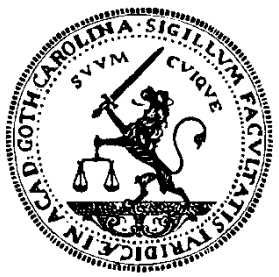

FACULTY OF LAW

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Anja Siöstedt

Law-abiding algorithms

How Big Data and AI challenges the competitive system

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Contents

Summary

In this thesis, the usage of pricing algorithms is analyzed to see how they facilitate new ways for companies to collude. To answer the question of how current competition legislation in the EU can be applied to algorithmic collusion, I studied the definition of the three forms of collusion in art. 101(1) TFEU through case law, Commission decisions, and literature on the subject. Subsequently, these definitions were applied to four scenarios of algorithmic collusion, the Messenger scenario, the Hub & Spoke scenario, the Predictable Agent scenario, and the Digital Eye scenario. The results of the study showed that collusion through algorithmic pricing models are difficult to enforce under current legislation in all scenarios but the Messenger scenario. The lack of human involvement in business decisions and the absence of an agreement between representatives of companies conducting collusive behavior renders the prohibitive rule in art. 101(1) TFEU difficult to apply. The implication of these findings is that the authorities cannot prohibit collusive outcomes on the market when the companies in question delegates decision-making to an algorithm.

Sammanfattning

I denna uppsats analyseras prissättningsalgoritmer för att undersöka hur de kan skapa nya sätt för företag att ägna sig åt kartellverksamhet. För att svara på frågan hur nuvarande konkurrensrättslig lagstiftning i EU kan appliceras på algoritmisk kartellbildning, studeras definitionen av de tre formerna av karteller i art. 101(1) FEUF. Genom ett studium av rättsfall, beslut från Kommissionen, samt litteratur på området kunde dessa definitioner appliceras på fyra olika sorters algoritmisk kartellbildning, the Messenger scenario, the Hub & Spoke scenario, the Predictable Agent scenario och the Digital Eye scenario. Resultatet av studien visar att kartellverksamhet genom prissättningsalgoritmer är svåra att lagföra under nu gällande konkurrensrättslig lagstiftning. Ett undantag är vid the Messenger scenario. Frånvaro av mänsklig inblandning i affärsbeslut och avsaknad av avtal eller överenskommelser mellan företag som ägnar sig åt kartellverksamhet resulterar i att förbudsregeln i art. 101(1) FEUF är svårt att tillämpa i dessa sitationer. Implikationen av dessa resultat är att myndigheter inte kan förbjuda kartelliknande utfall på marknaden när de aktuella företagen delegerar sitt beslutsfattande till en algoritm.

Preface

Law is often considered being a conservative subject. I have discovered, on the contrary, that the law is very much a living organism that evolves alongside the world it exists in. As new technologies emerge, so does the need for legislation in these areas. It has been thrilling to discover the quite novel subject of algorithmic pricing and how the legislative process has a challenge ahead to make sure we can harness this technology without restricting the free market.

I have had great help and guidance from my supervisor, Jacob Öberg, who provided me with direction for this thesis as well as rewarding tips on articles and books to read.

I would also like to thank my family for always giving me unconditional support.

Thank you.

Abbreviations

AI	Artificial Intelligence
CJEU	Court of Justice of the European Union
DOJ	U.S Department of Justice
EU	European Union
FEUF	Fördraget och Europeiska unionens funktionssätt
ML	Machine Learning
OECD	Organisation for Economic Co-Operation and Development
PCW	Price Comparison Website
RBS	The Royal Bank of Scotland
TFEU	Treaty on the Functioning of the European Union
USA	United States of America

1. Introduction

1.1 Background

"Can machines think?"[1]

Alan Turing first posed this groundbreaking question in 1950.[2] Since then, technological advances have enabled humanity to create incredibly complex algorithms, such as machines able to beat world champions in chess.[3] Today exist machines with the ability to process copious amounts of data. These machines can learn from historical data and make predictions off of the information in unknown situations – so-called Machine Learning (ML).[4] Collusion is an old field within competition law. In recent years, however, modern technology has introduced new situations within the legislative field. Artificial Intelligence (AI) and ML are two concepts that are quickly becoming more relevant, and both fields have also raised questions regarding how the output from AI and Intelligent Machines should be regulated.

1.2 Purpose

Algorithmic collusion is one output of AI and ML that has recently become more sophisticated. Therefore, the author's motivation for researching this subject is to investigate how the old legislation, Commission decisions, and case law apply to this field. The author's ambition is to research this field from both a competitor's and a consumer's perspective and ultimately, in this thesis answer the following;

[1] See Turing (1950) p. 1.
[2] Ibid.
[3] See Somers, J. (2013), *"The man who would teach machines to think",* The Atlantic, November, <www.theatlantic.com/magazine/archive/2013/11/the-man-who-would-teach-machines-to-think/309529/>, accessed 2019-11-24.
[4] See OECD, "Algorithms and Collusion: Competition policy in the digital age", p. 9, <https://www.oecd.org/daf/competition/Algorithms-and-colllusion-competition-policy-in-the-digital-age.pdf>, accessed 2019-12-02.

i) What constitutes an agreement, decision, or concerted practice in art. 101(1) TFEU and how can these definitions be applied in scenarios of algorithmic pricing?

1.3 Methodology

The methodology used in this thesis is qualitative. To answer the abovementioned research question objectively, mainly doctrine, legislative text, case law, academic articles, and other relevant materials are used. The sources are each selected to provide information on the topic from different perspectives.

1.4 Delimitations

The subject of algorithmic collusion is universal, and the basic descriptive concepts of the topic apply to any jurisdiction within the field of competition law. In this paper, mainly EU competition law will be used to illustrate how agreement, decisions, and concerted practice are defined. Case law from both the EU and the US will be reviewed.

Only article 101 of TFEU will be analyzed. Article 102 of TFEU falls outside the scope of this paper and will only be mentioned briefly to provide an overview of the competition legislation within the EU.

1.5 Structure

This thesis consists of four main chapters and a conclusive chapter. The introduction chapter presents the content and structure of this thesis. Chapter two presents the concept of pricing algorithms. In the following sub-categories of chapter two, pricing algorithms are analyzed from different perspectives to provide an insight in how pricing algorithms leads both to efficiencies and disadvantages for consumers and competitors. Chapter three presents EU legislation regarding collusion. To further understand how and why

cartels form and progresses, a brief overview of the economic theory behind cartels is presented.

Furthermore, the requisites for collusive behavior in art. 101(1) TFEU are reviewed alongside case law, to research how they are defined and utilized within the EU. Subsequently, chapter four connects the EU collusion legislation to the concept of algorithmic pricing, probing how current legislation is applicable to the topic of algorithmic collusion. The chapter systematically presents and explains algorithmic collusion through four different scenarios; the Messenger, the Hub-and-Spoke, the Predictable Agent, and lastly, the Digital Eye. Chapter five concludes this paper with a summary of the findings provided in chapter one through four and also answer the aforementioned questions of this thesis.

2. Pricing algorithms

2.1 Introduction

A general understanding of what an algorithm is and what it can do is necessary to understand the concept of algorithmic collusion fully. In the following chapter, an overview will be provided of what is meant with an algorithm and how algorithms are used in business today. Next follows a presentation of some benefits of using a pricing algorithm, first from a business perspective and, subsequently, from a consumer perspective.

This overview will help in gaining an understanding of a complex topic from different perspectives.

2.2 Algorithms in general

An algorithm is defined as "a procedure for solving a mathematical problem" or, more broadly, "a step-by-step procedure for solving a problem or accomplishing some end".[5] Programmers create a code designed to fulfill a purpose. The algorithm is the set of rules the code has to follow to solve the problem at hand.[6] An algorithm is like a recipe. A recipe consists of a number of steps that have to be executed in a particular order to create a specific dish.[7]

A pricing algorithm is a set of rules a code uses to assess the market and set prices accordingly. Depending on the company's strategy, the algorithm can set prices to, for example, maximize profits or penetrate a market. The appropriate pricing strategy is

[5] See Merriam Webster, *"Algorithm",* <https://www.merriam-webster.com/dictionary/algorithm?src=search-dict-hed#note-1>, accessed 2019-12-02.
[6] See BBC, *"What is an algorithm?",* <https://www.bbc.co.uk/bitesize/topics/z3tbwmn/articles/z3whpv4>, accessed 2019-12-02.
[7] See OECD, *"Algorithms and Collusion: Competition Policy in the Digital Age",* p. 8, <www.oecd.org/competition/algorithms-collusion-competition-policy-in-the-digital-age.htm>, accessed 2019-12-02.

dependent on the company's position in the market.[8] A company in a market with perfect competition can charge the equilibrium market price where supply corresponds to demand. A market with perfect competition is defined as "a market with many firms producing identical products and no barriers to entry".[9] When a company has market power, however, other pricing strategies can be applied. A company with market power can generate producer surplus and profit, which in theory is not possible in a perfectly competitive market. This market power can come from barriers to entry, economies of scale, or goodwill that enables the company to charge premium prices.[10]

In 1956, John McCarthy defined the term Artificial Intelligence (AI) as "the science and engineering of making intelligent machines".[11] A subsection of AI is Machine Learning (ML). ML is a process where intelligently designed machines use algorithms to learn from the use of data and experience. In its most advanced form, these machines can learn new things without explicit programming. ML can, in its turn, be divided into three categories, *supervised learning, unsupervised learning, and reinforcement learning*. The first two categories are dependent on a human writing the code, which the machine utilizes to solve problems or find patterns or execute a task. Reinforcement learning, on the other hand, is the process by which the machine performs tasks in a dynamic learning environment, learns through trial and error, and applies these insights on problems not previously known to it.[12] There are limitations to conventional ML, specifically in the processing of large amounts of raw data. The machine is often unable to recognize the relevant parts of the data, thus resulting in the usage of data irrelevant to solving the problem at hand.[13]

[8] See Goolsbee, Levitt & Syverson (2013) p. 396.
[9] Ibid p. 304.
[10] Ibid p. 348.
[11] See OECD, *"Algorithms and Collusion: Competition policy in the digital age",* p. 8-9, <https://www.oecd.org/daf/competition/Algorithms-and-colllusion-competition-policy-in-the-digital-age.pdf>, accessed 2019-12-02.
[12] Ibid.
[13] Ibid.

2.3 Benefits and disadvantages of pricing algorithms

In a data-driven economy, the use of pricing algorithms can offer benefits to companies and consumers by making processes more efficient and cost-effective. In this following sequence, benefits and disadvantages of pricing algorithms from two perspectives will be presented: *the business perspective* and *the consumer perspective*.

2.3.1 Business perspective

Historically, price setting has been a process by which a human tracks the market and competitor's prices. Thereafter, he or she sets the price of the own company's products accordingly. This process is time-consuming, and on many occasions, it would take weeks from the monitoring to the price setting, resulting in obsolete prices due to changes in market conditions.[14] With the development of pricing algorithms, companies can assess the market continuously through a digital process, and adjust prices accordingly within milliseconds.[15]

An example of where pricing algorithms are vital to companies is in high-frequency online markets such as hotel booking sites. On these platforms, the supply of hotel rooms change rapidly, creating a need for updated prices. In areas where there is a shortage of hotel rooms, prices will adjust upwards to meet the high demand, making it possible for the hotels to charge higher prices.[16] Airbnb is one company that uses pricing algorithms extensively. Users can set prices on their apartments and houses depending on factors such as seasonal fluctuations, special events occurring in the nearby area, and the supply of other available housing opportunities in the region. The algorithm advises the homeowner to raise prices when the algorithm finds demand to be high and recommends the homeowner to lower prices when demand is low. The result is that homeowners can charge higher prices when possible and still be able to rent out their property when

[14] See Ezrachi & Stucke (2016) p. 13.
[15] See Hwang & Kim (2006) p. 149-155.
[16] See Ezrachi & Stucke (2016) p. 14.

demand is lower, resulting in some revenue instead of none.[17] Access to additional data might prove advantageous, however, others have put forward that the advantages are negligible.[18] It should also be noted that Big Data today is readily available to many actors on the market, leveling the playing field for all actors, big or small.[19]

2.3.2 Consumer perspective

By making the market more efficient and transparent, the consumer may be offered the best product or service to the lowers price, thus resulting in the company with the most advantageous offer to thrive. The use of data on consumer behavior makes it possible for companies to tailor offers to their customers, providing them with the most appropriate product or service.[20]

In a market where information on competitors and consumers are readily available, the barriers to entry are generally low, which has a procompetitive effect. More companies in a market lead to a competitive environment, where companies are forced to charge lower prices or offer a better product or service to their customers.[21]

However, companies with substantial market power can also use pricing algorithms discriminatory. By assessing consumer behavior and purchase patterns, companies can charge the consumers a price they are willing and able to pay. In an imperfectly competitive market, this price may be well above the market equilibrium price in a perfectly competitive market.[22] This business practice can be used in an exploitative and

[17] See Hill, *"The secret of Airbnbs pricing algorithm"*, <https://spectrum.ieee.org/computing/software/the-secret-of-airbnbs-pricing-algorithm>, accessed 2019-12-02.
[18] See OECD (2019), "*Artificial Intelligence in Society"*, p. 104, OECD Publishing, Paris, <https://doi.org/10.1787/eedfee77-en.>.
[19] See McKinsey & Co., "*Big Data: The next frontier for innovation, competition, and productivity"*, p.98, <https://www.mckinsey.com/~/media/McKinsey/Business%20Functions/McKinsey%20Digital/Our%20Insights/Big%20data%20The%20next%20frontier%20for%20innovation/MGI_big_data_full_report.ashx>, accessed 2019-12-02.
[20] See Ezrachi & Stucke, "*Artificial Intelligence & Collusion: When computers inhibit competition*", p. 1781, University of Illinois Law Review 2017.
[21] See Goolsberg, Levitt & Syverson (2013) p. 304-305.
[22] See Goolsbee, Levitt & Syverson (2013) p. 348.

exclusionary way to increase the company's marginal revenue.[23] In these scenarios, however, the availability of data works both ways. With price comparison websites (PCW), consumers can use data to survey the market and find the most beneficial offer. If companies were to price discriminate or charge higher prices compared to a competitor, the PCW would provide this information to the consumer, thus resulting in the consumer taking this into consideration when making its well-informed purchase decision.[24]

2.4 Conclusion

A pricing algorithm is a tool for surveying the market and making well-informed business decisions. In markets where consumer data is readily available, companies respond rapidly to changes in consumer demand and tailor their offers accordingly. When many actors in a market use pricing algorithms, it is not a rational business decision to abstain. By being slower than the competition to respond to market changes, a company will repeatedly present their customers with obsolete offers.

From a consumer perspective, pricing algorithms may prove both beneficial and unfavorable. When companies have access to large amounts of consumer data, they can tailor business offers to suit the consumer better. On the other hand, access to extensive consumer data can also allow companies to price discriminate by assessing consumer willingness to pay for a product or service. Consumers, on the other hand, can use the availability of data through PCWs to browse for the most beneficial offer.[25]

[23] See Brodmerkel, "*Dynamic pricing: Retailers using artificial intelligence to predict top price you'll pay*", <https://www.abc.net.au/news/2017-06-27/dynamic-pricing-retailers-using-artificial-intelligence/8638340>, accessed 2019-12-19.
[24] See vor dem Esche et al. (2013) p. 259-260.
[25] Ibid.

3. Collusion regulations in the EU

3.1 Introduction

In the EU, collusion and collusive effects are regulated in article 101 and 102 in the Treaty of the Functioning of the European Union (TFEU).

In article 101(1) TFEU, it is stated that *agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between the Member States and which have as their objective or effect the prevention, restriction or distortion of competition within the internal market* are prohibited.

Article 102 TFEU states that a company in a dominant position is prohibited from abusing this position, for example, by acts of unfair pricing or limiting production.

The regulations have as their objective to encourage competition between companies to offer consumers advantageous terms on goods and services. The collusion prohibition is designed to encourage innovation and efficiency, to reduce prices and develop the market by companies acting independently of each other.[26]

3.2 The concept of collusion in economic theory

Collusion is the act of coordinated conduct between companies. Some specific forms of conduct are prohibited *per se*, such as horizontal price-fixing. Other forms of conduct, such as vertical distribution agreements, are prohibited if they are proved to distort or restrict competition.[27]

In a perfectly competitive market, one company has little to no market power. Prices are normally pushed down to the marginal cost of the product, and market output is relatively

[26] See European Commission, *"Antitrust"*, <https://ec.europa.eu/competition/antitrust/overview_en.html>, accessed 2019-11-26.
[27] See Marco Colino (2011) p. 152-157.

high. Situations with imperfect competition, however, make the market less stable. In his eighteenth-century work, The Wealth of Nations, famous economist and philosopher Adam Smith proposed that companies in an oligopoly market would benefit from colluding with one another to raise prices from where marginal revenue corresponds to marginal costs. The result is that the total market price and output correspond to the price and output in a monopoly market. This outcome is called the Nash Equilibrium and is represented in a situation known in game theory as the prisoner's dilemma. In a prisoner's dilemma, market moves are dependent on speculation of the competitor's next move. In the abovementioned example, in an oligopolistic market, each company has an incentive to increase output to collect a larger share of the revenue from the monopolistic pricing situation. However, if one company decides to breach the collusive agreement, the equilibrium ceases to uphold, resulting in both companies losing the additional revenue from colluding.

		Company A	
		Collude	**Increase output**
Company B	Collude	60, **60**	0, **100**
	Increase output	100, **0**	25, **25**

In a one-period game, each company has the incentive to deviate from the collusive agreement and raise output to maximize revenue. However, because both companies have the same incentive, according to economic theory, both companies might raise output, thus resulting in the outcome where both companies lose the additional revenue from colluding. In a situation of repeated games, the situation is different. Here, the companies take into consideration the long-term consequences of their actions. By breaching the collusive agreement, the long term profits will be significantly less than if they honor their agreement. Games can also take different forms where one company has a first-mover advantage. In such a situation, the first mover will choose the profit-maximizing outcome. The second mover will, with information of the first mover's decision, choose

the least disadvantageous option. In this case, the outcome will be both companies increasing output, thus resulting in modest profits.[28]

3.3 Express collusion

In art 101(1) TFEU, agreed coordinated conduct is prohibited. Art 101(1) TFEU provides that *all agreements between undertakings, decisions by associations of undertakings and concerted practices, which may affect trade between Member States and which have as their objective or effect the prevention, restriction or distortion of competition within their common market* shall be *prohibited as incompatible with the internal market*.[29]

The reason behind the prohibition is that collusion is considered a threat to competition, which in turn risks injuring both consumers and companies.[30]

3.3.1 Agreements between undertakings

Historically, collusive agreements have frequently been described as a "meeting by twilight of a trio of sinister persons with pointed hats close together"[31], as described in *William Goldman Theatres Inc. v Loew's Inc*. However, for an undertaking to fall within art. 101(1) TFEU, no formal contract is required, according to the broad interpretation of the paragraph made by the Commission. In *Polypropylene*, the Commission stated that no written agreement between the parties was necessary to establish an agreement to be "intended as legally binding upon the parties"[32]. The Commission settled that, for an agreement to exist, consensus between the parties and informal decisions on how the parties should act was enough evidence.[33] This point was later further established in the case *National Panasonic*.[34] In *Commission v. Anic Partecipazioni SpA*, an agreement is found when "parties express their joint intention to act on the market in a specific way".[35]

[28] See Goolsbee, Levitt & Syverson (2013) p. 439-444 & p. 484-498.
[29] See Marco Colino (2011) p. 153.
[30] See European Commission*, "Antitrust",* <https://ec.europa.eu/competition/antitrust/overview_en.html>, accessed 2019-12-02.
[31] *William Goldman Theatres Inc. v Loew's Inc. 150 F.2d 738 743n. 15 (3rd Cir. 1945).*
[32] *Polypropylene (IV/31.149) Commission Decision 86/398/EEC [1986] OJ L230/1.*
[33] Ibid.
[34] *National Panasonic (IV/30.070) Commission Decision 82/853/EEC [1982] OJ L354/28.*
[35] C-49/92 *Commission v. Anic Partecipazioni SpA*, EU:C:1999:356, para 130.

Explicit collusion agreements are prohibited *per se*. The Commission is not required to provide evidence for any actual market effects. The act of entering into an agreement of this sort is inherently illegal. The existence of an agreement between two or more undertakings is enough to constitute a prohibited behavior under art. 101(1) TFEU.[36]

3.3.2 Decisions by associations of undertakings

In cases of companies being members of an industry association, collusion of a different sort can arise. These industry associations have as their objective to coordinate the companies in the market. In *Roofing felt*, a cooperative organization for asphalters in Belgium provided its members with a recommended price list and recommended minimum prices for their products in the national market. Repercussions followed any deviation from the recommendations.[37] A similar situation faced the Commission in *Fenex*, concerning an association of freighters in the Netherlands. In this case, the association also provided its members with recommendations regarding scales of charges. They explicitly stated to its members that the recommendations were not legally binding. However, the association urgently recommended its members to pass the tariff increase. In a decision, the Commission stated, "the recommendation must be interpreted as being a faithful reflection of the association's resolve to coordinate the conduct of its members on the relevant market".[38]

3.3.3 Tacit collusion in contrast to the concept of concerted practice

In *William Goldman Theatres Inc. v. Loew's Inc.,* the Commission declared that the meeting in the twilight belonged to the history.[39] Today, collusive agreements are rarely concluded in sinister settings. Instead, digitalization and technological development has

[36] See Monti (2007) p. 325.
[37] *Roofing felt* (IV/31.371) Commission Decision 86/399/EEC [1986] OJ L232/15.
[38] *Fenex* (IV/34.983) Commission Decision 96/438/EC [1996] OJ L 181/28, para 41.
[39] *William Goldman Theatres v. Loew's, Inc., 150 F.2d 738 (3d Cir. 1945).*

opened up for implicit ways of colluding. It is essential to keep in mind that undertakings have the right to act on market cues and adapt to changing market conditions. This rational business behavior might give rise to situations of parallel behavior between undertakings without the existence of an agreement or ambition to collude – tacit collusion. Economically rational behavior does not necessarily fall under the prohibited behavior in art. 101(1) TFEU, if the undertakings can provide a logical explanation for their business actions, and the Commission fails to produce sufficient evidence of collusion. This point was presented by the Commission in *Dyestuffs,* where it argued that in some markets, especially oligopolistic markets, some parallel behavior was to be expected.[40] This contrasts the *per se* prohibition regarding explicit collusion agreements between undertakings. Concerted practice, on the other hand, is prohibited if undertakings coordinate, and without an explicit agreement to do so "knowingly substitutes for the risks of competition practical cooperation between them"[41] as established by the Commission in, among others, *Hüls AG v. Commission*.[42] Concerted practice also requires market conduct after the coordination and also a causational link between the coordinated undertakings and their subsequent market behavior.[43]

Concerted practice is difficult for the Commission to prove. Many times a joint intention to act on the market in a coordinated way appears to exist, but cannot be established, or the market behaves in a way that raises suspicion that two or more companies in a market are coordinating. The Commission has developed two strategies to establish the existence of collusion. The first strategy is to collect physical evidence that two or more companies have decided on a collusive behavior. The second strategy is to assess the market for clues of colluding companies. As presented in the passage on the economic theory behind cartels, prices and output are often close to where they would be in a monopolistic market. In *Wood Pulp*, a large number of Canadian undertakings announced their prices for the upcoming quarter in advance. The announcements were easy to access by consumers and other companies. The market effect that the Commission could discover was that imports of pulp to the EU from the US and Canada were cheaper than identical products from Scandinavia. The Court firstly established EU-law to be applicable to the

[40] *ICI v Commission case 48/69 [1972] CMLR 557.*
[41] *C-199/92 P Hüls AG v. Commission EU:C:1999:358, para 158.*
[42] See Monti (2007) p. 326.
[43] Ibid.

case and then stated that there was no conclusive evidence of a concerted practice. The Court settled that "parallel conduct cannot be regarded as furnishing proof of concertation unless concertation constitutes the only plausible explanation for such conduct".[44] The case, therefore, further establishes that economically rational behavior is legal, and as long as the companies can provide a logical explanation for the tacit collusion, concerted practice is not proven to exist.[45]

3.4 Conclusion

Primarily, an agreement or meeting of the minds must have been established between two or more actors in a market for art. 101(1) TFEU to be applicable. The consequence is that unilateral actions by one actor in a market cannot fall under the prohibition in art. 101(1) TFEU. However, the case law on the subject also illustrates that no formal, written agreement has to be in place for the requisite agreement to be fulfilled. Regarding decisions between associations of undertakings, it is sufficient that the coordination association have the intention to superficially raise prices. It is not possible to publish non- binding recommendations to superficially raise prices, and avoid responsibility. A resolve to coordinate the undertakings in question is sufficient.

An illustrative example of the difference between express and tacit collusion is when two competitors meet and agree upon a specific retail price on their identical goods. Once the competitors agree to the pricing strategy, a prohibited collusion agreement is established between the parties. If the same competitors instead would trade business intelligence regarding their business strategy for the upcoming year, then no collusion is in place until both parties act with this information in mind when setting their business strategy for the coming year. Once a company takes the competitor's inside information into account when planning one's strategy, a concerted practice is conducted.[46]

[44] *Wood Pulp* (IV/29.725) Commission Decision 85/202/EEC [1996] OJ L 085, para 71.

[45] See Marco Colino (2011) p. 158-159.

[46] See Monti (2007) p. 326.

Tacit collusion, realized by individual acts of rational business behavior, however, is legal. In *Wood Pulp*, the Court held that in absence of hard evidence on coordination, parallel behavior is legal of the companies can point to a plausible explanation.

4. Algorithmic collusion

4.1 The four collusion scenarios associated with algorithmic pricing

The rise of Big Data has facilitated new means for collusive behavior. The ability for smart machines to instantly detect competitor's price changes, deviations, or cheating from cartel agreements has provided companies with an efficient way to react to changing conditions instantly, and when deemed necessary, punish the deviating cartel member.

Historically, physical representatives of companies have entered into cartel agreements, and when detected by governmental authorities, these representatives or their superiors have been sentenced to prison sentences. However, with the development of AI and ML, many decisions regarding pricing, output, and bids no longer lie within the scope of an employee's working instructions. Instead, algorithms can, independently, make decisions that have a collusive effect. In this chapter, we will explore four scenarios in which modern AI and ML technology foster new ways of collusion.[47]

4.1.1 The Messenger scenario

In the first scenario, The Messenger scenario, human beings are the acting agents, and their decisions can be collusive. Technology, in this case, pricing algorithms, is a medium through which humans can monitor competition and code software on how the algorithm should act.[48]

The Messenger scenario is relatively easily enforced by the authorities. First, proving the existence of an agreement between undertakings will be relatively conventional since actual human beings are colluding.[49]

[47] See Ezrachi & Stucke (2016) p. 35-36.
[48] Ibid p. 42.
[49] Ibid.

The Messenger scenario illustrates the classic picture of a cartel, in which representatives from companies meet and collude in secrecy. Technology is used to monitor the stability of the cartel through tracking competitor's pricing decisions and alarming the human being behind the scheme when deviations from the collusive agreement are detected.[50]

An example of recent investigations regarding the Messenger scenario is when five major banks manipulated benchmark interest rates. In 2015, Citicorp, JPMorgan, Chase & Co., Barclays PLC, the Royal Bank of Scotland plc, and UBS AG, all pled guilty to felony charges of them entering into a collusive agreement with the intention to manipulate exchange rates. This group converged in a chatroom regularly for five years.[51]

Another case from 2015 is *United States v. David Topkins*[52]. The DOJ accused Topkins and his associates of price-fixing through a pricing algorithm, which provided them with information regarding competitor's pricing points on some posters sold through Amazon Marketplace. After receiving and analyzing this information from the algorithm, Topkins and his associates then replicated the competitor's pricing strategy, thus resulting in coordination of prices for identical posters online.[53]

4.1.1.1 Summary

The main takeaway from the Messenger scenario is the role of the algorithm. The algorithm here is simply utilized as a tool through which people in a company can obtain information on which they base strategic business decisions. The algorithm itself does not make any business-related decisions or even learn from its research of the market. The algorithm is coded, produces the intended output, and then awaits the coder's next instruction.

From a legal perspective, the Messenger scenario does not prove very different from regular cartels. The algorithm is used as an intermediary, through which human beings within a company can execute collusive tasks. Article 101(1) TFEU is applicable on the

[50] Ibid p. 39.
[51] Ibid p. 40.
[52] *United States v. Topkins, CR 15-00201 WHO (N.D Cal. Apr. 30, 2015).*
[53] See Ezrachi & Stucke (2016) p. 40.

ground that human beings are utilizing an algorithm to execute a predetermined collusive behavior, based on a bilateral or multilateral collusive agreement.

4.1.2 The Hub & Spoke scenario

The Hub & Spoke scenario differ from the Messenger scenario due to the algorithm being of more central importance. The algorithm is used as a hub, through which companies can coordinate on monitoring competitors pricing activities, discover deviations from collusive behavior and penalize breaches of said agreements.[54]

The hub in this case has the function of a spider in the web. It communicates with several spokes, resulting in the spokes having no need to communicate with each other. The spokes only work directly towards the hub, whereas the hub coordinates the efforts of multiple spokes.[55] The Hub & Spoke scenario bears similarities to decisions by associations of undertakings. In the previously mentioned case *Roofing Felt*, a cooperative organization coordinated the conduct of several members through recommended prices. The members themselves did not communicate with each other, but with the cooperative organization as a hub.[56] The hub coordinates the spokes without the existence of a formal agreement between the spokes.[57]

In the case of algorithmic Hub & Spoke, the situation is slightly different. When many firms outsource their price monitoring to a third party, those firms likely hire the same actor, thus resulting in all these firms using the same algorithm to survey their competitor's strategies. From an enforcement perspective, it can be challenging to prove collusive behavior. Because the spokes never communicate with one another, there is rarely an explicit agreement between them to collude through price-fixing. Instead, the result of many firms using the same algorithmic software is a market outcome similar to a traditional collusive outcome with higher prices and generally softens competition.[58]

[54] Ibid p. 46.
[55] Ibid.
[56] See Marco Colino (2011) p. 154-155.
[57] See Ezrachi & Stucke (2016) p. 46-47.
[58] Ibid p. 52.

Is it then collusive to outsource the business function of monitoring competitor's pricing through an algorithm? It has been established through case law that several other requirements have to be fulfilled too. The firms must be aware of the conspiracy or have reasonable cause to suspect that they are partaking in a collusive scheme. In *Eturas and Others*, the Court held that the recipient of business information must, on the basis of "objective and consistent indicia" be proved to have "tacitly assented to an anticompetitive action."[59], To avoid unintended collusive behavior, the Court stated that the recipient must publicly distance itself from the message or report the shared information to the authorities.[60]

The more actors using the algorithm, the more the market will align, and the more likely it is that each actor has or should have sufficient knowledge of the collective collusive behavior. However, a distinction must be made between the aim or intention of an action and the actual outcome of said action. As previously established, rational business behavior is legal, even if it might have collusive effects. One problem with the Hub & Spoke scenario is that the more firms using the same algorithm, the more data the algorithm collects. The additional data further fine-tune the algorithm, making it increasingly rational for the firms to use said algorithm.[61]

4.1.2.1 Summary

In regards to the prohibitive rule in art. 101(1) TFEU, the algorithmic Hub & Spoke scenario does not necessarily fall under the definition of an agreement between undertakings. However, as the spokes are aware that their collaboration with the hub has och could have collusive effects, the scenario could fall under the definition of a concerted practice. The challenge for the commission then is being able to prove that the companies collude and do not just partake in rational business behavior.

[59] C-74/14 *UAB and Others v Lietuvos Respublikos konkurencijos taryba (Eturas)*, EU:C:2016:42, para 45.
[60] See Ezrachi & Stucke (2016) p. 52.
[61] Ibid p. 48.

4.1.3 The Predictable Agent scenario

When companies purchase or develop a price-setting algorithm, the algorithm often bears similarities to the algorithm used by competitors. When these algorithms interact with each other, the outcome might be tacit collusion or conscious parallelism.[62] As seen in the passage on the economic theory behind cartels, the algorithms will make profit-maximizing decisions, based on, among other factors, competitor's pricing decisions. In a multiple sequence-game, the algorithms will all choose to raise prices or restrict output, as this is profit maximizing, taking competitor's profit maximizing strategy into consideration.[63]

The late economist Milton Friedman famously argued that the business of business is business. Friedman reasoned that the purpose of a company's existence was to increase profits and shareholder benefits.[64] When pricing algorithms are constructed, they are almost exclusively designed to maximize profits. The algorithms are programmed to monitor and react to a competitor's pricing, market output, and general trends. When all companies in a constricted market use algorithms to profit maximize, more data output is created, thus further increasing the market transparency. In order to profit maximize, the algorithm will be programmed to follow price increases when deemed appropriate. This dynamic pricing model can facilitate tacit collusion. As described above, tacit collusion is legal, even though the market outcome can prove identical to that if the companies in the market had consciously colluded.[65]

Art. 101(1) TFEU initially states that the prohibition is aimed at agreements between undertakings, decisions by associations of undertakings, and concerted practice, and that these behaviors have a restrictive effect on the market in question. As previously established, collusion needs to involve at least two actors in a market. Unilateral behavior does not constitute collusion.[66] When several firms unilaterally create and use a pricing

[62] Ibid p. 56.
[63] See Goolsberg, Levitt & Syverson (2013) p. 441-443.
[64] Friedman, Milton (1970), *"A Friedman doctrine – The social responsibility of business is to increase profits"*, New York Times.
[65] See Ezrachi & Stucke (2016) p. 65-66.
[66] See Marco Colino (2011) p. 154.

algorithm, it facilitates tacit collusion, but does not necessarily constitute a collusive agreement or prohibited concerted practice.[67]

4.1.3.1 Summary

In the Predictable Agent scenario, multiple actors in a specific market use individual algorithms, however, these algorithms are similar to each other. When the algorithms interact, it may result in tacit collusion or conscious parallelism. From a consumer perspective, this is problematic as it may lead to higher prices or restricted output.
From previously mentioned case law, we know that the requisite agreement between undertakings require a formal or informal agreement among the undertakings to collude. Concerted practice, on the other hand, requires a silent understanding between the undertakings that specific market behavior is to be executed, and that art. 101(1) TFEU is applicable when the undertakings take collusive actions on the market. In the predictable agent scenario, none of these criteria are being met. Rational market behavior is legal, even if the market outcome is identical to the outcome as if the companies had colluded.[68]

4.1.4 The Digital Eye scenario

When computers can process increasing amounts of data, their overview of the market is enhanced and comes close to what economists refer to as perfect information. AI and ML will also become more advanced, algorithms more sophisticated, and as machines learn from experience through reinforcement, autonomous decision-making becomes even more refined.[69]

An example of the Digital Eye scenario comes from Uber. In 2014, two former employees shared how Uber used software called *God View*. The software enabled Uber to track vehicles and customers in real-time, making it possible to allocate vehicles to customers fast and accurately. In the literature on the subject, the Digital Eye scenario is sometimes also referred to as God View, which is illustrative of how Big Data provide

[67] See Ezrachi & Stucke (2016) p. 56.
[68] See Marco Colino (2011) p. 152-157.
[69] See Ezrachi & Stucke (2016) p. 71.

companies with an almost perfect overview of the market.[70] Big Data also allows companies to gain information on a competitor's product assortment, stock levels, and delivery lead times. With an overview of the competitor's entire business structure, the algorithm can respond to changed competitor behavior quicker and more accurately. With better information about the market, the algorithm can soon predict market changes and anticipate how rivals will respond, making it possible for the companies to act on future market changes before they have occurred. As more and more companies use algorithms to make business decisions, all actors in a market have a God View. If one company reduced prices, the rest of the actors in the same market would have their algorithm telling them not to reduce prices, thus resulting in the discounter being pushed out of the market or increase prices once more. When companies are equipped with these algorithms, prices and output are likely to fixate at superficially high rates.[71] Since competition in the specific market is no longer perfect or near-perfect, companies can charge consumers more and restrict output. This equilibrium is maintained without a formal or informal agreement between the companies if their respective algorithms deem this pricing- and output strategy rational.[72] Conscious parallelism in the traditional form is not a possible outcome in the Digital Eye scenario since the algorithm independently determines how to maximize profits, based on knowledge gained through reinforcement learning. The algorithm is autonomous and does not require any human involvement.[73]

4.1.4.1 Summary

As with the Predictable Agent scenario, the Digital Eye scenario does not fall under the prohibition in art. 101(1) TFEU. There exists no agreement between undertakings. The actors in the market have no silent understanding that their behavior is collusive, and the objective is not necessarily to collude but to make rational business decisions in a more fast-paced and data-driven business environment. In fact, no human is involved in the

[70] Ibid p. 72.
[71] Ibid p 72-74.
[72] Ibid p. 80-81.
[73] See Ezrachi & Stucke, "*Artificial Intelligence & Collusion: When computers inhibit competition*", p. 1783.

business decision itself. The algorithm utilizes Big Data to survey the market and make rational business decisions, which is legal under current competition legislation.[74]

[74] See Ezrachi & Stucke (2016) p. 72-73 and Marco Colino (2011) p. 152-173.

5. Conclusion

Art. 101(1) TFEU was created to facilitate competition. In theory, in a situation with perfect competition, companies will be forced to offer the most advantageous goods or services to the customers, or be out-competed by a more efficient company. The ultimate goal of art. 101(1) TFEU is to provide the consumer benefits and restrict companies from charging monopolistic prices in oligopolistic markets, or superficially restrict output.

When companies collude, they enter into an agreement to, for example, superficially raise prices above the market equilibrium or restrict output to increase demand. Collusion hinders competition and ultimately harms the consumer, who has to pay a higher price for a good or service, whereas the company benefits from manipulating the market and reaping the profits.

Through case law, the Court has established that the term agreement does not exclusively include explicit agreements between undertakings. In *Polypropylene,* the Court held that an agreement did not have to be in written form, and in *Commission v. Anic Partecipazioni SpA,* the Commission established that a joint intention to act in a specific way in the market was enough to constitute an agreement between the undertakings. In these two scenarios, the enforcer doesn't need to prove a certain outcome in the market. The sole existence of an agreement between the undertakings to collude is enough to fall under the prohibition. This holds true even if the undertakings fail to actually act collusive on the market. The reason behind this is that these agreements are prohibited *per se*. When the contract is signed, the contracting parties are committing unlawful collusion.

In a digital context, the Messenger scenario meets the agreement criteria. Authorities can find evidence of human agents colluding and using technology, in this case, a pricing algorithm, to perform collusive behavior on their behalf. The Hub & Spoke-, Predictable Agent-, and Digital Eye scenarios all fall short in this remark, since none of them include an agreement between undertakings to collude, formal or informal.

The final criterion for an agreement between undertakings is that the agreement must be bilateral or multilateral. Unilateral actions by one company cannot, by definition, be collusive. This restriction of the use of art. 101(1) TFEU proves to be a challenge in a digital context. Whereas The Messenger scenario is similar to old-fashioned collusion and the Hub & Spoke scenario bear a resemblance to decisions between associations of undertakings, the Predictable agent and The Digital Eye scenarios both consist of unilateral behavior by actors in a market, and that this unilateral behavior results in the same market outcome as if the actors in the market had colluded. In *Wood Pulp*, the Court established that parallelism between companies in the same market is not *per se* prohibited, as it is perfectly legal for each company to make rational business decisions. This point holds true, even if the outcome results in higher consumer prices and restricted output. This conclusion is paradoxical because, as previously stated, the reason art. 101(1) TFEU exists is to prohibit actions, by which consumers cannot benefit from business efficiencies. Meanwhile, authorities hold that the same market outcome is perfectly legal if the actors in a market can provide evidence that their parallel business behavior is rational. Revisiting the *per se* prohibition regarding express collusion, these agreements, on the other hand, can be enforced as soon as a contract is signed or action agreed upon, without there having to be any collusive effects on the market.

This discriminatory way of enforcing collusion might seem overly legalistic. The Commission can enforce business agreements before they have had any collusive effect. However, it is not authorized to enforce conduct, which clearly can be proved to have a collusive impact on the market, as long as this behavior can be shown to be rational. In the context of pricing algorithms, AI and ML can develop and improve them to always make rational business decisions. The market might then experience superficially high prices and restriction of output as a result of perfectly legal, tacit collusion between all users of highly sophisticated pricing algorithms.

The EU has a challenge ahead. It can choose to promote the liberal idea of a free market and free competition, in which the economic theory proposes that the price of a good or service will be set at the interception of consumer supply and demand. However, by not regulating the field, the Commission faces the risk of disadvantageous market conditions for the consumers if the pricing algorithms collectively set monopolistic prices. The EU

can also focus on the reduction of adverse market outcomes for consumers, and regulate the field of algorithmic pricing. Then, however, it would risk prohibiting rational business behavior, which in turn could have lead to a more efficient market.

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