table 3**) summarises the four scenarios' key distinctions, focusing on evidence of horizontal agreements, relevant case-law and potential antitrust liability under competition law.

Scenario - *Category of algorithms*	**Description**	**Liability**	**Relevant case-law**
Messenger – *Signalling algorithms, Monitoring algorithms*	Algorithms help as **intermediaries** in executing the pre-existing explicit collusion →**Signalling** algorithms negotiate and align competitors' prices; **Monitoring** algorithms detect deviation and program retaliations	Strong evidence of **pre-existing explicit agreement** → "restriction of competition by object" (Article 101 TFEU) or "per se illegality" (Section 1 Sherman Act)	⇨ *Airline Tariff Publishing Company (ATPCO)* [1993] ⇨ *Poster Cartel* [2016] ⇨ *Asus, Denon & Marantz, Philips and Pioneer* [2018]
Hub and Spoke – *Hub-and-spoke algorithms*	a) **"De facto" Hub-and Spoke**: use of the same supplier's algorithm but no exchange of data b) **Algorithm- and data-fueled Hub-and-Spoke**: competitors provide the supplier's algorithm with data, used to fix the price c) **Platform Hub-and-Spoke**: platform's algorithm set the price and many competitors agree to use it	a) See **Predictable Agent scenario** b) When evidence of firms' anticompetitive intent → Hub-and-spoke conspiracy (Article 101 TFEU and Section 1 Sherman Act) c) **Uncertainty** about likely Hub-and-Spoke conspiracy	⇨ *Eturas* [2016] ⇨ *Meyer v Kalanick* [2016]
Predictable Agent - *Parallel algorithms* (especially *signalling algorithms*)	Each competitor use **unilaterally** its pricing algorithm to monitor and adjust prices	No evidence of agreement but **evidence of anticompetitive intent** → Article 101 TFEU: algorithms as information exchange but lack of "communication" → Article 102 TFEU: algorithms as "correlative factors" of collective	⇨ *Athena Capital Research* [2014]

		dominance but lack of "abuse" → **Section 5 FTC Act**: algorithms as "unfair practices" or "market manipulation" but need evidence of anticompetitive intent	
Digital Eye - *Self-learning algorithms*	Self-learning and deep learning algorithms execute **autonomously** whichever strategy they deem optimal	**No evidence** of agreement and anticompetitive intent → **Unclear** liability	None

Table 3 – Four categories of algorithmic collusion

III. Intervention and possible avenues for enforcers against algorithmic collusion

1. Main arising challenges for competition law enforcement. 1.1. The "to regulate or not to regulate" dilemma. 1.2. Liability: the role of humans on algorithmic collusion. *1.2.1.* Predictable Agent *algorithms as employees. 1.2.2.* Self-learning *algorithms as agents. 1.2.3 Algorithm's suppliers as cartel facilitators.* 1.3. Detection: how to uncover algorithmic anticompetitive dynamics. *1.3.1. Auditing the algorithm. 1.3.2. Market studies and investigations.* 1.4. Burden of proof: the *public distancing* requirement in an algorithmic environment. **2. Possible regulatory intervention on collusive algorithms.** 2.1. Revisiting existing competition regulation. *2.1.1.* Ex ante *intervention: merger control over algorithmic markets. 2.1.2.* Ex post *intervention: extending the notion of "agreement" and "concerted practice".* 2.2. Enforcing innovative regulatory countermeasures. *2.2.1. Regulation over algorithms: the "compliance by design". 2.2.2. Regulation over markets: policies making tacit collusion unstable. 2.2.3. Algorithmic countermeasures: the use of technology by policymakers and consumers.* **3. Conclusion.**

As more processes become automated and more transactions digitalised, one could expect the use of pricing algorithms to be increasingly more common in the future. In this context, the risks associated with collusion, together with challenges for competition agencies, will likely increase. How can competition law protect consumers? How could it ensure that the market digitalisation yields a competitive environment? The displacement of the Adam Smith's "invisible hand"[295] by the "digitalized hand"[296] heralds a change in dynamics which requires the enforcer to recalibrate the approach to markets and intervention.

Before addressing some of the open questions for enforcement in an algorithmic environment, a substantial distinction has to be reminded. On one hand, algorithms which amplify explicit collusion, as under the *Messenger* and *Hub-and-Spoke* scenario, ought to be assessed together with the infringement that they help enforcing: competition agencies thus rely on existing rules, making the discussion rather straightforward. Algorithms achieving a tacitly collusive outcome, as parallel and self-learning algorithms, on the other hand, are not covered by standard antitrust rules on anticompetitive cooperation: this Chapter thus focuses on the more complex challenges brought by algorithmic tacit collusion.

[295] The "**invisible hand**" is a metaphor for the unseen forces that move the free market economy: through individual self-interest and freedom of production, the best interest of society as a whole is fulfilled. The concept was first introduced by Adam Smith in *The Theory of Moral Sentiments*, written in 1759.

[296] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press), 203. 2016), 203.

In particular, Paragraph 1 will explore the main enforcement challenges which competition authorities need to face in an algorithmic environment; Paragraph 2, subsequently, highlights possible avenues for the enforcer to prevent or deter the anticompetitive scenarios of tacit collusion, including the use of current antitrust tools, together with new ones.

1. Main arising challenges for competition law enforcement

1.1. The "to regulate or not to regulate" dilemma

The dichotomy between interventionist and noninterventionist approaches over algorithmic alleged collusion may primarily affect and challenge competition law enforcement. As a matter of fact, some would defend the adequacy of an algorithm-based free-market, warning that any regulatory intervention would likely nullify the algorithmic efficiencies: in their view, the costs of "false positives"[297] from governmental intervention do overcome the costs of "false negatives"[298] from governmental abstention. On the opposite, interventionists would rather uphold the necessity of some competition regulation, given the alleged inability of algorithmic markets to self-correct. Inasmuch as it will widely influence the following analysis on regulation, the settlement of the discussion appears of utmost importance.

The Harvard School noninterventionist approach, on one hand, does rely on the Adam Smith's concept of "invisible hand", according to which an unobservable force may help to reach a market equilibrium automatically, without the need of any competition regulation. When controlled by algorithms, the "digitalized invisible hand" may determine the market price in any given market through complete knowledge and complex calculations, thus autonomously achieving an alleged competitive equilibrium[299]. As already outlined in Chapter II, indeed, the use of algorithms is in principle procompetitive: intelligent software can monitor the market and adjust prices at a very low marginal cost; long-term cost reductions may then be

[297] "**False positive**" refers to finding violations of competition law when the conduct did not harm competition, thus producing high social costs.
[298] "**False negative**" refers to finding no violations when the behavior did injure competition.
[299] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 209.

passed on to consumers in the form of lower competitive prices[300]. Furthermore, when implementing unilaterally price parallelism, as in the *Predictable Agent* and *Digital Eye* scenario, pricing algorithms – and their owners – may not be, in noninterventionists' view, found liable. According to the U.S. Court of Appeals for the Seventh Circuit, indeed, "it is one thing to prohibit competitors from agreeing not to compete; it is another to order them to compete"[301]. Hence, how is courts to decide how vigorously firms must compete, when the market appears to be driven by a procompetitive "digitilized hand"? What competition could do more if anyone actually possess through algorithms all the relevant information?[302] A regulatory intervention would thus give rise, in their opinion, to false positives and over-enforcement, able to prevent both technology developments and efficient (and even tacitly colluding) markets from arising.

According to an interventionist approach, on the other hand, competition alone would not be sufficient to drive out of the market fallible algorithms while simultaneously preserving the efficient ones. In particular, three algorithmic market failures could eventually compromise the ability of digital market to self-correct. First, both consumers and competitors would lack perfect market information, due to the absence of transparency in the way algorithms are programmed and run. Second, the development of predictive algorithms requires expensive complementary assets, thus raising data-driven barriers to entry and excluding small firms from digital markets. Lastly, by being programmed to select only the most relevant information, algorithms might fail to exploit the spill-over that a multi-disciplinary variety of knowledge could have on the process of innovation[303]. Taking this into account, the algorithmic price in a digital environment would thus not be the competitive price; instead, the "digitalized hand" and the pricing algorithms would merely create a fictitious price, enabling undertakings, under the guise of a "market-clearing" price, to earn extra profits at consumers' expense. Data collection by firms and platforms could therefore create a privately planned economy where prices are determined by

[300] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 19.
[301] *In re Text Messaging Antitrust Litigation*, 782 F.3d 867, 874 (7th Cir.) cert. denied. sub nom.; *Aircraft Check Services Co. v Verizon Wireless*, 136 S. Ct. 524 (2015).
[302] According to Friedrich A. Hayek, "*competition is important only because and insofar as its outcomes are unpredictable and on the whole different from those that anyone would have been able to consciously strive for*." (Friedrich A. Hayek (translated by Marcellus S. Snow), "Competition as a Discovery Procedure", *The Quarterly Journal of Austrian Economics* 5, n. 3 (Summer 2002): 10).
[303] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 45.

the technostructure, provided usually with a huge market power[304]. Having regard to the foregoing considerations, competition regulation does appear to be needful in order to prevent the rise of anti-competitive algorithmic prices. In this context, the alleged legality of tacit collusion may be reconsidered. Deeply affecting characteristics of digital markets, such as transparency and frequency of interactions, algorithms may make tacit collusion sustainable in a wider range of circumstances; furthermore, the algorithmic capacity to collect data could create a mutual certainty in price parallelism. In light of such increased efficiency, applicability and stability of tacit collusion, the rational once behind its legality seems no longer to be true in algorithmic environments: a normative change on conscious parallelism should thus be viewed, in order to address the substantial harm undergone by consumers[305]. In conclusion, competition regulatory intervention would be essential to avert unavoidable higher parallel prices and risky false negatives in algorithmic scenarios. The subsequent discussion will be therefore following the interventionist approach.

1.2. Liability: the role of humans on algorithmic collusion

Given the need for intervention over algorithmic tacit collusion, the following remarkable question arising from the algorithmic environment is whether firms' antitrust liability can be established when pricing decisions are made by a machine using an algorithm rather than by human beings. If algorithms tacitly collude, are human developers and owners liable? Especially when AI algorithms can achieve anticompetitive conducts autonomously, companies may attempt to hide behind their algorithms to claim that they are not responsible for pricing decision. "We are not setting the price. The market is setting the price. We have algorithms to determine what the market is"[306]: the wording of the founder of Uber Travis Kalanick does significantly exemplify the mentioned worrying trend. The question over human liability thus asks for a rapid and clear-cut answer.

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[304] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 208-212.

[305] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 34-35.

[306] The sentence was asserted by Travis Kalanick in reaction to a severe price increase one of its customers encountered for what should have been a normal Uber fare. (Jill Priluck, "When Bots Collude", *The New Yorker* (25 April 2015), available at: https://www.newyorker.com/business/currency/when-bots-collude).

In defining a potential solution for the liability issue, *Predictable Agent* algorithms, on one hand, and *self-learning* or AI algorithms, on the other hand, must be distinguished[307]. Finally, the potential liability of algorithm's suppliers has to be analysed.

1.2.1. Predictable Agent *algorithms as employees*

Predictable Agent algorithms, as already highlighted in Chapter II, do usually execute exactly the pricing strategies companies have previously planned: a likely evidence of human's anticompetitive intent is thus involved. Hence, no doubts arise about the company's responsibility over algorithms' behaviours, since the pricing software can be considered as a *de facto* tool of the firm.

In this context, the recent case *VM Remonts*[308] claimed for the application of employees' liability rules on *Predictable Agent* algorithms. Here, the European Court of Justice addressed a preliminary reference from the Supreme Latvian Court so as to what extent a company could be liable for the actions of one of its service providers. In deciding the case, the Court stated that it is possible for an alleged independent service provider to be in fact acting under the direction or control of an undertaking that is using its services, thus disguising an employment relationship[309]. When an employee (i.e. the service provider) performs his duties under the direction of the undertaking, it is considered to be incorporated into the economic unit comprised by that company[310]: accordingly, "any anti-competitive conduct on the part of an employee [i.e. the service provider] is thus attributable to the undertaking to which he belongs and that undertaking is, as a matter of principle, held liable for that conduct"[311]. Taking into account the previous considerations, the Court then established that an undertaking may, in principle, be held liable for a concerted practice on account of the acts of an independent service provider supplying it with services only if one of the following conditions is met: (a) the service provider was

[307] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 176-177.
[308] Case C-542/14, *VM Remonts and Others v Konkurences padome*, 21 July 2016, ECLI:EU:C:2016:578 [2016].
[309] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 16-17.
[310] Case C-542/14, *VM Remonts and Others v Konkurences padome*, 21 July 2016, ECLI:EU:C:2016:578 [2016], §23.
[311] *Ibid*., §24.

acting under the direction or control of the undertaking concerned; or (b) that undertaking was aware of the anti-competitive objectives pursued by its competitors and the service provider and intended to contribute to them by its own conduct; or (c) that undertaking could reasonably have foreseen the anti-competitive acts of its competitors and the service provider and was prepared to accept the risk which they entailed[312].

The judgement is of utmost importance as it lays the basis for the likely approach being taken by the Commission to make companies liable for their *Predictable Agent* algorithms' unlawful conduct. The above third condition, in particular, does exactly represent the algorithmic scenario under consideration, in which the firm's ability to predict the likely anticompetitive outcome can often be proved; furthermore, *Predictable Agent* algorithms usually remain under the firm's control like a *de facto* employee. Human liability may thus be solidly established in a *Predictable Agent* scenario, where parallel signalling algorithms achieve collusive outcomes[313].

1.2.2. Self-learning *algorithms as agents*

Self-learning algorithms, on the other hand, usually take autonomous pricing decisions. As a matter of fact, Artificial Intelligence "robo-sellers", using machine learning and trial-and-error technologies, execute independently whichever strategy they deem optimal to reach their target (such as the maximisation of profit), without the need for any human intervention. As the European Parliament has observed, "the more autonomous robots are, the less they can be considered to be simple tools in the hands of other actors"[314]: this would question, in turn, whether the ordinary rules on employee's liability are sufficient or whether it calls for new principles, thus requiring a more complex answer.

In dealing with AI algorithms that take anticompetitive actions, three are the possible choices in attributing responsibility: to the algorithm itself, to the humans who deploy it, or to no one. Choosing the third option – no liability – would however essentially provide immunity to anticompetitive conducts and leave the behaviour

[312] *Ibid*., §33; Case C-49/92 P, *Commission of the European Communities v Anic Partecipazioni SpA*, 8 July 1999, ECR [1999] I-04125, §87.
[313] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 17.
[314] European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics, 16 February 2017, 2015/2103(INL), §AB.

unchecked: such a choice of inaction would clash starkly with the efficiency-based contemporary competition law. The choice thus really comes down to the first two options[315].

Considering the choice of attributing liability to the algorithm itself, robo-sellers cannot be recognised as autonomous legal actors under current competition laws; instead, they should be considered as mere tools in firms' hands. Firstly, an algorithm could not be held liable of an Article 101 infringement, since it cannot legally qualify as an undertaking under the *Höfner* criteria[316]: computers, indeed, are not evidently engaged in any autonomous economic activity. In addition, the deterring nature of fines and criminal imprisonment would have no effect on an AI algorithm, as it will more likely be programmed to weigh the cost-benefit of any business decision purely in monetary terms, thus lacking the human psychology to understand fear[317]. Nevertheless, some argue that greater ability to act autonomously counsels for greater recognition of self-learning algorithms as actors in their own right, thus distinguishing computer agents from those who employ them[318]. As reminded by the European Parliament, however, "under the current legal framework robots cannot be held liable per se for acts or omissions that cause damage to third parties"[319]: attributing responsibility to the algorithm should thus not be considered as a potential option.

The remaining third possibility is that liability over the *self-learning* algorithm lies with the humans employing it, similarly to the *Predictable Agent* scenario. In this context, the relationship between the undertaking and the AI algorithm could be realistically related to the agent-principal connection in a vertical agency agreement[320]. As the Guidelines on Vertical Restraints of the European Commission

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[315] Salil K. Mehra, "Antitrust and the Robo-Seller: Competition in the Time of Algorithms", *Minnesota Law Review* 100 (2016): 1366.

[316] Case C-41/90, *Höfner and Elser v Macroton GmbH,* 23 April 1991, ECR [1991] I-1979, §21: "*it must be observed, in the context of competition law, first that the concept of an undertaking encompasses every entity engaged in an economic activity, regardless of the legal status of the entity and the way in which it is financed* […]."

[317] Dylan I. Ballard and Amar S. Naik, "Algorithms, Artificial Intelligence, and Joint Conduct", *Competition Policy International* (15 May 2017): 6.

[318] Samir Chopra and Laurence F. White, *A Legal Theory For Autonomous Artificial Agents* (University of Michigan Press, 2011), 172-173; Salil K. Mehra, "Antitrust and the Robo-Seller: Competition in the Time of Algorithms", *Minnesota Law Review* 100 (2016): 1368.

[319] European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics, 16 February 2017, 2015/2103(INL), §AD.

[320] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 178-179.

explain, an agent is a legal or physical person vested with the power to negotiate and/or conclude contracts on behalf of another person (the principal), either in the agent's own name or in the name of the principal, for the purchase or sale of goods or services by, or supplied by, the principal[321]. The firm which employs a *self-learning* algorithm to fix products' prices can thus be qualifies as "principal"; the computer software, instead, does decide the price in the name of the firm, fulfilling the typical negotiation function of the agent. Moreover, in the European Court of Justice's opinion, if an agent works for the benefit of his principal, he may in principle be treated as an auxiliary organ forming an integral part of the latter's undertaking, who must carry out his principal's instructions and thus, like a commercial employee, forms an economic unit with the undertaking[322]. Since it fixes the price always for the benefit of the undertaking, the algorithm-agent is included in the firm's economic unity: the responsibility for the algorithm's anticompetitive conduct is thus attributed to the undertaking who is employing it.

1.2.3. Algorithm's suppliers as cartel facilitators

The *Hub-and-Spoke* scenario would lastly deserve a separate and different analysis. When a third actor – such as a software or IT consulting society – supplies parallel or self-learning algorithms to undertakings, the algorithm-fueled hub-and-spoke raises concerns about supplier's liability for potential firms' algorithmic collusive conducts.

In this context, the standard outlined by the European Court of Justice in the *AC-Treuhand* case[323] appears to be applicable. Here, AC-Treuhand, a Swiss consultancy firm, was found liable for having participated in a series of agreements and concerted practices between a number of undertakings by organising meetings, supplying to producers data on sales and acting as a moderator between the cartelists. In defining AC-Treuhand responsibility, the Court applied a three-parts test, which consists in demonstrating (1) that the undertaking intended to contribute by its own conduct to the common objectives pursued by all the participants; (2) that it was aware of the actual conduct planned or put into effect by other undertakings in pursuit of the same

[321] Communication from the Commission - Guidelines on Vertical Restraints, OJ C 130/01, 19 May 2010, §12.
[322] Joined cases 40-48, 50, 54-56, 111, 113, 114-73, *Coöperatieve Vereniging "Suiker Unie" UA and others v Commission of the European Communities*, 16 December 1975, ECR [1975] 01663, § 480; Case T-325/01, *DaimlerChrysler AG v Commission of the European Communities*, 15 September 2005, ECR [2005] II-03319, §86.
[323] Case C-194/14 P, *AC-Treuhand AG v European Commission*, 22 October 2015, [2015].

objectives or that it could reasonably have foreseen it and that it was prepared to take the risk; and (3) that it contributed to the objectives, playing a relevant and not merely subsidiary role[324]. The case thus implemented the previously analysed *Anic* and *VM Remonts* standard.

Applying the test to the algorithm-fueled *Hub-and-Spoke* scenario, a supplier could hardly deny the second condition: it is indeed unlikely that, knowing the functioning of his algorithm, the "hub" could not predict the unlawful conducts of the "spokes". Moreover, even the "relevance" requirement would be fulfilled, given the central role of the algorithm in the cartel. Finally, the first condition would be automatically present if the concerned undertaking is aware of the collusive practice and the spokes' and suppliers' behaviours are complementary, which is supposedly the case at stake[325]. The algorithm supplier would thus be liable as cartel facilitator for the firms' anticompetitive conducts[326].

In light of what have been outlined, it is sufficiently clear that algorithms are, and will remain, virtual employees or agents working on behalf of undertakings. Even if pricing algorithms would engage in the future in explicit collusion with each other, the firms using such algorithms would remain liable for their behaviour, no matter how intelligent algorithms may become or how independently they can make decisions[327]. Neither algorithm's suppliers may usually escape liability for algorithmic collusion. Arguments such as "the algorithm made me do it" would thus barely stand up to scrutiny before enforcers and courts. The "algorithm veil", which may potentially screen firms from antitrust liability, is undeniably pierceable under the current legal principles[328].

1.3. Detection: how to uncover algorithmic anticompetitive dynamics

Assuming that the illegality of algorithmic tacit collusion and the liability of the undertakings concerned are given, one subsequently may face the challenge of

[324] *Ibid.*, § 30, 37.
[325] Case T-180/15, *Icap plc and Others v European Commission*, 10 November 2017, [2017], §180.
[326] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 179-181.
[327] Organisation for Economic Co-operation and Development, *Algorithms and Collusion – Note from the European Union* (21-23 June 2017), §28.
[328] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 177-178.

detection. Before prosecuting a crime, the unlawful conduct must first be detected; identifying algorithmic collusive behaviours, however, would not be as easy as detecting bank robberies or frauds. In an algorithm-based environment, indeed, it may be difficult for an enforcer to recognize the counterfactuals, i.e. the competitive position absent the use of pricing algorithms: regulators may thus not readily discern whether the collusive outcomes is the result of artificial algorithmic intervention or natural dynamics[329]. In this context, two main answers to the detection problem have been proposed.

1.3.1. Auditing the algorithm

The first alternative possibility does involve auditing the algorithm itself, through which competition agencies would assess whether the algorithm was designed to foster market changes and tacit collusion. Such a mechanism would thus guarantee that algorithms are programmed in a procompetitive way and may enable, at the same time, the application of countermeasures when industry-wide price coordination is identified[330].

Actually, the audit route has limited practical appeal: as a matter of fact, at least four main problems could be outlined. First, the ease with which algorithms may be set different optimization goals through machine-learning and trial-and-error could undermine effective scrutiny: pricing algorithms do not indeed necessarily include instructions to collude, but rather are usually used to maximise profit, without revealing their true effects[331]. Second, since algorithms can rapidly evolve or be amended, it may be hard to establish whether the algorithm submitted for audit is the one used in the marketplace[332]. A third challenge concerns then the ability to effectively audit an algorithm. Particularly in the case of neural networks and self-learning algorithms, enforcers may indeed lack the expertise to trace the steps taken by algorithms, given the opaque nature of their decision-making process: hence, "if

[329] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 34.
[330] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 230-231.
[331] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 42.
[332] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 35.

deciphering the decision making of the a deep learning network proves difficult, then identifying an anticompetitive purpose may be impossible"[333]. Fourth, barriers associated with commercial secrecy could hinder the algorithm auditing. To safeguard the intellectual property rights of undertakings, detection may in fact be confined to a dedicated competition agency under strict confidentiality, which does appear not fit to address online companies operating beyond national borders and competition frameworks[334]. Besides these, other issues would then include the huge number of algorithms which would require scrutiny and the difficulties of identifying credible counterfactuals.

In light of the highlighted problems, auditing algorithms as method to detect anticompetitive collusive conducts may prove futile. As Ezrachi and Stucke notice, however, the audit route may become feasible as technology and enforcers' expertise develops[335]: as a matter of fact, one way to empower the algorithms' auditing would be to have regulators reverse engineering algorithms, which may help to understand how the decision-making process functions[336]. Nevertheless, the audit tool does appear at the moment limited and meaningful, failing to lead to a suitable intervention.

1.3.2. Market studies and investigations

Given the alleged uselessness of the algorithm audit, a more general detection path may involve the use of market investigations or inquires. When there are sign that the market is not functioning well and a collusive conduct is suspected, competition agencies may decide to engage in market investigations or sector inquires even in the absence of any evidence of coordination among the market players[337]. Such approach could prove useful in helping enforcers detect the magnitude of any competitive problem, at the same time enabling them to understand the dynamics of algorithm-

[333] *Ibid*., 38.
[334] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 230.
[335] *Ibid*., 231.
[336] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 47.
[337] *Ibid*., 40.

driven markets and the circumstances under which algorithmic collusion is more likely to be observed[338].

Beyond the detection and analysis functions, the use of market investigations can lead also to recommendations for the government to engage in regulatory intervention or for the business community itself to foster stronger compliance with competition principles and boost the adoption of self-regulation in the form of codes of conduct. In some jurisdictions, such as the United Kingdom, Iceland and Mexico, market investigation laws also provide for a wider scope of remedies[339]. The U.K. Competition and Markets Authority (CMA), in particular, can carry out "calls for information" or directly initiate market investigations, gather and detect evidence and, where necessary, even impose structural or behavioural remedies[340]. Moreover, in order to more effectively uncover, investigate and take action against unlawful algorithmic activities, a continuous investment in new digital forensic tools and investigative technologies would be required. As the CMA reminded, indeed, the power of algorithms can also be used by competition agencies to better assess algorithmic impacts on competition, detect anti-competitive market behaviour, or design suitable remedies[341].

The advantage of market investigations, especially when enhanced by enforcers' algorithms, would be the high degree of flexibility in detecting unlawful conducts and restoring competition in the market: following an investigation, agencies may thus benefit from an effective and general tool of detection in algorithmic environments, that is unavailable through algorithms' auditing or any other mean[342].

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[338] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 33.

[339] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 41.

[340] Competition Commission, *Guidelines for market investigations: Their role, procedures, assessment and remedies* (April 2013), available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/284390/cc3_revised.pdf

[341] Organisation for Economic Co-operation and Development, *Algorithms and Collusion – Note from the United Kingdom* (21-23 June 2017), 12; Competition and Markets Authority, *Annual Plan 2017/18* (March 2017).

[342] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 33.

1.4. Burden of proof: the *public distancing* requirement in an algorithmic environment

Once the anticompetitive conduct has been detected, another main issue regarding enforcement against algorithmic collusion would concern the burden of proof. The 2016 EU case on algorithms *Eturas*[343], already analysed in Chapter II, was the first to raise awareness of the problem at stake: the traditional *Anic* presumption and *public distancing* requirement appear indeed extremely mutuated when implemented in an algorithmic environment, thus enhancing the tension with the EU principle of the presumption of innocence.

As to the burden of proof in European Union competition law jurisdiction, Article 2 of Regulation 1/2003[344] states that the burden of proving an infringement of Article 101(1) or 102 TFEU rests on the party or the authority alleging that infringement: this would be consistent with the presumption of innocence as a fundamental principle of the European legal order, which is also applicable to procedures relating to EU competition law[345]. According to this, it should be on the enforcement agency – i.e. the Commission – to demonstrate the existence of the circumstances constituting an infringement and the liability of the undertakings over the alleged collusive practice[346].

Having regard to the forgoing, it must be noticed that knowledge of collusion is necessary in order for the agreement element of Article 101(1) to be established. According to the ECJ standard definition of concerted practice, indeed, undertakings should "*knowingly* substitute practical cooperation between them for the risks of competition"[347] (emphasis added). It follows that antitrust liability is not attributable in the absence of positive knowledge of the anti-competitive arrangement:

[343] Case C-74/14, *Eturas UAB and Others v Lietuvos Respublikos konkurencijos taryba*, 21 January 2016, ECLI:EU:2016:42 [2016].
[344] Council Regulation (EC) n. 1/2003 of 16 December 2002 on the implementation of the rules on competition laid down in Articles 81 and 82 of the Treaty, OJ L 1, 4 January 2003, Article 2: "*In any national or Community proceedings for the application of Articles 81 and 82 of the Treaty, the burden of proving an infringement of Article 81(1) or of Article 82 of the Treaty shall rest on the party or the authority alleging the infringement."*
[345] Case C-199/92 P, *Hüls AG v. Commission*, 8 July 1999, EU:C:1999:358 [1999], §149–150; Case C-235/9 2P, *Montecatini SpA v. Commission*, 8 July 1999, EU:C:1999:362 [1999], §175–176.
[346] Case C-185/95P, *Baustahlgewebe GmbH v. Commission*, 17 December 1998, EU:C:1998:608 [1998], §58.
[347] Case 48/69, *Imperial Chemical Industries Ltd. V Commission*, 14 July 1972, ECLI:EU:C:1972:70, §64.

intuitively, an undertaking cannot participate to an unlawful practice that it has not been made aware of[348].

In proving the knowledge of the agreement, the European Court of Justice could rely on the so-called *Anic* presumption. In the opinion of the Court in the *Anic* case, "there must be a presumption that the undertakings participating in concerting arrangements and remaining active on the market take account of the information exchanged with their competitors when determining their conduct on that market, particularly when they concert together on a regular basis over a long period"[349]. Companies involved in an anti-competitive meeting cannot indeed wilfully ignore knowledge obtained at such a meeting; it is thus presumed that their subsequent conduct on the market is influenced by this knowledge. Hence, an undertaking that has attended (even passively) an anti-competitive meeting is deemed to have participated in a concerted practice within the meaning of Article 101[350].

When taking part in one or more anti-competitive meetings, a company might escape liability only by showing that it "publicly distanced itself" from any anti-competitive discussion. The key function of the *public distincing* requirement is, therefore, to rebut the *Anic* presumption: in particular, the undertaking must put forward evidence to establish that its participation in the meetings was without any anti-competitive intention and must demonstrate that it had indicated its different spirit to the other participant competitors[351]. Instead of resting on the Commission, the burden of proof is thus relying on the undertaking.

The scope and functions of the *Anic* presumption and the *public distancing* requirement seem to have evolved remarkably with the *Eturas* case, in which they were employed in determining travel agencies' liability for the algorithmic discounts cap announced through a message by Eturas administrator. Firstly, the application of the *Anic* presumption involved here a digital and algorithm-based environment, thus becoming broader. Secondly, and more specifically, the presumption could apply absent any anti-competitive meeting at all[352]. In *Eturas*, indeed, the European Court

[348] Ioannis Apostolakis, "Antitrust liability in cases of indirect contacts between competitors: VM Remonts", *Common Market Law Review* 54 (2017): 621.
[349] Case C-49/92 P, *Commission of the European Communities v Anic Partecipazioni SpA.*, 8 July 1999, ECR [1999] I-04125, §121.
[350] Marc Abenhaïm, "Public Distancing and Liability in Cartel Cases: Does Distance Lend Enchantment?", *World Competition* 39, n. 3 (2016): 413.
[351] Case T-7/89, *Hercules Chemicals v. Commission*, 17 December 1991, ECR [1991] II-1711, §232.
[352] Marc Abenhaïm, "Public Distancing and Liability in Cartel Cases: Does Distance Lend Enchantment?", *World Competition* 39, n. 3 (2016): 421.

of Justice allowed the simple dispatch of an "administrative notice" to serve as a basis for the presumption of knowledge of the anti-competitive conduct by the travel agencies, when supported by other "objective and consistent indicia"[353]. Even without having attended any meeting, or taken any anti-competitive initiative themselves, the undertakings could thus be presumed to have taken part in a concerted practice. In light of the forgoing, the amplified flexibility of the *Anic* presumption could however enhance its inherent tension with the general presumption of innocence of Article 48(1) of the EU Charter of Fundamental Rights[354]. This is exactly where the *public distancing* requirement plays a pivotal role: the wider the scope of the *Anic* presumption, indeed, the more important it is to demonstrate that public distancing remains realistically possible and reasonable, in order to be in line with Article 48[355]. In other words, the easier is to rebut the *Anic* presumption through *public distancing*, the more likely it is for the presumption to be compatible with the presumption of innocence. For this reason, the Court added in *Eturas* that undertakings should rebut the presumption of liability without having to take "excessive or unrealistic steps"[356]. Particularly, the *public distancing* requirement turns here more objective: as it is impossible for parties involved to know who its co-conspirators are in a such a platform collusion, the Court did not ask to companies to had made sufficiently clear to the other participants that they have no anti-competitive intentions, thus stepping away from the more subjective aspect of the requirement. Instead, the ECJ listed a number of different ways through which undertakings could nevertheless public distance themselves in this circumstance: by submitting a clear and express objection to the Eturas administrator; by reporting the concerted practice to the administrative authorities; by proving that the message was not received or that the party became aware of it only after some time; by systematically applying a discount exceeding the 3% cap in question[357]. The effectiveness of the latter, in particular, may raise some doubts: as a matter of fact, the option finds its reasoning in the assumption that only unaware companies would not lower their discounts to fit the collusive cap; this, however, does not take into account the possibility of aware companies that do not voluntary

[353] Case C-74/14, *Eturas UAB and Others v Lietuvos Respublikos konkurencijos taryba*, 21 January 2016, ECLI:EU:2016:42 [2016], §45.
[354] Charter of Fundamental Rights of the European Union, OJ C 326 (26 October 2012), Article 48(1): "*Everyone who has been charged shall be presumed innocent until proved guilty according to law".*
[355] Marc Abenhaïm, "Public Distancing and Liability in Cartel Cases: Does Distance Lend Enchantment?", *World Competition* 39, n. 3 (2016): 419-420.
[356] Case C-74/14, *Eturas UAB and Others v Lietuvos Respublikos konkurencijos taryba*, 21 January 2016, ECLI:EU:2016:42 [2016], §41.
[357] *Ibid.*, §41, 48-49.

lower their discounts in order to escape liability and to continue simultaneously to reap the benefits of the anti-competitive behaviour, since the Eturas technical restriction would enforce the cap anyway[358]. Hence, only when travel agencies have actually taken additional technical steps to circumvent the cap and offer an higher discount, they will be successful in rebutting the *Anic* presumption[359].

More generally speaking, the *Eturas* case may lead to a notable conclusion: in an algorithmic environment, liability for the infringement of Article 101 TFEU is attributable also on the basis of passive modes of participation to the collusion, such as receiving a message, subscribing to a pricing algorithmic platform through tacit assent or simply using a pricing algorithm[360]; the *Anic* presumption would thus exist even in cases of indirect contacts between competitors[361]. In algorithm-based frameworks, the burden of proof could therefore shift easily to the undertakings involved. In light of the principle of the presumption of innocence, however, the wider scope of the *Anic* presumption may not be reasonable enough[362]: the Court should therefore ensure to firms a realistic chance to rebut the presumption through *public distancing*, as the *Eturas* case has suitably emphasised. With more complex pricing algorithms – particularly self-learning ones – the *public distancing* proof would however hardly be possible, since firms are usually not able to control the price-setting behaviour of the algorithm: the lawfulness of such a strict reversal of the burden of proof should thus be discussed[363].

2. Possible regulatory intervention on collusive algorithms

Once the choice to regulate algorithmic collusion has been established and the meaningful issues concerning liability, detection and burden of proof have been discussed, the question about *how* to intervene will subsequently arise. In this context, two main possibilities would be feasible. On one hand, competition agencies

[358] *Ibid*., §12.
[359] Manon van Roozendaal, "Algorithms: Teenage Troublemakers of EU Competition Law", *European Law Institute* (2018): 6-9.
[360] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 168-169.
[361] Ioannis Apostolakis, "Antitrust liability in cases of indirect contacts between competitors: VM Remonts", *Common Market Law Review* 54 (2017): 622.
[362] Marc Abenhaïm, "Public Distancing and Liability in Cartel Cases: Does Distance Lend Enchantment?", *World Competition* 39, n. 3 (2016): 422.
[363] Monopolkommission, *Algorithms and collusion* (2018), §249.

could take action extending their existing legal tools through revisiting main antitrust concepts, on the ground of which current regulation would be applicable to an algorithmic scenario. On the other hand, traditional antitrust tools may prove, at times, difficult to apply to digital markets; for this reason, in dealing with collusive algorithms, enforcers would prefer to build both *ex ante* and *ex post* innovative measures.

2.1. Revisiting existing competition regulation

Adapting traditional competition provisions to the algorithmic environment does constitute the first plausible scenario. In this context, Chapter II has already highlighted the potential application of Article 102 TFEU, which may consider pricing algorithms as "correlative factors" for the existence of a collective dominant position; nevertheless, the difficulty in proving the abuse of collective dominance may in practice lead to the inefficiency of Article 102. The remaining *ex ante* intervention through merger policy and *ex post* regulation via Article 101 TFEU will thus be analysed below as conceivable alternatives.

2.1.1. Ex ante *intervention: merger control over algorithmic markets*

Traditionally being the preferred legal tool to address oligopolistic tacit collusion[364], the *ex ante* merger control under the European Union Merger Regulation may potentially be extended to markets with algorithmic activities.

Differently from a brick-and-mortar framework, such an approach will go beyond the traditional duopolies, where tacit collusion is more easily sustainable, to less concentrated markets, where the use of algorithms may nevertheless facilitate collusion. This may thus require competition agencies to consider lowering their threshold of intervention and investigate the risk of coordinated effects "not only in cases of 3 to 2 mergers, but potentially also in 4 to 3 or even in 5 to 4"[365]. Moreover, the analysis may be focused on the impact of merger transactions on market characteristics, such as transparency and frequency of interaction, which are most

[364] For a wide analysis of *ex ante* merger control in relation to tacit collusion, see Chapter I, Paragraph 2.1.
[365] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 41.

affected by the use of algorithms[366]. Finally, since pricing algorithms can respond to punishment mechanisms even in distinct product industries through multi-market contacts[367], competition enforcers should also carefully scrutinize conglomerate mergers[368], particularly those between firms offering the same type of product or service (e.g. airlines or retail stores) in different geographic markets[369].

As a US court observed, "it is a central object of merger policy to obstruct the creation or reinforcement by merger of such oligopolistic market structures in which tacit coordination can occur"[370]: merger control would thus prevent the rise of market structures which could in principle enhance the likelihood of tacit collusion. In algorithmic environment, less concentrated markets may raise conscious parallelism concerns as well, thus requiring a stronger merger policy. Academics outlined, however, that *ex ante* merger control would not work when other factors, such as the shift to algorithmic pricing itself, or firms exiting unilaterally, could foster tacit collusion anyways[371].

2.1.2. Ex post *intervention: extending the notion of "agreement" and "concerted practice"*

In order to *ex post* bring cases of algorithm-enabled price matching within the scope of EU competition law, a plausible alternative response would be to consider taking an expanded interpretation of Article 101 TFEU: as Borenstein outlined, indeed, "computer technology that permits rapid announcements and responses has blurred the meaning of 'agreement'"[372]. Since identifying an "agreement" or "concerted

[366] *Ibid*., 41.
[367] Federico Ciliberto and Jonathan W. William, "Does multimarket contact facilitate tacit collusion? Inference on conduct parameters in the airline industry", *RAND Journal of Economics* 45, n. 4 (Winter 2014): 765.
[368] A **conglomerate merger** is a merger between firms that are involved in totally unrelated business activities. These mergers typically occur between firms within different industries or different geographical markets.
[369] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 47.
[370] *Federal Trade Commission v H.J. Heinz Co*., 246 F.3d 708, 725 (D.C. Cir. 2001).
[371] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 45-48.
[372] Severin Borenstein, "Rapid Communication and Price Fixing: The Airline Tariff Publishing Company Case", Working paper (1997): 1, available at: http://faculty.haas.berkeley.edu/borenste/download/ATPCASE1.PDF.

practice" between competitors is a prerequisite to enforce the article against collusive outcomes, a new definition of what is an agreement or concerted practice for antitrust purpose would be required, trying in this way to incorporate other "meetings of minds" that are reached with the assistance of algorithms[373].

The notion of *agreement*, firstly, does entails the anthropocentric requirement of the existence of a "concurrence of wills between at least two parties"[374]: the concepts of reciprocity and meetings of minds thus go to the heart of what should be viewed as "agreement" in EU competition law. Hence, in order to treat algorithmic collusion similarly to a "meeting of minds", the reciprocity requirement should be demonstrated. The European courts, however, have widely limited the restriction: for there to be an agreement in the sense of Article 101, it is sufficient that one party send an invitation to collude to the other party and that the other party tacitly acquiesces to that invitation[375]; tacit acquiescence of the recipient arises if its business conduct is influenced by that invitation[376]. In light of the foregoing, defining which conduct is purely unilateral and which is not will become much harder: the unilateral use of signalling algorithms in the *Predictable Agent* scenario may thus resemble an actual negotiation process to implement a collusive agreement. The continuous dispatch of prices' signalling and the coherent competitors' reactions, indeed, could result in a proposal-acceptance relationship: a firm may make an invitation to collude by publicly releasing a price indication through a signalling algorithm, while competitors would tacitly accept the offer by raising and adjust prices in reaction to the algorithm. The use of parallel algorithms would thus determine a virtual but effective contact between firms, which, taking into account a broader interpretation of Article 101, would be able to reach the necessary "concurrence of wills" for the application of the article[377].

Similarly, in order to establish a *concerted practice* in the sense of Article 101 TFEU, a communication between parties, in the form of direct or indirect contact between competitors of such a kind as either to influence the market conduct of

[373] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 36-38.
[374] Case T-41/96, *Bayer AG v Commission*, 26 October 2000, ECR [2000] II-3383, §69.
[375] Joined cases C-2/01 and C-3/01, *Bundesverband der Arzneimittel-Importeure eV and Commission of the European Communities v Bayer AG.*, 6 January 2004, ECLI:EU:C:2004:2 [2004], §102.
[376] C-74/04 P, *Commission of the European Communities v Volkswagen AG.*, 13 July 2006, ECLI:EU:C:2006:460 [2006], §39.
[377] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 171-172.

competitors or to reveal future conducts to them, would be needed[378]. Applied to the digital world, one could argue that through repeated interactions, two different firms' pricing algorithms could come to "decode" each other: hence, even algorithms through which a firm merely observes another firm's price and draws its own conclusion would qualify as communication or information exchange, which may replace the uncertainty about competitors' actual and future conducts[379]. The Commission itself does appear aware that "one cannot fully rule out the possibility that more creative and novel types of interactions could in certain situations meet the definition of 'communication'"[380].

Another element that Chapter II has identified to be an obstacle to the enforcement of Article 101 TFEU (and Section 5 of the FTC Act) is the widespread reliance on firms' anticompetitive intention, in particular when the conduct appears ambiguous. In the absence of evidence on the objectives and intentions pursued by pricing algorithms, indeed, a much more detailed effects analysis will need to be conducted, thus hindering enforcement in practice[381]. However, two considerations must be reminded. Firstly, at least in European Union, an anticompetitive intention would not be necessary, nor sufficient, to establish a restriction to competition in the sense of Article 101 TFEU[382]: the lack of evidence of the anticompetitive intent may thus only make the enforcement of the article more problematic, though not impossible. Secondly, a different enforcement tool would help in practice to overcome the issue at stake: notably, Article 9 of Regulation 1/2003 does allow Commission and national competition authorities to start a proceeding on the basis of mere competition concerns[383]. Such concerns are communicated to the undertakings involved through a preliminary assessment, which summarises the main facts of the case[384]. Whereas the undertakings offer commitments to meet the concerns expressed

[378] Case C-74/14, *Eturas UAB and Others v Lietuvos Respublikos konkurencijos taryba*, 21 January 2016, ECLI:EU:2016:42 [2016], §27.
[379] Luca Calzolari, "La collusione fra algoritmi nell'era dei big data: l'imputabilità alle imprese delle "intese 4.0" ai sensi dell'art. 101 TFUE", *Media Laws* n. 3 (2018): 232.
[380] Organisation for Economic Co-operation and Development, *Algorithms and Collusion – Note from the European Union* (21-23 June 2017), §33.
[381] Jan Blockx, "Antitrust in Digital Markets in the EU: Policing Price Bots", *Radboud Economic Law Conference 9 June 2017* (2 June 2017): 7.
[382] Case C-8/08, *T-Mobile Netherlands and Others v Raad van bestuur van de Nederlandse Mededingingsautoriteit*, 4 June 2009, ECR [2009] I-4529, §27; Case C-67/13 P, *Groupement des cartes bancaires v Commission*, 11 September 2014, ECLI:EU:C:2014:2204 [2014], §88.
[383] Council Regulation (EC) n. 1/2003 of 16 December 2002 on the implementation of the rules on competition laid down in Articles 81 and 82 of the Treaty, OJ L 1, 4 January 2003, Article 9.
[384] Commission notice on best practices for the conduct of proceedings concerning Articles 101 and 102 TFEU, OJ C 308/6, 20 October 2011, §121.

to them, the Commission may make those commitments binding on the undertakings, thus finding that there are no longer grounds for action without concluding whether or not there has been an infringement[385]. Since it may provide flexible solutions to mutable competition concerns, this enforcement tool has been particularly employed by the Commission in data-driven and digital markets. Moreover, as to the rapid changeability of digital scenarios and the subsequent need of prompt intervention, Article 9 would be able to contrast alleged unlawful algorithmic conducts more quickly than ordinary proceedings, without the need of hard evidences. The adoption of decisions with commitments in a digital environment could thus disregard the solution of competition challenges raised by algorithmic collusion – such as the anticompetitive intent deficiency – facilitating in this way the enforcement of Article 101 TFEU[386].

Having regard to the foregoing, one could argue in conclusion that, when extensively interpreted, Article 101 TFEU may potentially be applied to the unilateral usage of pricing algorithms of the *Predictable Agent* and *Digital Eye* scenario. The use of signalling algorithms, in particular, could implement a collusive *agreement* in the meaning of Article 101; the price matching achieved through the employment of other parallel or self-learning algorithms, which solely monitor and adjust prices to the competitors' ones, may give rise to a *concerted practice*, with or without the evidence of the anticompetitive intent; whereas the framework could not be managed under the notion of concerted practice, parallel algorithms may nevertheless be considered as unlawful *information exchange*[387]. Instead of extending the application of Article 101 TFEU to unilateral tacit collusion derived from oligopolistic interdependence – this having been excluded at Chapter I – the approach thus affects a conduct which, thanks to pricing algorithms, may turn the natural oligopolistic interdependence into a proper unlawful explicit collusion[388]. Since proving that unilateral algorithmic tacit collusion constitutes an agreement or concerted practice can be difficult in practice under the current legal standards, competition scholars are

[385] Council Regulation (EC) n. 1/2003 of 16 December 2002 on the implementation of the rules on competition laid down in Articles 81 and 82 of the Treaty, OJ L 1, 4 January 2003, (13).
[386] Luca Calzolari, "La collusione fra algoritmi nell'era dei big data: l'imputabilità alle imprese delle "intese 4.0" ai sensi dell'art. 101 TFUE", *Media Laws* n. 3 (2018): 235-239.
[387] Organisation for Economic Co-operation and Development, *Algorithms and Collusion – Note from Italy* (21-23 June 2017), §18.
[388] Pietro Manzini, "Algoritmi collusivi e diritto antitrust europeo", *Mercato Concorrenza Regole* 1 (April 2019): 171-172.

claiming for a more clear and extended definition of Article 101 concepts, which will potentially address algorithmic collusion concerns[389].

2.2. Enforcing innovative regulatory countermeasures

Recognising the difficult enforcement of the traditional antitrust tool-box over algorithmic tacit collusion, academics and policy makers have engaged in a growing debate concerning the likelihood of innovative regulatory interventions. Some of the central topics discussed include, in particular, the need for a compliance-by-design, the employment of policies to make markets and tacit collusion unstable and the attempt to soften algorithmic collusion through "smart" countermeasures, all of which will be analysed in detail through the paragraph.

2.2.1. Regulation over algorithms: the "compliance by design"

Some of the regulatory interventions discussed in most recent debates appear to focus on algorithms' architecture and transparency, in order to prevent undertakings from coordinating anticompetitive prices. As to the enforcement of such regulations, the EU Commissioner Vestager proposed in a recent speech to shift the burden to companies: businesses would have the obligation of programming algorithms to deliberately comply with a set of guidelines and rules, from regulations on algorithmic design to antitrust, transparency and data protection laws[390]. Drawn from the principle of "data protection by design"[391], the concept of "compliance by design" would therefore aim to ensure that regulations addressing problems of

[389] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 39.

[390] Margrethe Vestager, "Algorithms and Competition", Speech at the Bundeskatellamt 18th Conference on Competition, Berlin (16 March 2017), available at: https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/bundeskartellamt-18th-conference-competition-berlin-16-march-2017_en

[391] "**Data protection by design**" is an international approach related to Data Protection Laws, which ensures to consider privacy and data protection issues at the design phase of any system, service, product or process and then throughout the lifecycle. Article 25(1) of the EU Regulation 2016/679 (General Data Protection Regulation) specifies the requirements concerning data protection by design.

algorithmic collusion are embedded in the design of the technology[392]. In other words, "algorithms need to be built in a way that doesn't allow them to collude"[393].

In order to prevent the rise of algorithmic collusion, policy makers could consider the creation of rules on algorithms' layout, which may *ex ante* restrict, through a "compliance by design" approach, the way algorithms are projected[394]. Firstly, specific regulations could inhibit algorithms from reacting on features or market variables that are necessary to sustain tacit collusion. As an example, one possibility may be to force programming the algorithm to ignore commercially sensitive information exchanges that facilitate tacit collusion but are of limited use to customers (i.e. "cheap talk"). However, it would likely be difficult and welfare-reducing for enforcers to specify what information the algorithm must ignore, inasmuch as computers usually link huge data sets and some data can promote efficiency even while raising competition concerns[395]. Secondly, algorithms may be mandatorily programmed not to react to most recent changes in prices or to price variations and behaviours of individual companies. Here, the German Bundeskartellamt preliminary investigation against Lufthansa Group for excessive pricing constitutes a meaningful example. Following the insolvency of a competitor (Air Berlin), Lufthansa's tickets on certain routes increased by average 25-30% during 2017, thus raising concerns about an alleged abuse of a newly acquired dominant position[396]. As Lufthansa Group runs a fully-automated algorithmic booking system, the case posed the question of whether a pricing algorithm should be programmed to ignore a competitor's insolvency – or similar changes in market structure and competitors' conducts; furthermore, given that the insolvency would have brought about market dominance of the remaining player Lufthansa, the issue became even more significant[397].

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[392] Kenji Lee, "Algorithmic Collusion & Its Implications for Competition Law and Policy" (12 April 2018): 45-46.

[393] Margrethe Vestager, "Algorithms and Competition", Speech at the Bundeskatellamt 18th Conference on Competition, Berlin (16 March 2017).

[394] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 50.

[395] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 231.

[396] Although the considerable price increase, it did not justify the initiation of an abuse proceeding: the quick subsequent entry to the market of EasyJet permitted prices on the respective routes to immediately fell again. (Bundeskartellamt, "Lufthansa tickets 25-30 per cent more expensive after Air Berlin insolvency – Price increase does not justify initiation of abuse proceeding", Press release (29 May 2018).

[397] Peter Georg Picht and Benedikt Freund, "Competition (law) in the era of algorithms", *Max Planck Institute for Innovation and Competition Research Paper Series* n. 18-10 (15 May 2018): 16.

Taking into consideration the different possibilities of algorithmic design rules, such regulations should then be made effective in practice. As a matter of fact, *self-learning* algorithms could circumvent safeguards and prohibitions imposed by coders and competition agencies: developers may thus be required to implement the "safe interruptibility" of pricing algorithms[398], through which humans would be able to interfere in price-setting and safely interrupt pricing agents[399].

Beyond enforcing rules on algorithms' architecture, the idea of "compliance by design" is also strictly connected to the need of regulations over algorithmic transparency and accountability: "designing in" compliance could indeed answer to the great demand for transparency as a requisite for effective competition policy in the age of algorithms[400]. As an example, the US Public Policy Council of the Association for Computing Machinery (USACM) proposed in 2017 a list of seven principles for algorithmic transparency and accountability, which are intended to provide context for what algorithms are and how they make decisions, thus being directly applied in designing and running pricing algorithms. According to some USACM's principles, questioning and redress for adversely affected individuals should be enabled; systems and institutions that use algorithmic decision-making are encouraged to produce explanations; algorithms, data and decisions should be recorded and, finally, a description of the training data provenance should be maintained by algorithm's developers[401]. Over and above transparency principles, scholars have even proposed the implementation of "Artificial Intelligence sunshine laws", according to which designers and operators of pricing algorithms would have to publicly disclose the codes and specifications of their AI systems, in order to allow a public scrutiny[402]. Furthermore, regulating algorithmic transparency may require interventions under different policy areas. With the adoption of the General Data Protection Regulation (GDPR) in April 2016, for instance, the European Parliament introduced at Article 13 the right of citizens to ask for the "existence of automated decision-making" and for "meaningful information about the logic involved, as well

[398] Niccolò Colombo, "Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours", *European Competition and Regulatory Law Review* 2, n. 1 (2018): 20.
[399] Laurent Orseau and Stuart Armstrong, "Safely Interruptible Agents" (July 2016), available at: http://intelligence.org/files/Interruptibility.pdf
[400] Simonetta Vezzoso, "Competition by Design", prepared for Presentation at 12th ASCOLA Conference, Stockholm University, 15-17 June 2017 (28 November 2017): 21.
[401] Association for Computing Machinery, US Public Policy Council, *Statement on Algorithmic Transparency and Accountability* (12 January 2017), 2.
[402] Matthew U. Scherer, "Regulating Artificial Intelligence Systems: Risks, Challenges, Competencies, and Strategies", *Harvard Journal of Law and Technology* 29, n. 2 (2016): 399.

as the significance and the envisaged consequences of such processing for the data subject"[403]. The Regulation thus effectively creates a citizens' "right to explanation" and implements algorithms' transparency, while enabling computer scientists to take the lead in designing algorithms which can ensure compliance with the regulatory framework[404].

Enforcing regulations over algorithms' design and transparency through a "compliance by design" approach, however, might turn out to be a challenging task in practice. As to rules on algorithmic architecture, the compliance to such regulations would likely constraint the ability of firms to develop innovative algorithms, reducing their incentive to invest in proprietary technologies. With respect to regulations over algorithmic transparency, moreover, making complex and *self-learning* algorithms fully transparent can be quite impossible: the intended purpose would require indeed that developers could explain the exact functioning of the pricing algorithm, that may be extremely difficult when facing black box algorithms that make autonomous decisions without having been instructed by anyone. Additionally, by posing further burden of supervising on competition agencies, regulating algorithm's design and transparency may be even difficult to enforce. It is still not clear, indeed, which authority would be best placed to review algorithms; on top of this, many online companies operate beyond national borders, or even at the interface of different branches of law, posing thereby a challenge of coordination and co-operation between regulators[405]. Nonetheless, additional arguments may make the idea of "compliance by design" particularly worth exploring. First of all, the concept can be seen as an effort to *ex ante* nudge the design of pricing algorithms in a direction that complies with competition principles "without locking it into a specific technological trajectory or paradigm"[406], thus not posing limits to digital innovation but rather preventing the looming issue of under enforcement (i.e. false negatives). What is more, "compliance by design" should not be seen as a substitute or replacement for traditional competition law enforcement;

[403] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation), OJ L 119 (4 May 2016), Article 13(2).
[404] Bryce Goodman and Seth Flaxman, "European Union regulations on algorithmic decision-making and a 'right to explanation'", *AI Magazine* 38, n. 3 (2017): 1.
[405] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 48-50.
[406] Simonetta Vezzoso, "Competition by Design", prepared for Presentation at 12th ASCOLA Conference, Stockholm University, 15-17 June 2017 (28 November 2017): 24.

on the opposite, it should be accounted as a potential complement to it in an algorithmic environment. Aside from the highlighted challenges, the measure could thus likely form part of an approach to competition policy enforcement in markets where velocity is key to competitive success and post-factum countermeasures are very often ineffective[407].

2.2.2. Regulation over markets: policies making tacit collusion unstable

Rather than legally challenge algorithmic tacit collusion through regulations over design and transparency, policymakers and agencies may attempt to actively destabilize it. The approach would thus implement policies to change the structural characteristics of digital markets that most facilitate conscious parallelism[408], which have already been analysed in Chapter I[409]. Algorithmic collusion incubators, in particular, can help regulators better understand what market factors are worth exploring: agencies would test which conditions added to, or removed from, the collusion incubator simulating the industry's algorithms would make tacit collusion more durable; change of such market dynamics may then be achieved through careful state and regulatory intervention[410].

First, policy makers might come up with interventions to make algorithmic markets less transparent, without undermining at the same time the competitive process itself. In this context, the regulators' enforcement of systems of secret bids and discounts could help destabilize algorithm-enhanced tacit collusion. By granting discount cards which provide secret discounts to users or by offering their best bid to each consumer through an app, dealers may decrease market transparency and complicate the detection of cheating by cartel members, while ensuring at the same time sufficient availability of information for consumers and not for rival firms, in order to limit the likelihood of behavioural price discrimination[411]. This simple measure thus allows

[407] *Ibid*., 24-25.
[408] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 50.
[409] Among the others, market transparency, high frequency of interaction and a low number of competitors in the market might facilitate tacit collusion in digital markets.
[410] Jin Li and Charles R. Plott, "Tacit Collusion in Auctions and Conditions for Its Facilitation and Prevention: Equilibrium Selection in Laboratory Experimental Markets", *Economic Inquiry* 47, n. 3 (July 2009).
[411] **Behavioural price discrimination** in digital markets is a form of price discrimination in which individual consumers are charged different prices based solely on their purchase history information,

firms to sell below the market price, making tacit collusion unstable[412]. Alternatively, another way to decrease transparency could be to impose restrictions on the information published online, in order to make it harder for algorithms to infer what competitors are doing[413].

Likewise, governments may attempt to reduce the speed and the frequency of algorithms' price adjustments. As an example, sellers may be limited in their ability to match each other's price more than a given number of times a day, thus facing a time delay in changing price[414]: under this scenario, the maverick firm could profit from being the first to discount. Competitors would however complain that the regulation is preventing them from discounting, leading literally to a price increase. An alternative would thus be the solution adopted in the Austrian fuel market in 2009: here, the enforcer allowed price decreases to be implemented immediately, but imposed a time lag only for price increases[415]. Nonetheless, the pricing delay could unintentionally foster tacit collusion anyway. Knowing that it could not rapidly raise its price after having been punished by competitors, the maverick firm would indeed calculate through algorithms the likelihood of retaliation and the costs and benefits before discounting. If competitors could instantly match the maverick's discount, the incentive to lower prices would be reduced: the system would thus serve at the end as a punishment mechanism for defecting from the tacitly collusive price[416].

Besides market transparency and frequency of interaction, regulators can target market structures by facilitating entry by companies and reducing entry barriers. In this context, one approach may involve supporting entry by a maverick firm[417], which could offer a disruptive technology or business model, cut prices or expand its

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gained through algorithms and web-browser cookies. (See Organisation for Economic Co-operation and Development (OECD), *Personalised Pricing in the Digital Era: Background Note by the Secretariat*, 28 November 2018).

[412] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 229.

[413] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 45.

[414] Such approach has been implemented, for instance, in the fuel sector in Western Australia.

[415] Evanthia Fasoula and Karsten Schweikert, "Price Regulations and Price Adjustment Dynamics: Evidence from the Austrian Retail Fuel Market", *Hohenheim Discussion Papers in Business, Economics and Social Sciences* n. 8 (2018): 5-6.

[416] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 229-230.

[417] A **maverick firm** is one that has a greater economic incentive to deviate than do most of its rivals and constitutes an unusually disruptive force in the market place.

production: if successful, the strategy may lead to an all-out price wars, which destabilizes algorithmic tacit collusion. A related avenue may consist in sponsoring entry by consumer-owned cooperatives, where supracompetitive profits are redistributed to consumers in the form of rebates, and social purchasing websites, such as CrowdZap[418], or group buying websites, such as Groupon[419], which, offering lower prices, are injecting competition in the market. Such countermeasures are, however, not problem-free. Beyond the difficulties in sponsoring entry by new firms, which may dissipate their profits, incumbents can develop counterstrategies to reduce the maverick's incentive to discount, thus fostering coordinated behaviour, especially through targeting rivals' customers and marginalizing competitors[420].

The list of potential regulatory interventions over markets dynamics discussed here is not intended to completely solve the algorithmic collusion issue. Such policies have indeed many unpredictable implications which could compromise the good functioning of digital markets: by reducing the information available, by preventing fast price adjustments or by forcedly introducing new firms on the market, the intervention would be likely to result in severe restrictions to competition, requiring therefore to be narrowly designed[421].

2.2.3. Algorithmic countermeasures: the use of technology by policymakers and consumers

Change of market dynamics and regulations' enforcement may be in principle achieved not only through traditional state intervention, but also by using the same technologies and algorithms employed by market players. If, indeed, private firms can exploit Big Data and algorithmic agents to effectively set (sometimes collusive) prices, why could not governments and consumers use the same tools to destabilize prices, or apply countermeasures?[422] The need and the chance to power policies on

[418] Websites as **CrowdZap** does assemble buying groups and does achieve economies of scale in purchasing, enabling it to offer discounts to users.
[419] **Groupon**, **Wowcher** and **Living Social** do offer consumers discount vouchers when enough consumers sign up for an offer.
[420] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 228-229.
[421] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 50.
[422] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 212-213.

algorithmic collusion through "smart" regulations and algorithmic measures should thus be discussed.

Over the past few years, policymakers have been firstly interested in developing algorithmic screening tools to identify collusive conducts, particularly in industries where variables for price are easily observable: this may help regulators to test digital markets and the likely effects of plausible countermeasures.
Beyond the screening function, a more intrusive "smart" regulation could be to post the market-clearing price of products and services. Providing consumers with the competitive bench price, identified via algorithms, buyers are thus able to compare it to firms' prices and to choose the optimal one[423]. On top of this, agencies could be tempted to set the benchmark price or to introduce significant maximum price regulations, basing on results of algorithmic market studies. The smart parking system experimented since 2011 in San Francisco could illustrate an early example: the parking prices in the city would in fact adjust according to periods of high or low demands by employing a data-driven dynamic pricing algorithm[424]. Going a step beyond, the San Francisco case may mark a likely rebirth for risky price regulations and centrally planned economies, albeit under more modern and acceptable terms[425]. By reducing incentives to innovate and creating a focal point for collusion in digital markets, governments' maximum price regulations might pose significant barriers to competition and should be replaced with more efficient alternatives[426].
Another state-sponsored countermeasure may be in the form of a "disruptive algorithm", which can be introduced in the market to undermine the existing collusive equilibrium through mixed signalling. Despite being appealing, the idea of a destabilizing maverick algorithm may likely generate inefficiencies, as it would counteract the activity of market regulatory algorithms listed above[427].

Apart from policymakers and governments, even consumers can rely on algorithms programmed to maximise consumer surplus and undermine tacitly collusive outcomes. In order to describe the phenomenon, Michal Gal and Niva Elkin-Korren

[423] *Ibid*., §134-135.
[424] San Francisco Municipal Transportation Agency, *SFpark Pricing* (2016), available at: http://sfpark.org/how-it-works/pricing/
[425] Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition: the promise and perils of the algorithm-driven economy* (Cambridge, Massachusetts: Harvard University Press, 2016), 214.
[426] Organisation for Economic Co-operation and Development (OECD), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), 49-50.
[427] Ariel Ezrachi and Maurice E. Stucke, "Two Artificial Neural Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)", *The University of Tennessee Legal Studies Research Paper Series* n. 323 (July 2017): 49-50.

introduced in 2017 the concept of "algorithmic consumers"[428]: while traditional price comparison websites algorithms are available only to assist in purchasing decision, such new algorithms, known as "digital half" or "digital butlers", would directly make and execute decisions for the consumer. By communicating with other systems through the internet, the "digital butler" automatically identifies the consumer's need; then, taking supply conditions and consumer's preferences into account, it searches for an optimal offer and it executes finally the transaction for the consumer. As depicted by **Figure 12** below, algorithmic consumers may use algorithms at all stages of the transaction. From data collection, to data analytics, decision-making and performance, humans may potentially be substituted by computer algorithms, thus increasing equality among consumers: even unskilled users can, indeed, easily rely on digital butlers to optimise purchasing strategies on their behalf[429]. Besides pure demand-side efficiencies, however, the strengthening of algorithmic consumers' buyer power increases suppliers' competitive pressure and their incentives to innovate. Moreover, the race between the two algorithmic sides might lead to a procompetitive "algorithmic war", which could counteract the collusive benefits created by suppliers' pricing algorithms. By empowering consumers, such algorithms may thus rebalance the welfare equation, enabling customers to recognise forms of price coordination and to strengthen incentives for entry by new firms[430].

Still, the demand-side measure does raise risk of distorting competition, including reduction of the autonomy of consumers' choices, harm to users' privacy or potential increase of oligopsony[431] power[432]. According to the maxim "it takes a computer to beat a computer"[433], a controlled effort to engage in algorithmic countermeasures, both on enforcers- and consumers-side, does remain nonetheless indispensable.

[428] Michal Gal and Niva Elkin-Koren, "Algorithmic Consumers", *Harvard Journal of Law and Technology* 30, n. 2 (2017).
[429] *Ibid*., 5-9.
[430] *Ibid*., 21-33.
[431] An **oligopsony** is a market form in which there are only a few large buyers for a product or service. This usually allows buyers to exert a great deal of control over the sellers and can effectively drive down prices.
[432] *Ibid*., 16-18.
[433] Organisation for Economic Co-operation and Development, *Algorithmic Collusion: Problems and Counter-Measures – Note by A. Ezrachi & M. E. Stucke* (31 May 2017), §131.

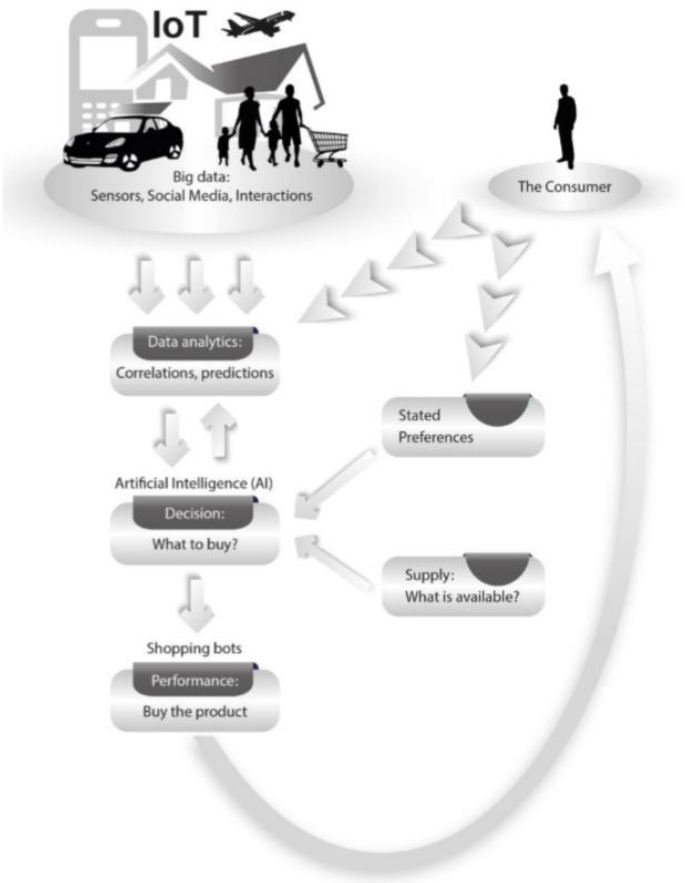

Figure 12 – Decision-making process of algorithmic consumer (**Source**: Michal Gal and Niva Elkin-Koren, "Algorithmic Consumers", *Harvard Journal of Law and Technology* 30, n. 2 (2017): 10)

3. Conclusion

Following an interventionist approach over the problematic scenario of algorithmic tacit collusion, Chapter III has first focused on the main enforcement challenges posed by an algorithm-based environment. As to whether companies could be held liable for their algorithms' unlawful conduct, Paragraph 1.2. has claimed for the application of employees' liability rules over *Predictable Agent* algorithms, while comparing the connection between a firm and its *self-learning* algorithm to a principal-agent relationship; in an Hub-and-Spoke scenario, algorithm's suppliers have been then considered liable as cartel facilitators for the anticompetitive conduct

of their spokes. It is thus clear that "businesses need to know that when they decide to use an automated system, they will be held responsible for what it does"[434]. Given the liability of the undertakings, the Chapter has subsequently faced the challenge of detection of algorithmic unlawful activities: failing to lead to a suitable resolution, the route of auditing the algorithm itself is apparently overcome by a more general path involving market studies and investigations. Once detected, the algorithmic tacit collusion might then be proved. The expanded scope of the *Anic* presumption, which could potentially be applied even to indirect contacts between competitors, may lead to a strict and not totally reasonable reversal of the burden of proof: when dealing particularly with self-learning and autonomous algorithms, the *public distancing* requirement would indeed hardly be satisfied.

After having discussed the main arising questions, the Chapter has then highlighted two meaningful possibilities of regulatory intervention. On one hand, competition enforcers could extend existing legal tool to the algorithmic scenario. If a stronger *ex ante* merger control would not be properly effective, *ex post* intervention through the application of an extensively interpreted Article 101 TFEU (and concepts of agreement and concerted practice) might potentially address algorithmic collusion concerns. Although the algorithmic nature of tacit collusion does not make obsolete the traditional competition law framework, the implementation of innovative regulatory solutions, on the other hand, would be desirable. The table below (**Table 4**) does list market-based and algorithm-based plausible countermeasures presented in Chapter III, which agencies might be willing to consider in the near future.

[434] Margrethe Vestager, "Algorithms and Competition", Speech at the Bundeskatellamt 18th Conference on Competition, Berlin (16 March 2017).

	Innovative countermeasure	Examples	Risks and problems
Regulation over algorithm (enforced through "compliance by design")	**Regulation of algorithm's design**	⇨ Regulation to inhibit algorithms from reacting on market variables and price behaviours of rivals ⇨ Regulation to implement "safe interruptibility" of algorithms	Risk of restraining innovation; Difficulties in identifying information the algorithm must ignore
	Regulation of algorithm's transparency	⇨ USACM principles of algorithmic transparency and accountability ⇨ AI "sunshine" laws (to publicly disclose codes of algorithms) ⇨ Article 13 GDPR ("right to explanation")	Impossibility to make algorithms fully transparent; Challenge of co-operation between different regulators
Regulation over markets characteristics facilitating tacit collusion (to destabilize it)	**Policies to reduce market transparency**	⇨ Enforcement of systems of secret bids and discounts ⇨ Restrictions on the information published online	Risk of behavioural price discrimination
	Policies to reduce frequency of interaction	⇨ Allowing price matching a given number of times a day ⇨ Imposing time lags for price increases	Risk of reducing the possibility to discount; Risk of serving as punishment mechanism for defecting from collusive price
	Policies to facilitate entry in the market	⇨ Supporting a maverick firm ⇨ Sponsoring consumers' cooperatives and social purchasing or group buying websites	Difficulties in sponsoring entry; Possibilities of counterstrategies of incumbents
Algorithmic ("smart") measures	**Government's algorithmic countermeasures**	⇨ Screening algorithms ⇨ Setting competitive benchmark price	Risk of rebirth of centrally planned economies; Risk of creating a

(employing technology)		⇨ Maximum price regulations ⇨ Introducing "disruptive algorithms"	focal point for collusion; Risk of counteracting regulatory algorithms
	Consumers' algorithmic countermeasures	⇨ Price comparison websites ⇨ "Algorithmic consumers"	Reduction of consumers' autonomy; Harm to consumers' privacy; Potential increase of oligopsony power

Table 4 – Innovative countermeasures to algorithmic collusion and potential risks

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Conclusion

The new digital ecosystem, in which business pricing decisions are taken by algorithms, challenges the basic antitrust assumptions about how markets operate and how undertakings compete or collude. As shown, automated systems can make price adjustments and coordination easier and quicker than ever, thereby reducing firms' incentive to compete. When implemented by algorithms, tacit collusion widens its borders from oligopolistic markets to less concentrated ones. Two major algorithmic mechanisms explain how advanced technology is increasing the instances in which conditions for tacit collusion are present. Firstly, the employment of algorithms deeply affects market characteristics, particularly price transparency and frequency of interaction between competitors. As explained in Chapter I, the outlined conditions of the marketplace may make tacit collusive outcomes always stable, attenuating the cartelists' incentive to deviate from the coordinated price. Secondly, by sending market signals, monitor competitors' pricing strategies, optimising firms' profits and negotiating cartels' conditions, advanced and self-learning tools might strengthen tacit collusion, which would achieve the same outcome of explicit cartels without the need of any direct agreement in "smoke-filled rooms" between undertakings. Following this, if tacit collusion in oligopolistic brick-and-mortar markets has always been held lawful and rational under EU competition law, when implemented by algorithms, tacitly coordinated outcomes would require a suitable intervention by antitrust authorities; the "oligopoly problem" will therefore concern all kinds of digital marketplaces, where wealth would be transferred from purchasers (and ultimately us) to suppliers.

Assuming the need of regulation to lessen welfare-reducing effects of algorithmic tacit collusion, this Work explored some of the enforcement challenges to competition raised by the use of algorithms. As to the role of companies' liability over algorithms' anticompetitive conducts, Paragraph 1.2. of Chapter III outlined the applicability of employees' liability rules over *Predictable Agent* algorithms and agents' liability rules over *self-learning* algorithms; lastly, *Hub-and-spoke* algorithms' suppliers have been held liable as cartel facilitators. What emerges from the forgoing considerations is that algorithms are, and will always remain, tools working on behalf of someone else. The company employing them is thus responsible for the illegal consequences of algorithmic conducts. With regard to the problem of detection in digital environments, the audition of the algorithm has

limited practical appeal, as enforcers may lack the expertise to trace the decision-making process of a self-learning algorithm; a more general detection tool – and even less effective – would thus be, at the present time, market investigations and sector studies. Lastly, the digital world raised meaningful challenges as to the burden of proof of the anticompetitive conduct. Given the difficulty in finding strong evidentiary inferences of an explicit communication, courts employ the *Anic* presumption of liability even in cases of indirect contacts between undertakings through an automated system. By widening the scope of the assumption, *Anic* may unreasonably shift the burden of proof to the companies involved; thereby, the alternative of *public distancing* must be ensured to the alleged cartelists. In *Digital Eye* scenarios, where algorithms are complex, autonomous and extremely difficult to control, public distancing themselves from algorithm's conduct would be rather arduous for firms and would require additional elucidations by European Union.

Having answered to the foregoing enforcement questions, competition agencies explored alternative courses of possible intervention. On one hand, existing antitrust tools can capture some of the cases in which pricing algorithms facilitate coordination. When simply enforcing pre-established explicit agreements, monitoring and signalling algorithms may be straightforwardly held unlawful under Article 101 TFEU; as in the 2016 *Eturas* case, the use of a single supplier's algorithm to determine the price charged by numerous competitors may give rise to a traditional hub-and-spoke conspiracy, prohibited by Article 101 TFEU. Besides explicit collusion, algorithmic parallel conducts, which resemble oligopolistic conscious parallelism, do meet substantial obstacles. Firstly, the *ex ante* approach through Merger Regulation does not result properly effective, as algorithmic price adjustments would foster tacit collusion in less concentrated markets anyways. Among the *ex post* regulations, the abuse of collective dominance is the most arduous to attest. If pricing algorithms may potentially be regarded as "correlative factors" between firms for the existence of a collective dominant position, the impediment of establishing the "abuse" has led to the inefficacy of Article 102 TFEU. Beyond this, practitioners have tried to apply Article 101 TFEU to algorithmic collusive scenarios. On one hand, parallel algorithms may be regarded as "facilitating practices"; by reducing uncertainty about competitors' actions and intentions, algorithms show specifically similarities with information exchange devices, which may be held unlawful under Article 101. In order to include cases of algorithm-enabled price matching within the scope of the article, however, courts and agencies should consider taking an expanded interpretation of the notion of

"agreement" and "concerted practice". The dispatch of prices through algorithms and the subsequent competitors' price adjustments would in this way result in a "concurrence of wills", turning straightforwardly algorithmic tacit collusion into a proper explicit agreement, or, at least, into an illegal facilitating practice.
Since algorithms can result in multiple unexpected market failures, this Thesis posed adequate attention to the potential need for a regulatory reform in the digital economy. Besides traditional competition law framework, innovative regulatory approaches might be considered. Among the others, Chapter III identifies the likelihood of regulations over algorithm's design and transparency, which can be enforced *ex ante* through the principle of "compliance by design"; the possibility to implement policies to restrain market characteristics that facilitates tacit collusion; the enforcement of governments' measures through the employment of automated systems and, lastly, the rise of demand-side algorithmic countermeasures. Given the potential benefits of algorithms on society and the risk of false positives, concerns might arise as to the likely negative impact of regulatory intervention on digital markets competition.

The multi-dimensional nature of algorithms, nevertheless, requires the development of innovative policy approaches, in order not to replace, rather to complement Article 101 and 102 enforcement. New countermeasures should be cautiously implemented in co-operation with competition law agencies, together with data and consumer protection authorities; furthermore, practitioners of computer science and deep learning may help in dealing with "smart" regulations and algorithmic measures. Whatever actions are taken in the next future, what is clear is the undeniable risk that algorithms may pose on competition. In the words of Melvin Kranzberg,

Technology is neither good nor bad; nor is it neutral[435].

Given their challenging role in facilitating tacit collusion and the welfare stakes involved, pricing algorithms should thus be subject to deep assessment and a careful approach. The advancement of technological means "needs not leave antitrust law behind"[436]; further understanding of algorithms' functioning will be essential in the near future. Having regard to the algorithmic path of tacit collusion, this Thesis tried to take a step in its direction.

[435] This is the first law of the six Kranzberg's laws on technology, declared in 1986. (Melvin Kranzberg, "Technology and History: 'Kranzberg's Laws'", *Technology and Culture* 27, n. 3 (July 1986): 549).
[436] *Spencer Meyer v Travis Kalanick*, 15 Civ 9796; US. Dist. Lexis 43944 [2016], Section 7.

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