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Algorithms and Collusion: Competition Law Challenges of Pricing Algorithms

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Summary

The purpose of this paper is to find possible measures to tackle algorithmic collusion, caused especially by pricing algorithms, from the perspective of competition law. This paper does not intend to analyse all possible measures that may exist, but rather, focus on a few measures that are seen reasonable. Before proceeding further to analyse these possible measures, the concepts of algorithms and collusion are examined. The second chapter consists of analysis examining the meaning of algorithms as well as certain benefits derived from them. The third chapter analyses the concept of collusion from the perspective of EU Competition law. Essentially, competition law of the EU will function as an appropriate benchmark for further analysis. The fourth chapter is there to examine the concept of algorithmic collusion through four scenarios: the Messenger, the Hub-and-Spoke, the Predictable Agent, and the Digital Eye. The first two scenarios are dealing with situations where algorithms are used as helpful tools to make explicit collusion possible. In other words, there is an element of agreement or meeting of the minds between the colluding undertakings. In the last two scenarios, there is no element of agreement, but undertakings are seen to tacitly collude with the help of algorithms. Greater focus will be on the Predictable Agent and the Digital Eye since these scenarios are not as easily tackled with current competition rules as the first two scenarios.

In the fifth chapter, it is finally time to analyse certain measures to address algorithmic collusion. First of all, when it comes to fully autonomous pricing algorithms, these algorithms may constantly learn from past and current data to always optimise the best price for their masters. This optimisation may take a form of stable supra-competitive pricing harmful for the consumers. Now, in order to tackle these concerns, we may expand the interpretation of agreement or concerted practices to forbid the usage of harmful pricing algorithms that cause anti-competitive effects to the relevant market. Alternatively, the possibility of prohibiting tacit collusion with the help of clearly formulated criteria is examined. Both "by object" or "by effect" approach could be applicable. However, the effects-based approach would offer a more reasonable balance between the opposing interests of competition authorities and the undertakings. Overall, it is up to each jurisdiction to decide their own approach on how to tackle algorithmic collusion based on their political will for instance. After all, there is no one single measure that would be definitively correct in tackling this challenge.

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List of Abbreviations

AI	Artificial Intelligence
CJEU	Court of Justice of the European Union
CJ	Court of Justice
CFR	Charter of Fundamental Rights of the European Union
DL	Deep Learning
EC	European Commission
EU	European Union
GC	General Court
ML	Machine Learning
OECD	Organisation for Economic Co-Operation and Development
PCW	Price Comparison Website
R&D	Research and Development
TEU	Treaty on European Union
TFEU	Treaty on the Functioning of the European Union
Uber	Uber Technologies Incorporated
USA	United States of America

1. Introduction

1.1. Background

Collusion is something that most jurisdictions are trying to fight against. Whether it comes to competition rules of the European Union (EU), or antitrust rules of the United States of America (USA), collusion is commonly seen as a negative phenomenon.[1] Inherently, collusion is in direct contradiction with the idea of protecting competition where consumers are receiving the best products at the lowest price. In other words, undertakings are expected to compete rigorously without resorting to collaboration with competitors. Collusion can be seen to refer to any kind of coordination between competitors, which often has the goal of accumulating higher profits than without collusion. For example, undertakings may be seen to collude when they are trying to fix prices in their relevant market for the detriment of consumers. This can happen through secret written agreements or even through simple oral agreements.[2]

The concept of collusion may seem as a relatively simple term to understand but sometimes exceedingly difficult to prove in practice. We shall analyse the concept of collusion in greater detail, but at this point, we may note that one of the key elements is the existence of an "agreement", "concurrence of wills" or "meeting of the minds" between competitors.[3] If there is no evidence that this element exists between the competitors, it is significantly more difficult to prove that undertakings are colluding. Undertakings may simply act rationally taking independent market decisions, even though these decisions may have negative effects to the market. Sometimes this is not the case and undertakings may be aware of their decisions having harmful effects to the market. "Tacit collusion" or "tacit coordination" can be seen to exist where negative effects on the relevant market, such as in a form of stable supra-competitive prices, are witnessed similarly as they would in a scenario of actual collusion; however, in the case of tacit collusion, there is no evidence of any kind of

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[1] For the sake of clarity and consistency, the term "competition law" will be used to cover any competition rules that legal jurisdictions may have unless otherwise stated.

[2] See eg Edward J Green, Robert C Marshall and Leslie M Marx, 'Tacit Collusion in Oligopoly' in Roger D Blair and D Daniel Sokol (eds), *The Oxford Handbook on International Antitrust Economics, Volume 2* (Oxford University Press 2014).

[3] See eg Alison Jones and Brenda Sufrin, *EU Competition Law: Text, Cases, and Materials* (6th edn, Oxford University Press 2016), 140-170.

agreement or coordination between the undertakings, even though the undertakings may be aware of the anti-competitive effects caused by their conduct. Naturally, as can later be seen, some markets with certain characteristics are more prone to tacit collusion, such as oligopolistic markets, but this does not mean that this concept should be underestimated.[4]

With the emergence of new technological innovations, we are seeing algorithms that are rather sophisticated and complex. Especially with the growing amount of data, increased computing power, and constant progress made in the field of Artificial Intelligence (AI), algorithms are able to collect an immense amount of data and use this data in a way to make logical decisions.[5] This is particularly relevant in our context of pricing algorithms. In this paper, all algorithms that are used in the process of price-setting are referred to as pricing algorithms. In other words, both algorithms that are only aiding in setting a price and algorithms that automatically adjust prices without human interaction are covered by this concept. A greater focus will be on algorithms that automatically set prices since these can be seen more problematic to tackle by competition authorities.[6] In further chapters, we shall discuss the definitions and benefits of algorithms in more detail. Now, a few challenges caused by pricing algorithms will be discussed to better understand the significance of this paper.

First of all, when considering some of the competition rules of the EU[7] and the USA[8] for instance, they may seem rather straightforward at first hand. For example, when it comes to the articles 101 and 102 of the Treaty on the Functioning of the European Union (TFEU)[9], they are rather simplistically articulated, but their application is rather complicated leaving a lot of room for interpretation. It can be seen that the competition law of the EU is constantly evolving through case-law. This kind of case-by-case basis approach has its benefits in being

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[4] For the reasons of clarity and consistency, we shall use the term "tacit collusion", which means exactly the same as the term "tacit coordination". It is merely a question of linguistic preference. In regard to tacit collusion, see eg Richard Whish and David Bailey, *Competition Law* (9th edn, Oxford University Press 2018), ch 14.
[5] See eg Richard E Neapolitan and Xia Jiang, *Artificial Intelligence: With an Introduction to Machine Learning* (2nd edn, CRC Press/Taylor and Francis Group 2018).
[6] See eg Joseph E Harrington, 'Developing Competition Law for Collusion by Autonomous Artificial Agents' (2018) 14(3) Journal of Competition Law & Economics 331, 341-346.
[7] See eg arts 101-109 TFEU and Council Regulation (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EC Merger Regulation).
[8] See eg Sherman Antitrust Act of 1890 [15 U.S.C. §§ 1-38, as amended], Federal Trade Commission Act of 1914 [15 U.S.C. §§ 41-58, as amended] and Clayton Antitrust Act of 1914 [15 U.S.C. §§ 12-27, 29 U.S.C. §§ 52-53, as amended].
[9] Treaty on the Functioning of the European Union (TFEU) [Consolidated version of 7 June 2016] OJ C 202/47.

flexible to cover a variety of collusive behaviour.[10] If we now consider the fact how digital innovations have changed the way how increasing number of consumers are buying their products online, it can be asked whether the current competition rules are still able to efficiently tackle collusion in this new market environment. Certainly, it can be argued that the same rules are perfectly fine to tackle any anti-competitive infringements even if they are occurring in digital markets. However, what makes the digital markets different from regular brick-and-mortar markets are the extensive use of sophisticated algorithms that completely change the way how undertakings are able to compete.[11]

The challenge with pricing algorithms is that they may be particularly beneficial for undertakings while consumers are not always receiving the fair share of the benefits, namely the best price. Firstly, it can be argued that undertakings can monitor their competitors' prices and change their prices accordingly with the help of pricing algorithms. When it comes to automatic price-setting algorithms, the prices may be changed instantly without any human intervention as often as needed. It would make sense that undertakings should compete rigorously thanks to these pricing algorithms. However, with the aim of maximising profits for the undertakings, what if the algorithms are sophisticated enough to learn from all the collected data that trade wars are not preferable, but they should rather opt for a scenario where maintaining stable supra-competitive prices is the correct decision. As can be guessed, this is exactly an issue that has been argued.[12]

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[10] See eg Paul Craig and Gráinne De Búrca, *EU Law: Text, Cases, and Materials* (6th edn, Oxford University Press 2015), chs 26-28.

[11] Naturally, pricing algorithms may be helpful in brick-and-mortar markets as well. For instance, when using regular paper price tags, the price changes are made manually but even in these scenarios, pricing algorithms may still give appropriate guidance in setting a new price. Furthermore, with the possibility of using electronic price tags, the usage of pricing algorithms may become even more relevant. See eg Competition and Markets Authority (CMA), 'Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing' (8 October 2018, CMA94) (CMA Paper). See also Marion Garaus, Elisabeth Wolfsteiner and Udo Wagner, 'Shoppers' acceptance and perceptions of electronic shelf labels' (2016) 69 Journal of Business Research 3687; Ray Sourav and others, 'Pricing Better' (2019) ZBW – Leibniz Information Centre for Economics <http://hdl.handle.net/10419/201843> accessed 28 August 2019.

[12] See eg Emilio Calvano and others, 'Artificial Intelligence, Algorithmic Pricing and Collusion' (26 April 2019) <https://ssrn.com/abstract=3304991> or <http://dx.doi.org/10.2139/ssrn.3304991> accessed 28 August 2019; Emilio Calvano and others, 'Algorithmic Pricing What Implications for Competition Policy?' (2019) 55 Review of Industrial Organization 155. See also Timo Klein, 'Autonomous Algorithmic Collusion: Q-Learning Under Sequential Pricing' (July 2019) Amsterdam Law School Research Paper No 2018-15, Amsterdam Center for Law & Economics Working Paper No 2018-05 <https://ssrn.com/abstract=3195812> or <http://dx.doi.org/10.2139/ssrn.3195812> accessed 28 August 2019.

What makes the situation even more problematic is the fact that automatic pricing algorithms are being used by increasing amount of undertakings, and it is likely that this number will not decrease.[13] Quite the contrary, it can be seen that these algorithms are much more efficient in setting prices compared to human counterparts, and therefore, there does not seem to be many reasons for not using them. As a consequence, undertakings that do not use these algorithms may be seen at a disadvantage. For example, when an undertaking wants to sell their product at a discount, the automatic pricing algorithms of the competitors can change their prices instantly to the same or lower level as the discounter, making that discount rather redundant. The initial discounter who does not use pricing algorithms may lose more customers since it cannot react as fast to the price changes made by competitors who use these algorithms. In addition to the reaction time of automatic pricing algorithms, there are many other benefits such as the fact that these pricing algorithms are able to optimise the price level in a way that it will increase when the demand is high and decrease when the demand is low. This way the undertakings may always reap the maximum profits.[14] Other benefits of pricing algorithms will be discussed later,[15] but it is appropriate to state that overall it is rather difficult and costly for undertakings without pricing algorithms to compete in a similar manner. Therefore, it is no surprise that more pricing algorithms would be used by competitors in the same relevant market. This, on the other hand, would significantly increase the likelihood of achieving stable supra-competitive prices. After all, in order to maximise profits for the undertakings, this seems to be the most logical strategy for pricing algorithms to take.[16]

As can be seen, the existence of pricing algorithms has changed quite dramatically the way how pricing on certain markets is decided. Compared to the time where human personnel had to collect all the relevant data, analyse it, and finally make conclusions based on this data, is quite different to nowadays scenario where pricing algorithms can react to price changes almost instantly. As can be understood, the decision to change prices by human personnel could take days or even weeks, and at that time, the collected data could already be obsolete. Obviously, pricing algorithms, and algorithms overall, can be seen as a great innovation in

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[13] See eg Commission, 'Final report on the E-commerce Sector Inquiry' (Report from the Commission to the Council and the European Parliament) COM(2017) 229 final (E-Commerce Sector Inquiry).

[14] See eg OECD (2017), 'Algorithms and Collusion: Competition Policy in the Digital Age' (OECD 2017 Paper) <www.oecd.org/competition/algorithms-collusion-competition-policy-in-the-digital-age.htm> accessed 28 August 2019, especially 14-18.

[15] See ch 2.3.

[16] See eg E-Commerce Sector Inquiry; Calvano and others, 'Artificial Intelligence, Algorithmic Pricing and Collusion' (n 12); Calvano and others, 'Algorithmic Pricing What Implications for Competition Policy?' (n 12).

making certain processes, such as price-setting, much more efficient, but on the other hand, it raises many concerns that are not necessarily as beneficial for the consumers, or society as a whole, as one would think.

1.2. Purpose

One of the reasons why the author chose this topic was to learn more deeply about the novel topic of algorithmic collusion. Since algorithms are becoming much more sophisticated and efficient, particularly with the rising relevance of AI, we are starting to see how algorithms are influencing our everyday life. Despite all the potential positive effects that algorithms may bring, certain concerns can also be raised. This contradiction, particularly when it comes to pricing algorithms, raised the curiosity of the author to appropriately analyse this challenge from an objective perspective. With author's interest in competition law, it seemed perfect to analyse the challenge of algorithmic collusion from this perspective.

Therefore, research question that is intended to be answered in this paper is following:
   i)   How should competition law deal with the challenge of algorithmic collusion caused especially by pricing algorithms?

1.3. Methodology

The methodology of this paper is mainly a qualitative one. Mostly written sources such as legislation, case-law, books, academic articles, empirical evidence, and other relevant materials are used in this paper. By using a variety of sources, it will be possible to analyse the differing concepts presented in this thesis, and finally give a reasonable answer to the aforementioned research question in an objective manner.

1.4. Delimitations

Since the topic itself is relatively novel, the approach of the paper will be a universal one. Legal jurisdictions that have some kind of competition law regime would need, more or less, to deal with the issue of algorithmic collusion. Therefore, the analysis performed within this paper is useful for varying jurisdictions. EU Competition law will mainly be used as a helpful benchmark when discussing differing issues. For example, the whole chapter 3 will be

analysing the concept of collusion from the perspective of EU Competition law. That is why, if not otherwise indicated, the rules of the EU Competition law are used within this paper.

1.5. Structure

This master thesis consists of six main chapters. As already seen, the first chapter is an introductory one, essentially explaining what this paper is about. The second chapter is there to provide an appropriate overview to algorithms, which will be useful when analysing our challenge of algorithmic collusion. General understanding of algorithms is provided together with analysis discussing certain benefits that can be derived from these algorithms. The main emphasis of this paper will be on pricing algorithms. Structure of the third chapter is rather similar to the second one in a way that it intends to provide an overview to a topic. Namely, third chapter will analyse the concept of collusion from the perspective of EU Competition law. The purpose of the third chapter is not to provide an exhaustive analysis for the concept of collusion, but rather, to briefly explain certain aspects relevant for the upcoming analysis in chapters 4 and 5. When it comes to the fourth chapter, the concept of algorithmic collusion is explained and analysed through four scenarios: the Messenger, the Hub-and-Spoke, the Predictable Agent, and the Digital Eye. In the first two scenarios, an element of "agreement" can be seen to exist in some form between the colluding undertakings. Algorithms may be seen as helpful tools to make explicit collusion possible. In the last two scenarios, algorithms are helping the undertakings to tacitly collude or coordinate. In other words, it may be more challenging to apply traditional competition rules to these scenarios since there is no element of agreement between the undertakings. In the fifth chapter, it is finally time to analyse certain measures that could be used to address the complicated challenge of algorithmic collusion. This chapter will provide an answer to our research question. Although, it should be understood, that there may be various ways of dealing with the challenge of algorithmic collusion, and therefore, the solutions presented in this paper are not supposed to be exhaustive. Lastly, the sixth chapter will provide a conclusion to this thesis.

2. Overview of Algorithms

2.1. Introduction

First of all, before proceeding further with more substantial analysis, it is appropriate to understand the fundamentals of algorithms. In this chapter, we are going to shortly explain what is meant by algorithms. Afterwards, we shall describe some of the benefits resulting from algorithms. This knowledge will help us to better understand the complicated nature of our topic where on the one hand, algorithms have certain benefits that are positive, but on the other hand, certain concerns as well that should not be overlooked. As it is often the case, the question of perspective is something that should be kept in mind. For example, something that is beneficial for the undertakings may not necessarily be beneficial for the other persons on the market, such as consumers, and *vice versa*. Therefore, careful understanding of both benefits and concerns is needed.

2.2. General Understanding of Algorithms

The concept of "algorithm" itself is not something extraordinarily new. In nowadays society, the concept of algorithm has become increasingly relevant. This is especially for the reason that computers' computational power is constantly improving. Combined with the huge amount of available data, it is possible to create algorithms that are remarkably sophisticated. What comes to the specific definition of an algorithm, in this paper we shall follow the definition recognised by the Organisation for Economic Co-Operation and Development (OECD). Simply put, an algorithm can be seen as a "sequence of rules that should be performed in an exact order to carry out a certain task", or alternatively, as an "instance of logic that generates an output from a given input."[17] To give a more visual example, simple execution of a food recipe can be compared to the way how algorithm functions. In order to have a delicious meal as an output, certain ingredients are needed. These ingredients can be seen as inputs. Individually, these ingredients are rather ordinary, but when specific "rules" are followed in exact order, the meal will be created as an output. Similarly, with modern sophisticated algorithms executed by computers, the purpose is to have an output, such as a goal of setting a price. As can be understood, this cannot be done without inputs, in this case,

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[17] OECD 2017 Paper, 8-9.

data. Based on the available data and rules, the computer will then execute its function similarly as a human counterpart would do, and set a final price.[18]

As can be understood, the function of "rules" has their significance. First of all, human programmers can manually set rules on how the algorithm should achieve the desired output. One of the benefits of this approach is that the algorithm will function in a predictable manner as intended by the programmers. However, the setting of these rules can be rather laborious. Therefore, an alternative measure can be used: namely, self-learning algorithms. To be more specific, it can be seen that Machine Learning (ML) and Deep Learning (DL) algorithms can be recognised as self-learning algorithms. First of all, ML can be seen as a subfield of AI, while DL a subfield of ML. Depending on the way how ML algorithms learn, they can be classified in three categories: supervised, unsupervised, and reinforcement learning. Supervised learning can be seen as a rather simple form of learning process where both an example input and the desired output is presented to the computer, similarly as when using flash cards. For example, by showing a picture of an orange and telling the algorithm that it is an orange, the algorithm will learn this fact and later individually identify whether an encountered input is an orange. Supervised learning may be used for face recognition purposes or to teach the computer to recognise which emails are inappropriate. When it comes to unsupervised learning, the algorithm is given unlabelled data to identify possible hidden patterns and structures. Essentially, it is not always feasible to have clear labelled data combined with a specific goal and instructions from the human programmers, and therefore, it may sometimes be more helpful to trust the algorithm to make its own conclusions based on the unlabelled data in the hope it will be something useful. For example, without any expert knowledge, the algorithm may use clustering to separate the given data in categories based on their similarities. Therefore, the algorithm may swiftly distinguish differing categories that would take human labour a considerable amount of time. Furthermore, anomaly detection may be a useful outcome in banking industry to detect, for instance, unusual buying behaviour. Association is also a curious application where, for example, depending on what a customer is purchasing, be it a personal computer and a screen, the algorithm may then suggest for the customer other useful products that are associated with these items, such as a computer keyboard and a mouse. Now, when talking about reinforcement learning, here the algorithm will learn through trial-and-error process to find the most optimal route in a

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[18] ibid. See also "Algorithm" Britannica Academic, Encyclopædia Britannica, 1 Jun. 1999; "algorithm, n." OED Online, Oxford University Press (June 2019).

dynamic environment to achieve a specific goal. Examples can be given from self-driving cars or from games, where there is a certain goal, such as in a chess to win within the limitations of the rules. Each time the algorithm succeeds in its goal, it will remember this fact in trying to reach its goal even more efficiently in future attempts. As can be understood, the more times the algorithm repeats this process, the more efficient it will become, always trying to improve its strategy in reaching the goal.[19]

Now, when it comes to DL algorithms, they present a fascinating approach to the learning process. While in traditional ML algorithms the learning process is linear with the possibility to understand how the algorithm reached a certain collusion, DL algorithms function differently. It can be seen that traditional ML algorithms cannot necessarily process raw data, but there is a need for "feature engineering". This means that depending on the goal to be achieved, relevant features may have to be extracted from the raw data before allowing the ML algorithm to run. As can be understood, this process may be laborious since it requires human labour to identify the relevant features. DL algorithms can perform this whole process autonomously without the need for manual feature engineering. With the help of sophisticated software, DL algorithms create complex artificial neural networks to learn and make their decisions based on numerous inputs. This kind of artificial neutral network resembles a learning process of a human brain, which is rather complicated compared to the linear process of traditional ML algorithms. Therefore, the learning process of DL algorithms can be rather swift and sophisticated. However, since there is no process of feature engineering, it is challenging to know how exactly the DL algorithm made its decision. The concept of "black box" is aptly used to demonstrate this phenomenon.[20]

In conclusion, it can be seen that a fascinating aspect of self-learning algorithms is that they can essentially replace the need of human programmers to constantly describe the rules on how the algorithms should function. It can be seen that through constant learning, the self-

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[19] See eg OECD 2017 Paper, 8-11; OECD (2019), 'Artificial Intelligence in Society' (OECD 2019 Paper) (OECD Publishing, Paris, 11 June 2019) <https://doi.org/10.1787/eedfee77-en> accessed 28 August 2019; Ai Deng, 'An Antitrust Lawyer's Guide to Machine Learning' (2018) 32(2) Antitrust 82; Iyad Rahwan and others, 'Machine behaviour' (2019) 568 Nature 477; Neapolitan and Jiang (n 5). See also eg Isha Salian, 'SuperVize Me: What's the Difference Between Supervised, Unsupervised, Semi-Supervised and Reinforcement Learning?' (2 August 2018) NVIDIA Blog <https://blogs.nvidia.com/blog/2018/08/02/supervised-unsupervised-learning/> accessed 28 August 2019.

[20] ibid. See also eg OECD 2017 Paper, 31-32; Ian Goodfellow, Yoshua Bengio and Aaron Courville, *Deep Learning* (MIT Press 2016); Yann LeCun, Yoshua Bengio and Geoffrey Hinton, 'Deep learning' (2015) 521 Nature 436.

learning algorithms can become significantly sophisticated in achieving the ultimate output, such as maximising profits for the undertakings. Put differently, the question is about automation, which is definitely something that undertakings want. However, as we have already witnessed and will later see as well, the lack of transparency can be seen as an issue. Especially in the case of DL algorithms, it may be practically impossible to know how exactly the intelligent computer made its decision. This can be a difficult challenge for the competition authorities to deal with.

2.3. Certain Benefits of Algorithms

In this chapter, we shall analyse certain benefits or efficiencies that can be derived from the usage of algorithms. We will not analyse all possible benefits that can be derived from algorithms, but will focus more on benefits relevant to pricing algorithms.

First of all, we may begin with benefits relevant for the demand-side of the market, such as consumers. Benefits related to pricing algorithms could be the reduction of search and transactions costs. An example can be given of markets where various price comparison websites (PCW) exist, making it possible to book a plane ticket or a hotel room after an algorithm has compared different affiliate websites selling the same services for differing prices. This way, the consumers should receive the best price between those sellers that are included in the PCWs. As can be understood, not all possible offers are always included in the PCWs, which means that the consumers may not always receive the best price possible. Furthermore, with the help of PCWs, consumers can be seen to make more rational purchasing decisions since the consumers are comparing prices of several different sellers instead of only a few. In that sense, undoubtedly, pricing algorithms do help consumers to expand their possibility to compare prices of more sellers in a swift manner than without the usage of pricing algorithms. As a consequence, the buyer power of the consumers may be seen to increase. For example, when the sellers realise that many of the consumers are using PCWs, they may be forced to keep prices at a competitive level in order to survive.[21]

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[21] See eg OECD 2017 Paper, 17-18; House of Lords, 'Online Platforms and the Digital Single Market' (2016, Select Committee on European Union, 10th Report of Session 2015–16, HL Paper 129).

As an additional demand-side benefit, a new phenomenon of a "digital butler" can be recognised, where algorithms may aid consumers to make better purchasing decisions.[22] For instance, these digital butlers may decide and even execute a purchase in the behalf of a consumer in the most rational manner. For consumers who are not able or willing to search for offers themselves, may prefer to outsource their purchasing decision to an algorithm, which acts swiftly based on a large amount of information of the relevant market. This way, it may be possible to make a rational decision that is extremely convenient for the consumer. Naturally, the idea of a digital butler that acts in a rational and neutral manner is intriguing, but raises the concern whether it truly is unbiased. After all, the algorithm is as unbiased as the used data, and if the data is somehow biased, it may obviously affect the purchasing decision. Therefore, it is definitely relevant, especially for competition authorities, to know what kind of data was used to make sure the consumers are protected.[23]

When it comes to the supply-side benefits derived from the usage of algorithms, we may begin with the general concept of efficiency. After all, one of the main reasons to use algorithms is to somehow perform a task, such as monitoring and setting a price, more efficiently than with human labour. This, on the other hand, will bring cost savings for the undertakings selling their products. As can be understood, these cost savings may help undertakings to improve the quality of their products, to invest in new innovations, or ultimately to lower the end prices for the consumers. Obviously, it is not guaranteed that the cost savings of the undertakings would benefit the consumers since it may greatly depend on the relevant market at hand. For example, in markets where competition is healthy creating pressure to improve and to keep prices low, the consumers can be seen to benefit. However, in oligopolistic markets for instance, the cost savings of the undertakings may never benefit the consumers if there is no reason to innovate or to keep prices low. In these kinds of situations, undertakings may prefer to reap maximum profits instead of transferring cost savings to the consumers.[24]

Additionally, the usage of algorithms is not only seen to create efficiency in terms of cost savings, but also by creating new services, as well as improving their quality as the algorithms

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[22] Michal S Gal and Niva Elkin-Koren, 'Algorithmic Consumers' (2017) 30(2) Harvard Journal of Law & Technology 309, especially 334-339.
[23] ibid
[24] See eg OECD 2017 Paper, 14-16; Green, Marshall and Marx (n 2).

become more sophisticated. An example of search engines can be given which was made possible with the usage of algorithms. As time has passed, the search engines have become increasingly useful not only because of increased amount of data for example, but also because of algorithms being constantly improved bringing new features both for the benefit of undertakings and the end-user.[25]

Furthermore, a curious phenomenon of dynamic pricing can also be seen as a benefit derived from the usage of algorithms. Although, it is debatable whether it is beneficial for the demand-side as well, or solely for the supply-side of the market. Essentially, dynamic pricing makes it possible to use pricing algorithms in a way to always optimise the end-user prices depending on various criteria, such as demand and supply. For instance, when there is not enough supply, the undertakings may raise their prices in order to reap maximum profits, and *vice versa*, when the demand is low, the prices may be lowered. Undoubtedly, the usage of dynamic pricing offers a lot of flexibility to accommodate to different market situations, and that way increase the profit potential. Nevertheless, certain negative concerns may be caused for the consumers because of dynamic pricing. First of all, if the pricing algorithms function solely to maximise profits for their masters in a dynamic manner, the pricing may become rather discriminatory. Certainly, some may argue for the favour of price discrimination because of its efficiency benefits, but for many it may seem questionable to have excessive shifts in prices even within the same day. What is more, the practice of personalised pricing takes dynamic pricing to a new level of sophistication where prices would be based on the individual level. With no doubt, the optimal scenario for undertakings would be to charge maximum possible price that a consumer would be willing to pay, and that way charge differing prices from different consumers. However, the question that can be raised is whether these kinds of practices are what consumers truly want, and whether it is beneficial for the society as a whole.[26]

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[25] See eg the case of search engine Google to better understand how many changes have occurred to their algorithms since its conception, and what kind of features have been presented. See in this regard <https://developers.google.com/search/docs/guides/search-features>; <https://moz.com/google-algorithm-change>; <https://searchengineland.com/library/google/google-algorithm-updates> accessed 28 August 2019.

[26] See eg OECD 2017 Paper, 14-16; Le Chen, Alan Mislove and Christo Wilson, 'An Empirical Analysis of Algorithmic Pricing on Amazon Marketplace' In Proceedings of the 25th International Conference on World Wide Web (2016) International World Wide Web Conferences Steering Committee 1339-1349 <https://doi.org/10.1145/2872427.2883089> accessed 28 August 2018; Harrington (n 6) 349-359.

2.4. Conclusion

In this chapter, we have given a short overview of algorithms and their benefits in order to better understand the upcoming analysis regarding algorithmic collusion. It is appropriate to comprehend what exactly is meant by algorithms and what kind of benefits do they offer. Certain concepts relevant for this paper were analysed, such as ML and DL algorithms. These algorithms can be seen as self-learning. Depending on their method of learning, algorithms can be classified in different categories. Essentially, algorithms may be used for various purposes to serve the specific needs of their masters. For example, the functioning process of DL algorithms is fascinating since the algorithm is given a great amount of autonomy to reach its goal, but at the same time, it becomes less transparent in a way that it may be difficult to know how the algorithm made its decision. As can be understood, the lack of transparency is worrying for the competition authorities. When it comes to the benefits of algorithms, their usage does create many efficiencies for differing markets. Through these efficiencies, many positive consequences may be derived both for the supply and demand side of the market. However, at the same time, it is not completely straightforward whether the benefits are equally distributed within the relevant market. Especially from the usage of pricing algorithms, certain effects may be seen more beneficial for the supply than the demand side. Therefore, careful analysis is needed of both benefits and concerns before making any definitive conclusions whether to unconditionally accept pricing algorithms, or rather, to approach them more cautiously.

3. Concept of Collusion in the EU

3.1. Introduction

As can be understood, the concept of collusion may have varying interpretations depending on the legal jurisdiction. It would be possible to dedicate a whole thesis for this topic. In order to keep the analysis more succinct, we are going to focus on the jurisdiction of the EU. The EU Competition law will function as an appropriate benchmark to understand certain elements necessary for further analysis. More specifically, we are going to focus on article 101 TFEU tackling collusive practices. As can be understood, article 102 TFEU, merger control, and other regulatory and non-regulatory measures may also play their own role in tackling unlawful collusion.

3.2. Overview of Explicit Collusion

When talking about collusion, we have already seen that it is something undesirable. Article 101(1) TFEU essentially provides that all kinds of "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 internal market" should be prohibited as "incompatible with the internal market". It is further continued with conduct that is seen particularly worrisome, which include for example, price fixing.[27] It is unlikely that these actions would have more benefits than disadvantages for the competitive market, but it is naturally possible to prove otherwise by invoking article 101(3) TFEU.[28]

First of all, as we have shortly discussed, the element of "agreement" or "meeting of the minds" is something fundamentally relevant in showing the existence of collusion. The main underlying principle is that there is no collusion if agreement is not seen to exist. Certainly, the concept of agreement is given a broad interpretation within the EU Competition law. Essentially, any kind of agreement or meeting of the minds between undertakings can be

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[27] More specifically, "(a) directly or indirectly fix purchase or selling prices or any other trading conditions" (See Article 101(1) TFEU).

[28] In this regard, see eg Jonathan Faull and Ali Nikpay (eds), *Faull and Nikpay: The EU Law of Competition* (3rd edn, Oxford University Press 2014), paras 3.445-3.511.

recognised as collusion no matter the actual form it takes place. Even a simple attendance within the meeting may function as a sufficient evidence indicating that there is an agreement or a meeting of the minds between the relevant undertakings.[29] This kind of collusion where the element of agreement is seen to exist can be recognised as "explicit collusion". Essentially, in order for explicit collusion to exist, evidence is needed to prove it.[30] Article 101 TFEU seems to be construed in a way to tackle explicit collusion rather well. However, as we will soon analyse, the case of tacit collusion is much more complicated.

Similarly, the "decisions by associations of undertakings" is included in article 101 TFEU to not make it possible to circumvent the element of agreement. One of the goals of article 101 TFEU is to have as wide coverage as possible in combatting collusion.[31] We shall not analyse this category in great detail, but suffice it to say that undertakings cannot escape the liability caused from colluding with each other through an intermediary. Certainly, differing associations, such as trade associations, may have their helpful role in making an industry more competitive through standardisation for instance.[32] However, at the same time, these associations tend to be a convenient way to coordinate collusion between the undertakings taking part. For example, trade associations may give anti-competitive recommendations that will affect the conduct of their members,[33] the associations may disseminate sensitive information between its members,[34] or the associations may uphold certification schemes that are intended to foreclose the relevant market from non-members.[35] When it comes to the concept of concerted practices, we will soon analyse it together with the concept of tacit collusion.[36] Concept of concerted practices will also be relevant at a later stage in chapter 5.

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[29] See eg Case C-8/08 *T-Mobile Netherlands* EU:C:2009:343, [2009] ECR I-4529, paras 54-62.

[30] See eg Jones and Sufrin (n 3) 650-662.

[31] See eg Case C-238/05 *Asnef-Equifax, Servicios de Información sobre Solvencia y Crédito, SL v Asociación de Usuarios de Servicios Bancarios (Ausbanc)* EU:C:2006:734, [2006] ECR I-11125, paras 31-32. See also eg Jones and Sufrin (n 3) 140-141.

[32] See eg Thomas C Lawton, Tazeeb Rajwani and Amy Minto, 'Why Trade Associations Matter: Exploring Function, Meaning, and Influence' (2018) 27(1) Journal of Management Inquiry 5.

[33] See eg *Fenex* (IV/34.983) Commission Decision 96/438/EC [1996] OJ L 181/28.

[34] See eg Joined Cases 40 to 48, 50, 54 to 56, 111, 113 and 114-73 *Coöperatieve Vereniging "Suiker Unie" UA and others v Commission of the European Communities (Suiker Unie)* EU:C:1975:174, [1975] ECR 1663.

[35] See eg Case 8/72 *Vereeniging van Cementhandelaren v Commission of the European Communities* EU:C:1972:84, [1972] ECR 977. See also Jones and Sufrin (n 3) 162-164.

[36] See ch 3.3.

Now, when it comes to the nature of anti-competitive conduct, it can be seen either harmful "by object" or "by effect".[37] This is relevant for the reasons of evidence. In other words, if an act is seen harmful by object, the standard of proof is low, meaning that it is presumed that the act, such as price fixing, is *per se* harmful. It is sufficient for the competition authorities to simply prove that this act occurred and it was caused by certain perpetrators. Now, it is up to the undertakings involved to prove otherwise invoking article 101(3) TFEU. In cases where it cannot be seen that the act is harmful *per se*, the standard of proof is considerably higher, meaning that the competition authorities are required to provide an extensive analysis of why the effects of the act are harmful to the competitive market. Only after the competition authorities are seen to prove at a satisfactory level that the acts of the undertakings are indeed harmful, as well as the fact that the undertakings caused this harmful act, the burden of proof will shift to the undertakings to prove otherwise in accordance with article 101(3) TFEU.[38]

3.3. Concepts of Concerted Practices and Tacit Collusion

It is appropriate to understand the difference between the relevant concepts of concerted practices and tacit collusion. This comparison will help us to better understand what exactly is considered as unlawful collusion, and acceptable conduct on the other hand. This analysis will not be exhaustive, but tries to offer a basic understanding of these concepts.

First of all, before proceeding further to the concepts of concerted practices and tacit collusion, we should remember the fact that undertakings have the right to intelligently adapt to market conditions by taking unilateral decisions that are based on rational economic reasoning. This may be the case even in situations of parallel behaviour where the conduct of the undertakings may be surprisingly similar. For example, the undertakings may adjust their prices accordingly, which may seem as there would exist collusion between these competitors. Therefore, the main rule is that if the undertakings are able to indicate a logical reasoning behind their business decisions without any evidence of actual collusion, this kind of behaviour is generally accepted.[39]

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[37] See eg Pablo Ibáñez Colomo, *The Shaping of EU Competition Law* (Cambridge University Press 2018), ch 3.
[38] ibid
[39] See eg *Suiker Unie*, paras 172-174; Case 172/80 *Gerhard Züchner v Bayerische Vereinsbank AG* EU:C:1981:178, [1981] ECR 2021, paras 12-14. See also a later case of *T-Mobile Netherlands*, paras 32-35. See also eg Jones and Sufrin (n 3) 161-162, 693-702.

Now, when discussing the concept of concerted practices, it refers to a situation where anti-competitive coordination between undertakings can be seen to exist in some form, but nevertheless, the coordination has not reached the stage of explicit collusion through an agreement or decision for example. In other words, concerted practices can be seen as its own category of collusion, which does not require an element of meeting of the minds.[40] This kind of cooperation may take a form of information exchange. As can be understood, exchange of sensitive information between competitors may cause significant harm for the competitive market by making it easier for the competitors to fix prices for instance. If undertakings are aware of their competitors' future pricing decisions, they may then coordinate their prices in a mutually beneficial manner to reap maximum profits for the detriment of consumers.[41] Overall, by forbidding concerted practices, the goal is again to catch as many anti-competitive acts as possible. Essentially, any kind of conduct that cannot be seen as individually construed may quickly be considered as collusion if there is evidence to indicate it.

To shortly continue with concerted practices, because of its broad interpretation, even parallel behaviour may be considered as a relevant indication that there may exist an anti-competitive conduct that has somehow changed the normal conditions of the market. Of course, this does not mean that mere parallel behaviour would be considered as unlawful itself, but demonstrates that the concept of concerted practices is intended to be broadly construed.[42] As can be understood, this will help the CJEU to conveniently tackle new forms of anti-competitive conduct that may rise in ever evolving markets. As can later be seen, this is also a relevant fact to remember in our case of pricing algorithms.

Lastly, when it comes to the concept of tacit collusion, it is much more complicated scenario to deal with. While in concerted practices there is some kind of evidence of collusive conduct between undertakings, such as in the form of information exchange, in the case of tacit collusion, there is simply no form of agreement or other evidence that would indicate

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[40] See eg Case C-48/69 *Imperial Chemical Industries Ltd. v Commission of the European Communities (Dyestuffs)* EU:C:1972:70, [1972] ECR 619, paras 64-68; Case T-587/08 *Fresh Del Monte Produce v Commission* EU:T:2013:129, paras 294-300 with special emphasis on para 300.

[41] See eg Case C-455/11 P *Solvay SA v European Commission* EU:C:2013:796, paras 39-41. See also David Bailey and Laura Elizabeth John (eds), *Bellamy & Child: European Union Law of Competition* (8th edn, Oxford University Press 2018), paras 2.038-2.115.

[42] See eg *Dyestuffs*, paras 64-68. See also eg Michael L Polemis and Aikaterina Oikonomou, 'Tacit collusion or parallel behaviour in oligopolistic markets? The two faces of Janus' (2018) 14(1) European Competition Journal 1.

coordination between undertakings. Nevertheless, harmful effects to the competitive market may exist in a form of stable supra-competitive prices for instance. Therefore, tacit collusion could be seen as a grey area outside of the categories of explicit collusion and concerted practices.[43]

What makes the concept of tacit collusion rather complex challenge to tackle is the fact of every undertaking being allowed to intelligently adapt to the market conditions.[44] Especially in oligopolistic markets, this intelligent adaptation may take a simple form of tacit collusion in the hope of attaining higher profits. We shall not analyse the concept of "oligopoly" in great detail, but shortly, it can be seen as a concentrated market with few leading undertakings. None of the undertakings have a monopoly position, but they are rather equal in terms of market power. What can be seen as a characteristic of oligopoly is the fact of interdependence between the undertakings. This may indicate itself through high transparency, and the fact that each of the undertakings' decisions on output or pricing for example, will greatly affect the decision of others. For instance, if an oligopolist decides to sell its products at a low price, it will cause great pressure for the other competitors to lower their prices as well, unless they are willing to take the risk of losing profits by decreased sales and market share. Now, if all the oligopolists will always react to price reductions by lowering their prices, the market shares tend to stay the same while the undertakings may lose profits because they reduced their prices. Eventually, the oligopolists may realise that constant price reductions, or the fact of keeping the prices at a bare minimum, will not be that profitable in the long run. Certainly, rigorous competition is optimal for consumers, but not optimal for the oligopolists wishing to maximise their profits. Therefore, as an alternative, the oligopolists may realise that more profitable solution would be to gradually increase their prices. Because of the high interdependence on the market, the undertakings may quickly notice if the other competitors are willing to accept this option. If the undertakings do want to accept this proposal, tacit collusion can be seen to exist. As can be understood, this scenario does not require any form of coordination or information exchange. The undertakings simply understand that the prevailing market conditions are favourable to reap higher profits through tacit collusion. After all, if there is a possibility to legally have stable high profits instead of

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[43] See eg Whish and Bailey (n 4), ch 14.
[44] See eg text to n 39.

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rigorous competition with the risk of losing profits, the option to tacitly collude seems rather tempting.[45]

What is more, when tacit collusion is seen to exist in oligopolies, this scenario is labelled as an "oligopoly problem". As we have shortly discussed in the previous chapter, oligopolistic markets do tend to have characteristics that make tacit collusion more convenient. Undoubtedly, it is more difficult for tacit collusion to function in markets where competition is fierce with many competitors. These kinds of markets may have low barriers to entry or other factors that make it highly competitive. As can be understood, it seems rather difficult to maintain tacit collusion in these kinds of markets without resorting to actual coordination. Indeed, tacit collusion seems to require a certain amount of trust or mutual understanding that would somehow replace the need for explicit collusion. After all, it is often enough if even few undertakings deviate from the common scheme to maximise profits since it will soon show as a loss for the other competitors if they do not react accordingly. Therefore, understandably, the market conditions prevalent in oligopolies are more reasonable in maintaining tacit collusion.[46] Although, as we will later see, the usage of pricing algorithms may be seen to change this fact by increasing the number of markets where tacit collusion could exist.

3.4. Conclusion

In this chapter, we have shortly analysed certain aspects of the concept of collusion within the EU Competition law that may prove helpful in understanding the further analysis. Collusion is a rather complex concept that often refers to cooperation between undertakings that has an anti-competitive goal. EU Competition law tries to interpret this concept as broadly as practicable in order avoid harmful effects to differing markets. Starting from explicit collusion, the current competition rules seem rather sufficient to tackle this kind of behaviour. As long as there is evidence of some kind of agreement or meeting of the minds, the competition authorities may quite successfully tackle various conducts. When it comes to tacit collusion, enforcement becomes much more complicated. At the moment, there does not seem

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[45] See eg Edward H. Chamberlin, 'Duopoly: Value Where Sellers Are Few' (1929) 44 Quarterly Journal of Economics 63; Jones and Sufrin (n 3), ch 9. See also Green, Marshall and Marx (n 2).

[46] See eg Nicolas Petit, 'The oligopoly problem in EU competition law' in Ioannis Lianos and Damien Geradin (eds), *Handbook on European Competition Law: Substantive Aspects* (Edward Elgar Publishing 2013); Xavier Vives, 'Cournot and the Oligopoly Problem' (1989) 33 European Economic Review 503.

to be a clear solution that would make it possible to tackle this kind of behaviour. Undoubtedly, there may be many conducts that cause anti-competitive effects, but at the same time, competition authorities have to respect the right of the undertakings to intelligently adapt to the market conditions. This is a particularly difficult challenge that requires a careful case-by-case approach. After all, each market may have its own characteristics that distinguish it from others. Recognising concerted practices as an unlawful anti-competitive conduct can be seen as a reasonable compromise to tackle more discrete type of behaviour, such as information exchange.

4. Algorithmic Collusion

4.1. Introduction

Now that we have a reasonable understanding of algorithms and collusion as individual concepts, it is appropriate to proceed further and analyse what is meant by algorithmic collusion. Essentially, algorithmic collusion can be seen to refer to a situation where algorithms are used in some manner to aid undertakings collude with their competitors. This includes the usage of algorithms to automatically collude with competitors without human intervention. In order to analyse the concept of algorithmic collusion, it is possible to distinguish different scenarios. We shall analyse what exactly are these recognised scenarios and at the same time examine why pricing algorithms in particular can be seen problematic. Overall, the analysis will demonstrate how the pricing algorithms may have several anticompetitive effects to the competitive market. A greater focus will be on the Predictable Agent and Digital Eye scenarios, which essentially deal with tacit collusion, since these are more problematic scenarios for competition authorities to deal with. After we have analysed these scenarios, it is then appropriate to analyse how to possibly tackle the raised issues in chapter 5.

4.2. Scenarios of Algorithmic Collusion

4.2.1. Messenger Scenario

Messenger scenario can be seen as the simplest form of algorithmic collusion where humans are the ones who decide to collude through a cartel agreement for example, while algorithms are used as a helpful tool to make this collusion possible. In other words, algorithms are seen as messengers who fulfil the will of their masters, humans in our case. As can be understood, in these kinds of Messenger scenarios, the element of "meeting of the minds" exists through an agreement for instance, which means that it is possible for competition authorities to tackle these scenarios relying on traditional competition rules. It should be noted that this is the case even if the algorithms are seen to enforce the illegal agreement automatically. The will of the

humans to collude is the significant factor that matters, not the way how the collusion is executed.[47]

To give an example of a situation where Messenger scenario can be seen to apply, recent decisions quite aptly demonstrate how algorithms were used as a significant tool to artificially maintain stable supra-competitive prices. From the decisions of the European Commission (EC) in *Asus*[48], *Denon and Marantz*[49], *Philips*[50], and *Pioneer*[51] it can be seen how manufacturers of certain electronic products managed to control the freedom of online retailers to set their own prices. First of all, it can be seen that the will of the competing undertakings was indeed to maintain stable supra-competitive prices. In order to achieve this goal, the competing undertakings used different algorithms, including pricing algorithms, to monitor current prices and see whether any of the retailers were diverging from the price-level suggested by the manufacturers. If retailers were seen to offer low prices below the recommended price, the manufacturers would suggest them to raise their prices to the recommended level or face retaliatory consequences in a form of refusal to supply for instance. In majority of the cases the threatening was successful.[52]

What is fascinating about this case-study is not just the fact of manufacturers using algorithms to monitor prices and then threatening the retailers, but the larger effect of this scheme. It can be seen that many of the retailers are using pricing algorithms, including the larger ones, to automatically monitor and adapt their prices in accordance with the competitors. This fact of increasing usage of pricing algorithms is also well indicated in the EC's E-Commerce Sector

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[47] See eg Ariel Ezrachi and Maurice E Stucke, *Virtual Competition: The Promise and Perils of the Algorithm-Driven Economy* (Harvard University Press 2016), ch 5.

[48] *Asus (vertical restraints)* (Case AT.40465) Summary of Commission Decision C/2018/4773 [2018] OJ C 338/08. See also *ASUS* (Case AT.40465) Commission Decision C(2018) 4773 final [2018].

[49] *Denon & Marantz (vertical restraints)* (Case AT.40469) Summary of Commission Decision C/2018/4774 [2018] OJ C 335/05. See also *Denon & Marantz* (Case AT.40469) Commission Decision C(2018) 4774 final [2018].

[50] *Philips (vertical restraints)* (Case AT.40181) Summary of Commission Decision C/2018/4797 [2018] OJ C 340/07. See also *Philips* (Case AT.40181) Commission Decision C(2018) 4797 final [2018].

[51] *Pioneer (vertical restraints)* (Case AT.40182) Summary of Commission Decision C/2018/4790 [2018] OJ C 338/11. See also *Pioneer* (Case AT.40182) Commission Decision C(2018) 4790 final [2018].

[52] See also eg Pat Treacy, Stephen Smith and Edwin Bond, 'Maintaining price competition between retailers in e-commerce markets: the European Commission's recent RPM decisions' (2018) 39(11) European Competition Law Review 470; Clemens Graf York von Wartenburg, Craig G Falls and Michael I Okkonen, 'Recent EU fines for resale price maintenance are symptoms of broader challenges faced by today's consumer-goods manufacturers' (2018) 39(11) European Competition Law Review 495.

Inquiry.[53] As can be understood, if pricing algorithms are becoming the new industry standard in many online retail markets, it essentially means that all the prices will be automatically set by algorithms. Now, if we return to our case-study, the scheme of forcing low-price online retailers to raise their prices, had the influence of stabilising the price-level of the concerned products overall. It can be seen that since there is no effective price competition because of the scheme, the pricing algorithms did adapt accordingly to the situation by keeping the prices stable and high in order to maximise profits. After all, if the consumers are still buying the products at higher prices, why should the pricing algorithms radically lower their prices. It can be seen that even if the colluders would not contact all the possible retailers in the market, the pricing algorithms of the competitors would still adapt to this artificially inflated "market price". Furthermore, it is aptly noted that the effects of this scheme may have not only increased the price level of the products in question but also prices for other similar products. In other words, consumers of other brands may have paid higher prices as well because of the existing scheme. All in all, even without this additional concern, it was seen that the strategy to eliminate low prices by contacting the online retailers that did not meet the recommended prices, effectively increased the prices in the relevant market for the detriment of the consumers.[54]

As can be seen from the aforementioned case-study, algorithms are useful tools to make collusion rather efficient. What is an important point to note is the fact that the undertakings that were seen to collude, did decide to cooperate with the EC during the proceedings. This fact cannot be underestimated since the concerned undertakings did provide evidence to make the enforcement proceedings more convenient for the EC. Naturally, these undertakings were rewarded accordingly by significantly reducing their amount of fines.[55] It is fascinating to consider how much different the case would have been without the evidence provided by the undertakings. As with traditional cartels for instance, they may operate unnoticed for long periods until some kind of evidence of collusion occurs, if it ever does.[56] Often the required evidence is provided thanks to the usage of "leniency rules" that may tempt parties to the

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[53] See eg n 13.

[54] See text to nn 48-52.

[55] For the cases in *Asus*, *Denon & Marantz*, and *Philips*, the reduction for cooperation was 40% while in the case of *Pioneer* it was 50%. In addition to Commission Decisions, see also Commission, 'Antitrust: Commission fines four consumer electronics manufacturers for fixing online resale prices' (Press Release, 24 July 2018, IP/18/4601).

[56] See eg Joseph E Harrington and Jr Yanhao Wei, 'What Can the Duration of Discovered Cartels Tell Us About the Duration of All Cartels?' (2017) 127 The Economic Journal 1977.

cartel to co-operate with competition authorities in the hope of reduced penalties.[57] All in all, if traditional cartels are challenging to detect, algorithmic collusion is not seen to make this detection any easier.[58]

4.2.2. Hub-and-Spoke Scenario

When it comes to the Hub-and-Spoke scenarios, they are not something extraordinarily new as a phenomenon. It can be started with traditional Hub-and-Spoke scenarios to better understand the scenarios where algorithms play a role. First of all, it should be noted that a third party, a "hub", plays an important role. If we look back at the Messenger scenario, we may see that there is some kind of collusion occurring directly between the competing undertakings. Now, if we consider a Hub-and-Spoke scenario, the situation changes in a way that the competing undertakings are seen to intentionally use a third party to coordinate the collusion in a manner that it may seem as if the competing undertakings are not directly colluding. For example, while the competing undertakings have a mutual understanding with each other in a form of horizontal agreement or conspiracy, they will now form individual vertical agreements with one third party, such as a retailer, to fix their prices. It should be noted, however, that there may be situations where the competing undertakings are making individual vertical agreements with the third party, but are not having horizontal agreements with each other. This cannot be seen as a single Hub-and-Spoke scenario since there should exist some sort of horizontal understanding between the competitors.[59]

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[57] See eg Eric Van Damme and Jun Zhou, 'The dynamics of leniency application and the knock-on effect of cartel enforcement' (February 2016) Bruegel Working Paper 2016/02; Johan Ysewyn and Jennifer Boudet, 'Leniency and competition law: An overview of EU and national case law' (2 August 2018) e-Competitions Bulletin Leniency, N°72355. See also International Competition Network, 'Good practices for incentivising leniency applications' (30 April 2019, Subgroup 1 of the Cartel Working Group).

[58] It has even been estimated that yearly detection rate of cartels within the EU would be approximately 13% [See Emmanuel Combea, Constance Monnierb and Renaud Legal, 'Cartels: the Probability of Getting Caught in the European Union' (March 2008) Bruges European Economic Research Papers, BEER paper n°12]. In the USA, this number is estimated to be approximately 13-17% [See Peter G Bryant and E Woodrow Eckard, 'Price Fixing: The Probability of Getting Caught' (1991) 73 The Review of Economics and Statistics 531].

[59] See eg Elizabeth Prewitt and Greta Fails, 'Indirect information exchanges to hub-and-spoke cartels: enforcement and litigation trends in the United States and Europe' (2015) 1(2) Competition Law & Policy Debate 63; Diego Hernández, 'Drawing the Boundaries Between Hub-and-Spoke Cartels and Vertical Agreements: Lessons from the United Kingdom and the United States to Chilean Competition Law' (2018) 41(2) World Competition 275.

Before proceeding to the Hub-and-Spoke scenarios where algorithms are used, it should be noted that when discussing the usage of pricing algorithms, the competing undertakings are not always willing to develop their own algorithms since it may be costly and time consuming. Instead, what if it would be possible to use an external provider of a pricing algorithm that does the price setting automatically for the undertakings. Indeed, this is something that is possible, and the question that now arises is what happens if the same external undertaking providing the pricing algorithm supplies other competing undertakings as well. As we will soon analyse, it is not difficult to foresee how a single pricing algorithm may now become a hub controlling the prices in the relevant market if all the competing undertakings are using this same algorithm.[60]

First of all, what makes this scenario rather worrying is the fact that the effect of price fixing may happen automatically without any intent of collusion. After all, the algorithm provider may simply want to maximise its profits by supplying as many undertakings as possible without any anti-competitive intent in mind. Similarly, competing undertakings without knowledge of other competitors' usage of pricing algorithms, may want to use external pricing algorithms, for the reasons of convenience for instance, to maximise their profits. Now, if all the competing undertakings are using the same pricing algorithms, it is no surprise if the price behaviour is suspiciously similar having the effect of price fixing in the relevant market. As can be understood, this scenario may be rather challenging for the competition authorities to deal with if no anti-competitive intent is involved.[61]

Naturally, there may be situations where the competing undertakings provide their own data for a third-party pricing algorithm supplier in the hope of maximising their profits. Now, if all the competing undertakings are using the final pricing algorithm, which was made possible thanks to the data provided by all the competing undertakings, this situation seems rather different from the earlier scenario. It can be argued that the competing undertakings should be aware that the final pricing algorithm is made possible by using their data combined with the competitors' data. Essentially, this could be considered as some form of information exchange. As a consequence, it can be asked whether this could be a sufficient reason to

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[60] See eg Ezrachi and Stucke, *Virtual Competition* (n 47), ch 6.
[61] ibid

declare the competing undertakings responsible of having an intent to collude. As can be seen, this seems as a rather challenging question to tackle.[62]

An interesting case can be given that seems to well resemble a Hub-and-Spoke scenario, and at the same time raise several challenges for competition authorities to deal with. The undertaking in question is Uber Technologies Incorporated (Uber). First of all, it can be seen that the business model of Uber was rather innovative when it occurred. Essentially, Uber created an online platform that makes it possible for drivers to conveniently connect to the customers via a smartphone application. Certainly, the Uber's online platform has a significant role to play in this transaction. Namely, Uber's pricing algorithm provides a price for the ride automatically without any kind of negotiation between the driver and the customer. In other words, all the drivers for Uber agree to the fact that they will all be tied to the price that one single pricing algorithm provides for each individual ride. Furthermore, customers pay the fares directly to Uber, which means that there is no practical possibility for the drivers to compete with prices even if they would want to. What is more, Uber's pricing algorithm is rather sophisticated in setting prices depending on various different factors, such as the location and the time of the day. For example, it has been shown how different customers are paying different prices in different cities for practically same length trips. Naturally, the fact of changing prices depending on demand and supply, for instance, may be a reasonable reason for differential pricing, but this may again, bring up the issue of optimising the price in a way that the undertaking will always reap maximum profits at the expense of the customer. After all, the customer is never certain of the actual market price if the price is fluctuating constantly even for the same route.[63]

At first sight, the scheme operated by Uber seems as a rather classical Hub-and-Spoke scenario where Uber functions as a hub that fixes the price for the rides through its pricing algorithm. Firstly, it can be seen that Uber and the competing drivers, "spokes", have individual vertical agreements to allow Uber's pricing algorithm to function as intended. When it comes to horizontal agreements between the competing drivers, there is not necessarily an intent for these drivers to fix the prices on the relevant market. Nevertheless, all

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[62] ibid

[63] See eg Julian Nowag, 'When sharing platforms fix sellers' prices' (2018) 6 Journal of Antitrust Enforcement 382; Julian Nowag, 'UBER between Labour and Competition Law' (2016) 3 Lund Student EU Law Review 94. See also OECD (2019), 'An Introduction to Online Platforms and Their Role in the Digital Transformation' (OECD Publishing, Paris) <https://doi.org/10.1787/53e5f593-en> accessed 28 August 2019.

the competing drivers understand that there will always be a single price determined by the Uber's pricing algorithm. With no doubt, the scheme operated by Uber and its drivers resembles a Hub-and-Spoke scenario.[64]

Now, what makes this situation rather peculiar is the fact that the business model of Uber has brought certain positive benefits. One major reason why customers were happy to use the services of Uber was the fact of lower price. Combined with the ease of use of the Uber's online platform, it is no surprise why it became successful. In addition to benefits for end-user customers, the Uber's model made it possible for non-professional drivers to be remunerated for their effort. In practice, anyone with a vehicle could apply to become an Uber driver, and make trips whenever suitable for them. With no doubt, this kind of flexibility is rather attractive. Although, it should be noted that not all were delighted about this fact, including professional drivers. Essentially, Uber's business model made it possible for non-professional drivers to be remunerated for similar work to professional drivers without bearing the possible responsibilities that may arise in the form of permits for example. We shall not analyse this issue in great detail since it is a debatable, complex issue, that is highly dependent on the laws of each jurisdiction. Nevertheless, it can be argued that non-professional drivers are not directly comparable to traditional professional drivers. However, in practice, both drivers can be seen to compete for the same or at least similar customers. Therefore, it is not completely straightforward whether Uber drivers are enjoying an unreasonable advantage over professional drivers. This may also partly explain the reason why Uber can offer lower prices.[65]

As we have seen above, the beneficial nature of Uber's business model cannot be denied overall. However, in the context of algorithmic collusion, the competition authorities should still be aware of certain challenges that are caused by the Uber's pricing algorithm. First of all, a major concern can be linked to its growing usage. If more people are using Uber's online platform, both drivers and customers, it becomes much more attractive. Essentially, if customers know that there are plenty of drivers available, they will be enticed to use the platform. *Vice versa*, if the drivers know that there is a large pool of customers using the Uber's platform, it will similarly attract even more drivers. Other factors, such as brand

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[64] ibid

[65] ibid. See also eg Benjamin G Edelman and Damien Geradin, 'Efficiencies and Regulatory Shortcuts: How Should We Regulate Companies Like Airbnb and Uber' (2016) 19(2) Stanford Technology Law Review 293.

loyalty may also be influential in choosing the service. When the online platform has become exceedingly popular, possibly achieving a dominant position, it may become difficult for other undertakings on the market to compete. Now, the fact of having a single hub controlling the prices for numerous competitors, and that way for the customers as well, may be a concerning fact for the competition authorities to consider.[66]

All in all, the analysed case of Uber may be seen as an example of Hub-and-Spoke. However, at the same time, this case of Uber quite well demonstrates how challenging it is to unequivocally decide whether a scheme is anti-competitive. Even if price-fixing is often seen as a harmful anti-competitive conduct by object in accordance with article 101(1) TFEU, it is not always clear whether the actual anti-competitive effects are greater than the benefits. Therefore, a much more thorough analysis is needed in this regard. This may be a rather challenging task for the competition authorities to take, but is, nevertheless, a task that should be approached with caution especially now with the ever-increasing sophistication of algorithms.

4.2.3. Predictable Agent Scenario

In the Predictable Agent scenario, each undertaking on the relevant market creates their own pricing algorithm with the goal to maximise their profits. Because of this common goal to maximise profits, these pricing algorithms often function similarly. As we have already seen, a distinct phenomenon for pricing algorithms is to avoid trade wars and to keep prices at stable supra-competitive level. Furthermore, what makes the Predictable Agent scenario rather fascinating is that the undertakings understand that their competitors are using pricing algorithms, as well as the fact that a wider usage of pricing algorithms within the relevant market will facilitate tacit collusion. This, on the other hand, creates a better possibility for the undertakings to achieve higher prices. It can be seen that there is no actual agreement between the competitors, but an existence of anti-competitive intent to unreasonably increase profits by using pricing algorithms. It may be argued that the undertakings are simply understanding the way how these profit-maximising pricing algorithms function, which also explains the title "Predictable Agent". Essentially, the pricing algorithms function as predictable agents

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[66] See eg James Currier, 'The Intentional Network Effects of Uber' NFX <https://www.nfx.com/post/the-network-effects-map-nfx-case-study-uber> accessed 28 August 2019.

that are there to maximise profits for their masters. Undertakings are simply abusing this fact.[67]

In order to increase the prices to the most optimal level for the undertakings, the pricing algorithms may use signalling techniques for instance. The way how this signalling works, is by pricing algorithms raising prices only for a short period of time at a time when consumers are unlikely to make purchases, such as at the middle of the night. Now, even though the consumers may not notice these price changes, the competitors' pricing algorithms will surely notice. As a consequence, the competitors' pricing algorithms can then either react to these "offers" by raising their prices to the same level or not react to the price increase, in which case the initial undertaking which increased the price may return their price to its original state rather swiftly. The quickness of this process is one of the significant reasons why these kind of signalling techniques are worth using in the context of pricing algorithms. With no doubt, these kind of signalling techniques could be used in the markets where pricing algorithms do not exist, but the challenge is that the competitors may be much slower to react. During this slow waiting period, the initial undertaking which increased its prices may lose lot of sales as a consequence. Now, if the competitors will react positively to the initial offer made by an undertaking to increase the market price, the pricing algorithms may further continue this cycle indefinitely by offering new price increases. By repeating this cycle, the market price will always stay at the most optimal level for the undertakings to reap maximum profits.[68]

In conclusion, it can be stated that there are certain factors that make the algorithmic tacit collusion, including the Predictable Agent scenario, rather successful. Firstly, it can be seen that the usage of pricing algorithms provides a much more convenient and faster way to monitor the prices in the relevant market compared to human labour. Furthermore, the pricing algorithms are also fast in setting the relevant prices, which makes, for instance, the aforementioned signalling techniques much more powerful. Secondly, tacit collusion benefits greatly from price transparency. If prices are more transparent, it will be easier for competitors to notice any price reductions and retaliate accordingly. This, on the other hand, will make price reductions unattractive, and at the same time function as a barrier to entry for new entrants. After all, the new entrants may not be happy to enter the market knowing how

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[67] See eg Ezrachi and Stucke, *Virtual Competition* (n 47), ch 7.
[68] See eg OECD 2017 Paper, 29-31.

quickly the prices may decrease. Finally, the stability of the collusion is significantly increased by the usage of pricing algorithms. For example, where humans would make price changes slowly with outdated data and with a risk of suffering losses from that decision, pricing algorithms could make more subtle price changes constantly with lower risk. All in all, the advantage derived from the usage of pricing algorithms seems rather significant for undertakings, and therefore, it is no wonder why they are used.[69]

4.2.4. Digital Eye Scenario

The final algorithmic collusion scenario, the "Digital Eye", is definitely a challenging one. The difference from the Predictable Agent is the fact of using AI as a basis for the pricing algorithms to function. In other words, these pricing algorithms can be seen as self-learning, through trial-and-error for instance, to achieve the most optimal strategy to maximise profits. Indeed, the ultimate goal of these pricing algorithms is still to maximise profits, but this time the human programmers are not actively interfering but leaving the pricing algorithms to decide their own route how to achieve this goal. Essentially, the Digital Eye refers to a scenario where pricing algorithms function fully autonomously always improving their strategy to maximise profits. What is more, thanks to their ability to process an immense amount of data, they are able to constantly monitor the current market in real time, achieving a "God-like view of the marketplace".[70] Based on the past and current knowledge, they are always able to make the most optimal pricing decision to maximise profits for their masters. What makes the Digital Eye scenario remarkable, is the fact that even if the programmers would advise the programs not to fix prices, the pricing algorithms may still learn to do this in an alternative manner without the programmers understanding how the pricing decisions were made. Put differently, even if the effect on the relevant market may be that of stable supra-competitive pricing harmful for the consumers, it may be impossible for the competition authorities to know how the pricing algorithms made their decision if even the programmers do not know the answer. The concept of "black box" is aptly used which demonstrates how the pricing algorithm may use a vast amount of information, inputs, to produce an output, namely the price-setting, but the decision-making process remains a mystery. With no doubt, this makes the Digital Eye scenario rather worrying for the competition authorities to deal

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[69] ibid. See also Ariel Ezrachi and Maurice E Stucke, 'Tacit Collusion on Steroids - The Tale on Online Price Transparency, Advanced Monitoring and Collusion' (2017) 3(2) Competition Law & Policy Debate 24.
[70] Ezrachi and Stucke, *Virtual Competition* (n 47) 71.

with if no intent is seen to exist. Perhaps there is a need to revise the known enforcement tools to be able to tackle this scenario.[71]

Even though the Digital Eye scenario may not be yet as strongly visible in the current markets as the Messenger and Hub-and-Spoke scenarios, it should not be underestimated. Undoubtedly, the process of achieving a perfect Digital Eye scenario where all the relevant competitors are using self-learning algorithms, may not happen immediately. However, the reason why the Digital Eye scenario may become increasingly relevant is the fact of AI becoming more and more sophisticated. Similarly, as an increasing amount of undertakings adopted the usage of pricing algorithms because of their significant efficiency reasons compared to human labour, likewise, the self-learning pricing algorithms may become the next competitive advantage. After all, the question is about maximising profits for the undertakings. If self-learning pricing algorithms can provide more efficiency than regular pricing algorithms, it is not difficult to foresee why these new tools are worth using. Furthermore, when self-learning pricing algorithms are used even by few undertakings in the relevant market, this fact may create significant competitive pressure for other undertakings to adopt these new algorithms. As a consequence, an industry-wide usage of self-learning pricing algorithms may not be that unrealistic as one would think.[72]

What comes to the current sophistication of the AI, it is already fascinating to witness how the AI has progressed so far beating, for instance, one of the best Go player.[73] In the field of

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[71] See eg Ezrachi and Stucke, *Virtual Competition* (n 47), ch 8; Maurice E Stucke and Ariel Ezrachi, 'Antitrust, algorithmic pricing and tacit collusion' in Woodrow Barfield and Ugo Pagallo (eds), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar Publishing 2018); Frank Pasquale, *The Black Box Society: The Secret Algorithms That Control Money and Information* (Harvard University Press 2015), eg ch 1; Niccolò Colombo, 'Virtual Competition: Human Liability Vis-a-Vis Artificial Intelligence's Anticompetitive Behaviours' (2018) 2(1) European Competition and Regulatory Law Review (CoRe) 11.

[72] ibid. See also eg Ariel Ezrachi and Maurice E Stucke, 'Artificial Intelligence & Collusion: When Computers Inhibit Competition' (2017) University of Illinois Law Review 1775; Niccolò Colombo, 'What the European Commission (still) does not tell us about pricing algorithms in the aftermath of the e-commerce sector inquiry' (2018) 39(11) European Competition Law Review 478.

[73] See eg Will Knight, 'AlphaGo Zero Shows Machines Can Become Superhuman Without Any Help' (18 October 2017) MIT Technology Review <https://www.technologyreview.com/s/609141/alphago-zero-shows-machines-can-become-superhuman-without-any-help/> accessed 28 August 2019. Furthermore, in the field of poker an AI powered algorithm was able to consistently win professional poker players in a setting with multiple players. This is rather remarkable since it aptly demonstrates how the AI powered algorithm can perfect its strategy even in an environment with several players, not only with one opponent. This can also be seen relevant in our case of pricing algorithms where algorithms can function even in markets with multiple competitors. For an article regarding the poker scenario, see eg Will Knight, 'Facebook's new poker-playing AI could wreck the online poker industry - so it's not being released' (11 July 2019) MIT Technology Review

chess, the superiority of the AI has already been demonstrated for some time now,[74] but the Go game was considered to be a rather complex game that requires a usage of creative strategies. Therefore, many were surprised how a self-learning algorithm could learn through a simple trial-and-error process to achieve such a level of sophistication. It is remarkable to realise how this self-learning algorithm started from scratch with only simple instructions of the rules of the game and the ultimate goal to win the game. No complex programming was needed, but the algorithm learned everything by itself. Similarly, in our case of self-learning pricing algorithms, they will constantly learn through trial-and-error to maximise profits for their masters. Given a sufficient amount of time, the profit maximisation scheme may become increasingly sophisticated and subtle to a degree that we as humans cannot even comprehend the adopted strategy. Therefore, it is advisable to be aware of the outcome that may be caused from an industry-wide usage of self-learning pricing algorithms.[75]

To continue with empirical evidence, there are studies indicating how certain self-learning pricing algorithms function as essentially described by Ezrachi and Stucke.[76] Namely, the results of the studies confirm the hypothesis that self-learning pricing algorithms do tend to adopt a collusive strategy in a form of keeping prices stable and supra-competitive in order to maximise profits for the undertakings. This is a rather remarkable outcome, which demonstrates the danger of completely relying on autonomous self-learning pricing algorithms. What comes to the study itself,[77] it was conducted by benchmarking two self-learning algorithms in a sandbox environment by giving the goal to maximise profits. The results demonstrate how in the beginning the prices were set apart, but eventually, the pricing algorithms followed each other to an equilibrium level above the competitive price. As can be understood, this kind of exploration or trial-and-error approach to find an optimal price level may take years for human labour to perform, but with self-learning pricing algorithms, they can perform this learning process rather swiftly. Naturally, as the authors of the study note as well, the real-life markets tend to be more complex with competitors possibly using varying

<https://www.technologyreview.com/s/613943/facebooks-new-poker-playing-ai-could-wreck-the-online-poker-industryso-its-not-being/> accessed 28 August 2019.

[74] See eg Matthew Lai, 'Giraffe: Using Deep Reinforcement Learning to Play Chess' (MSc Dissertation, Imperial College London, September 2015) <https://arxiv.org/abs/1509.01549> or <https://arxiv.org/abs/1509.01549v2> accessed 28 August 2019.

[75] See eg OECD 2017 Paper, 31-32.

[76] See eg Calvano and others, 'Artificial Intelligence, Algorithmic Pricing and Collusion' (n 12); Calvano and others, 'Algorithmic Pricing What Implications for Competition Policy?' (n 12); Klein (n 12).

[77] Calvano and others, 'Artificial Intelligence, Algorithmic Pricing and Collusion' (n 12); Calvano and others, 'Algorithmic Pricing What Implications for Competition Policy?' (n 12).

algorithms or no algorithms at all. Therefore, more empirical evidence would surely be welcome to test differing market situations. However, even though the current study was performed in a controlled environment, it still aptly confirms how quickly the pricing algorithms learn to collude. Again, it should be noted that this collusive outcome happened without any specific instructions to collude. What makes the situation even more worrisome is the fact of ever-increasing usage of pricing algorithms. It would only seem as a matter of time when the prices eventually stabilise even in complex markets with multiple competitors.[78]

Certainly, not everyone are concerned that algorithmic collusion, including the Digital Eye, would require something to be done.[79] It is aptly stated that some competition authorities may even prefer a market situation which functions in a perfectly predictable and stable manner.[80] On the one hand, this view has its benefits of not unreasonably interfering with new technological advancements, and leaving the relevant market to function as freely as possible. Undoubtedly, this would be a more convenient solution for the competition authorities to adopt since it would not require any additional monetary investments on new enforcement tools. On the other hand, the reality is that the undertakings may always try to reap maximum profits on the expense of the consumers. This will eventually bring us to the difficult balancing exercise between the rights of the undertakings and the rights of the consumers. Undoubtedly, this is a great dilemma. This perfectly demonstrates the fact how sometimes the competition law is highly dependable on the political will of the people. As can be understood, different jurisdictions may put more value to certain issues than others, and therefore, when it comes to the Digital Eye scenario, we may see varying approaches to this issue as well.[81]

4.3. Conclusion

In this fourth chapter we have analysed the concept of algorithmic collusion through four different scenarios. Starting from the simple Messenger scenario all the way to the complex Digital Eye, it can be seen that the usage of algorithms, including pricing algorithms, do bring

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[78] ibid

[79] See eg Ulrich Schwalbe, 'Algorithms, Machine Learning, and Collusion' (2018) 14(4) Journal of Competition Law & Economics 568; Jeanine Miklós-Thal and Catherine Tucker, 'Collusion by Algorithm: Does Better Demand Prediction Facilitate Coordination Between Sellers?' (2019) 65(4) Management Science 1552.

[80] See eg Ezrachi and Stucke, *Virtual Competition* (n 47) 77-79.

[81] ibid ch 8.

certain concerns for competition authorities to deal with. While the Messenger and Hub-and-Spoke scenarios are possibly easier to deal with without fundamentally changing the interpretation of the current competition rules, the Predictable Agent and the Digital Eye scenarios are more worrisome. It can be seen that the increasing usage of pricing algorithms seems to have a profound influence on the way how pricing decisions are made in certain markets. Especially those markets where pricing is transparent and fully online, it is much easier for the pricing algorithms to function freely and create pressure for other competitors not using these algorithms. It can be seen that the usage of pricing algorithms is simply much more efficient than using human labour to monitor and change prices. Naturally, this kind of increased efficiency is attractive for the undertakings, and therefore, it is not difficult to see why the usage of pricing algorithms is increasing. However, as we have seen, the danger of having stable supra-competitive prices does not seem that attractive for the consumers or the society as a whole.

5. Measures to Address Algorithmic Collusion

5.1. Introduction

Now that we have analysed what is meant by algorithmic collusion, and we have seen how pricing algorithms have their significant role to play, it is appropriate to proceed with the analysis of possible measures to address these concerns. This chapter is certainly fascinating and relevant, but it should be understood that there may be countless of different ways to deal with algorithmic collusion. Therefore, it would be possible to discuss these measures in extensive manner. However, in this paper we are going to focus on few measures that would present a reasonable solution to the presented concerns. With the help of academic literature and case-law, the goal is to have a basic understanding of these possible measures. Although, it should be noted that the focus of this chapter will be mainly on the Predictable Agent and the Digital Eye scenarios. Of course, it does not mean that the Messenger and the Hub-and-Spoke scenarios should be forgotten, but the fact is that for these scenarios the current competition rules do seem to apply rather well. All in all, hopefully this analysis will encourage the readers to proceed further with their own research on how to tackle these complex issues.

5.2. Expanding the Concept of Agreement or Concerted Practices

A common way for undertakings or competitors to collude is through an agreement. As we have already seen throughout this paper, the existence of an agreement or some kind of meeting of the minds between the undertakings, is an important element for competition authorities to prove.[82] It can be seen that article 101 TFEU is heavily influenced by this fact. The fact that tacit collusion is not considered unlawful, is particularly for the reason that there is no element of agreement between the undertakings. The anti-competitive effect may be there in a form of stable supra-competitive prices for instance, but if no agreement is seen to exist in any form, the competition authorities seem rather helpless. Especially in our case of pricing algorithms, the need for agreement is often redundant. Therefore, the question that can now be asked is whether the understanding of agreement could be expanded in order to tackle these situations of algorithmic collusion. Certainly, the concept of agreement has already a

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[82] See eg ch 3.

rather wide interpretation within the EU law, but exactly for that reason, it would not seem unreasonable to widen this scope further.[83]

Certainly, in addition to "agreements between undertakings", article 101 TFEU mentions "decisions by associations of undertakings" and "concerted practices" that may be prohibited as anti-competitive. In our case of pricing algorithms, when it comes to Predictable Agent and Digital Eye scenarios, we shall analyse the category of concerted practices more deeply since it seems to be the most relevant in our context. As can be seen from an earlier chapter, under the rules of the EU law, concerted practice refers to a situation where formal agreement or decision cannot be seen to exist, but nevertheless, there is some form of cooperation between undertakings that is considered anti-competitive.[84] This definition of concerted practice quite aptly describes the situation we have at hand; namely, the fact of not having a formal agreement, but the undertakings may be seen to cooperate through the usage of pricing algorithms. Unfortunately, there is no case-law that would give an unambiguous answer to all our collusive scenarios, but nevertheless, there are cases that may indirectly prove to be helpful. These cases are mostly dealing with situations where information exchange is considered as a concerted practice.

First, we may begin with the question asking what kind of information exchange would be considered as a concerted practice. This is particularly relevant question in nowadays markets where information is swiftly disclosed online, and where other undertakings can receive this information instantly. In this regard, EC has presented some guidance through the Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements (Horizontal Guidelines)[85]. Firstly, it is noted that information exchange that may reduce "strategic uncertainty" in the relevant market, can be seen as a concerted practice.[86] Essentially, this means sharing of strategic data, such as market strategies to competitors in a form of future pricing information, that makes the market artificially more transparent. This, on the other hand, can be seen to facilitate coordination on the market.[87] Naturally, there are different types of information, and for example, the more

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[83] ibid
[84] See ch 3.3.
[85] Commission, 'Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements' (2011/C 11/01) (Horizontal Guidelines), see ch 2 (paras 55-110).
[86] Horizontal Guidelines, para 61.
[87] ibid paras 58, 62, 65.

strategic the data being exchanged, the greater the impact it may have for the competitive market.[88] Furthermore, factors such as transparency, concentration, and stability of the market may affect the way how aggravating this information exchange will be for the relevant market.[89] What comes to the reason why sharing strategic data should be seen as concertation, is the fact that lowered strategic uncertainty may reduce the willingness of competitors to compete, as well as their willingness to act independently.[90] Indeed, why bother making independent business decisions and competing rigorously if all the relevant information is there for all the competitors to see.

Even though the notion of "reducing strategic uncertainty" may seem rather simple at first hand, the fact of undertakings being able to intelligently adapt to the current or future market situation, is recognized.[91] What this means is that the undertakings are allowed to observe both present and future conduct of their competitors, and make appropriate strategy decisions based on these observations. On the one hand, this may seem slightly contradictory with the fact that every undertaking should determine themselves the policy they wish to adopt on the relevant market, as well as the conditions they wish to offer their customers. On the other hand, the ability to intelligently adapt to the changing market conditions seems logical, but raises the question of where to draw the line. Naturally, this is always the challenge with concepts that are broadly construed. As we have already seen, markets do differ from each other, and therefore, it is appropriate to analyse the characteristics of the market before deciding whether information exchange has reduced strategic uncertainty.[92]

Overall, Horizontal Guidelines can be seen to provide a reasonable overview explaining when information exchange should be recognised as a concerted practice. Although, as can be understood, a communication from the EC in a form of guidelines cannot be seen as a legally binding instrument.[93] In other words, only the view of the CJEU will prevail if there is some form of discrepancy between the views of the EC and the CJEU.[94] Certainly, EC as the main

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[88] ibid para 86.
[89] ibid para 58.
[90] ibid paras 61, 86.
[91] ibid paras 60-61.
[92] ibid. See also eg n 39.
[93] See eg Whish and Bailey (n 4) 551-559.
[94] Naturally, many of the findings of the Horizontal Guidelines are directly derived from the case-law of the CJEU. However, since the Horizontal Guidelines are from 2011, there are some newer cases that are not taken into consideration in these Guidelines.

body bringing enforcement proceedings against differing anti-competitive infringements, will naturally influence the fact of what kind of cases are dealt. Even though the undertakings may appeal the EC's decisions to the CJEU, in practice, many of the cases are settled without reaching the CJEU. This has the effect that EC's guidelines may have their significance, and therefore, should not be underestimated. Of course, EC tries to align their understanding of the EU law as closely with that of the CJEU, but sometimes, especially when it comes to newer issues where the CJEU has not yet given their interpretation, EC may introduce more novel approaches while waiting for the interpretation of the CJEU, if that ever comes.[95] We shall now proceed further to analyse what the CJEU has said regarding the information exchange as a concerted practice.

Starting from the case of *John Deere*[96], the General Court (GC) demonstrated how information exchange played a significant role in finding a concerted practice. Essentially, the GC confirms the same logic as stated in the Horizontal Guidelines. Namely, the fact that information exchange system in the present case reduced or removed a "degree of uncertainty" from the relevant market, and this was seen to have an adverse effect for the competition.[97] In other words, any kind of exchange of information that reduces uncertainty in the relevant market, may be seen anti-competitive, and that way, forbidden as a concerted practice. This fact was also reaffirmed by the Court of Justice (CJ) in later cases of *T-Mobile Netherlands*[98] and the *Dole Foods*[99] for example.

To continue with the *John Deere* case, an interesting fact that can be seen relevant in our case of pricing algorithms, is the CJEU's statement saying that without the formed information exchange system, "all the registration data exchanged might not be obtainable at the same level of quality and with the same frequency by individual market research or through a market research company."[100] Similarly, in our case of pricing algorithms, it would not be possible to monitor and change the prices as efficiently with human labour as with pricing

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[95] See eg Jones and Sufrin (n 3), ch 7; Ariel Ezrachi, *EU Competition Law: An Analytical Guide to the Leading Cases* (4th edn, Hart Publishing 2014), ch 5.

[96] Case T-35/92 *John Deere Ltd v Commission of the European Communities (John Deere)* EU:T:1994:259, [1994] ECR 957.

[97] ibid para 90.

[98] See para 35.

[99] Case C-286/13 P *Dole Food Company, Inc. and Dole Fresh Fruit Europe v European Commission (Dole Foods)* EU:C:2015:184, para 110.

[100] *John Deere*, paras 125-126.

algorithms. It can be argued that because of this extraordinary efficiency of these pricing algorithms, their usage may replace the need for actual information exchange. After all, why would the competitors bother deliberately exchanging strategic information with each other and risk being caught by the competition authorities, when the usage of pricing algorithms may offer the same results with no risk. Indeed, this is what makes the usage of pricing algorithms a convenient option to choose, and at the same time, exceedingly worrying for the competition authorities to deal with. Therefore, it can be concluded that the pricing algorithms play a major role by significantly reducing the degree of uncertainty in the relevant market. As a consequence, it would not seem unreasonable to compare the usage of pricing algorithms to information exchange if the effect is similarly anti-competitive in both scenarios. The following may be asked: should not the goal of competition law be to prevent harmful anti-competitive effect no matter how it was caused if there is a clear link between the conduct and the effect? Indeed, similarly as information exchange, so could the usage of pricing algorithms be seen as a concerted practice.[101]

More recent case of *Eturas[102]* is also an interesting one dealing with the category of concerted practice. To give a short background to the case, an electronic E-TURAS system was used by travel agencies as an online booking system. For differing reasons, such as for monetary ones, it may be more convenient for travel agencies to acquire a license to use a ready-made online platform to sell their services than to build their own system. Now, the owner of the E-TURAS system, Eturas, wanted to modify their system in a way to limit the possibility of travel agencies to grant discounts with a maximum limit of 3%. According to the licensing contracts, there were no provisions that would grant the system administrator a possibility to interfere with the prices set by travel agencies for their own services. Eturas informed the travel agencies about this maximum limit through the system's messaging application. Essentially, this application functions as an electronic mail system, where the recipient of the message needs to open the message. In any event, this modification was automatically implemented to apply for all the travel agencies using the system. It is noted that it was possible for travel agencies to grant higher discounts for their customers, but this would have required additional technical measures to be taken. Therefore, the question that was now

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[101] See also eg Vlad Dan Roman, 'Digital markets and pricing algorithms - a dynamic approach towards horizontal competition' (2018) 39(1) European Competition Law Review 37.

[102] Case C-74/14 *"Eturas" UAB and Others v Lietuvos Respublikos konkurencijos taryba (Eturas)* EU:C:2016:42.

raised by the national court was whether Eturas and all the travel agencies using the system were colluding in a form of concerted practice. After all, all the travel agencies now knew that the maximum discount limit would be 3%, and could benefit from this fact when managing their strategies. It can be seen that the strategic uncertainty between the competitors using this system was significantly decreased. Additionally, it was asked whether the travel agencies could be presumed to participate in the concerted practice if they did not oppose to the 3% discount restriction. The logic behind this question is that the travel agencies were aware, or at least should have been aware, of the message sent through the system, and that way tacitly accepting the new restriction.[103]

CJEU took the view that the travel agencies could indeed be presumed to have participated in a concerted practice, if they were aware of the content of the message.[104] Although, this would not be the case if the participants "publicly distanced themselves from that practice, reported it to the administrative authorities or adduce other evidence to rebut that presumption."[105] In other words, even if the travel agencies were aware of the content of the message, they could still take active measures to prove that they did not want to participate in the concerted practice. Understandably, the CJEU left the "assessment of evidence and the standard of proof" for the national court to analyse according to their national law.[106] The CJEU noted that the national court could rely on "objective and consistent indicia" to presume that the travel agencies were aware of the message's content.[107] Naturally, this presumption of awareness could be rebutted by the travel agencies by showing, for example, that they did not receive the message or that they only read it at a later time.[108] What is more, the CJEU noted that in accordance with the presumption of innocence, a simple dispatched message alone is not sufficient evidence to imply that the recipient "ought to have been aware of the content of that message".[109] In conclusion, this means that the travel agencies in the present case cannot be directly presumed as part of the concerted practice, but some kind of evidence of their awareness is needed.

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[103] See *Eturas* overall for the facts.
[104] *Eturas*, para 41.
[105] ibid paras 50-51. See also eg paras 46-49.
[106] ibid para 50.
[107] ibid para 40.
[108] ibid para 41.
[109] ibid paras 38-39.

Now, if we analyse our scenarios of algorithmic collusion, especially the Predictable Agent and Digital Eye, we may notice some helpful indications in *Eturas*. Firstly, we may argue that if there is a market where tacit collusion is seen to exist, similarly as in *Eturas*, we most likely could not automatically assume that the undertakings are aware or ought to be aware of the fact that their usage of pricing algorithms may cause tacit collusion. After all, the presumption of innocence can be seen to apply, as well as the fact of undertakings' ability to intelligently adapt to the market conditions. If, for example, an undertaking operates in a market that has oligopolistic tendencies and realises that the usage of pricing algorithms may increase its efficiency, the undertaking may be unaware of the potential anti-competitive consequences that may be caused by the usage of pricing algorithms. However, what if we now consider a situation where the undertakings in the relevant market are aware of the fact that the usage of pricing algorithms may create a situation of mutual understanding where the pricing algorithms are tacitly colluding with other competitors. Now, the question that may be presented is whether the same reasoning of *Eturas* would also apply to the case of pricing algorithms if it can be shown through *objective and consistent indicia* that the competitors were aware of the anti-competitive element regarding the usage of pricing algorithms (emphasis added). Indeed, this approach would not seem unreasonable to adopt, and would still leave the undertakings at hand a possibility to rebut the presumption of awareness. If the presumption could not be rebutted, this could be recognised as an indication of participation in the concerted practice of using harmful pricing algorithms to tacitly collude. Certainly, this solution may have its practical challenges in tackling situations where there are simply no indicia of undertakings' awareness. Nevertheless, this may at least be a first step towards a more sophisticated solution.[110]

5.3. Tacit Collusion: Should it be Prohibited?

When it comes to the concept of tacit collusion, the current view does not consider it unlawful. It seems that the fact of not having the element of "agreement" or "meeting of the minds" is seen too problematic to tackle. Furthermore, because of its traditional occurrence in oligopolistic markets, it is often marginalised as an "oligopoly problem".[111] Certainly, it is unlikely that tacit collusion would occur in every possible market. As we have seen, certain

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[110] See also eg Stephen Lewis and Derek Ridyard, 'Automatic harm to competition? Pricing algorithms and co-ordination' (2018) 39(8) European Competition Law Review 341.

[111] See eg ch 3.3.

characteristics should be present in the market to make tacit collusion more probable, such as transparency. Therefore, understandably, there has not been much political willingness to forbid tacit collusion. However, now, the increasing usage of pricing algorithms has drastically changed the way how certain markets are functioning. The level of price optimising for the benefit of the undertakings is incredible. Human labour could hardly reach the same efficiency as algorithms would, and that is certainly the reason why pricing algorithms are used. If tacit collusion was challenging to tackle before, the usage of pricing algorithms has made this challenge even worse. Not only markets which already have oligopolistic tendencies, but also varying markets may now face the challenge of tacit collusion. Would it be a relevant time to consider whether tacit collusion should be prohibited?[112]

In order to analyse the possibility of prohibiting tacit collusion *ex post*, we may begin with something concrete; namely, *ex ante* measures in the form of merger review. It is appropriate to note that the EC has a significant influence to the fact whether mergers and acquisitions[113] are approved in accordance with the EC Merger Regulation. What is fascinating is the fact that competition authorities are trying to prevent mergers that would create markets with oligopolistic tendencies.[114] This way, there is at least the goal to prevent tacit collusion. Now, if there are existing *ex ante* measures trying to tackle mergers that would lead to tacit collusion, would it be feasible to extend these views to *ex post* situations as well. With no doubt, with pre-determined political agenda, it may be more convenient for the competition authorities to act beforehand by carefully analysing the potential anti-competitive effects of the possible merger. As can be understood, there may be no serious damage affected to the current market structure if the merger is not approved since the undertakings may continue to operate as usual. If the merger is approved, there may, nevertheless, be unexpected anti-competitive consequences to the market despite performing a careful merger review. After all, merger review involves an element of prediction, which may not always be correct. Therefore, *ex ante* merger review is not completely riskless. When it comes to the *ex post*

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[112] See eg Francisco Beneke and Mark-Oliver Mackenrodt, 'Artificial intelligence and collusion' (2019) 50(1) International Review of Intellectual Property and Competition Law 109; Alistair Lindsay, 'Do we need to prevent pricing algorithms cooking up markets?' (2017) 38(12) European Competition Law Review 533.

[113] Hereinafter, for the reasons of clarity and consistency, "merger" will refer to both mergers and acquisitions, unless otherwise indicated.

[114] See eg the EC Merger Regulation, para 25; Commission, 'Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings' (Horizontal Merger Guidelines) (2004/C 31/03), para 22.

measures, the competition authorities are not required to predict the future, but the challenge is to have reasonable competition rules that are not excessively intrusive to the market structure. The fear of being prosecuted for unilateral actions, such as for the decision to use pricing algorithms, may significantly change the way how undertakings will behave in the relevant market. On the other hand, as we have seen throughout this paper, the ability for undertakings to use pricing algorithms may bring significant competition concerns that should be tackled. Therefore, the question that ultimately remains is whether it is worth tackling this challenge or simply leave it untouched.

The practice in merger review may prove to be helpful in analysing the way how would it be possible to tackle tacit collusion through *ex post* measures. The case of *Airtours*[115] may be used as a benchmark.[116] From this case it can be seen how the CJEU recognises the fact how sometimes even if there is no agreement or concerted practice between the competitors, the possible merger between the relevant parties could lead to harmful anti-competitive effects, such as to collective dominance.[117] In other words, tacit collusion is seen as a concern that the competition authorities should take into consideration when reviewing a merger. In *Airtours*, the CJEU verified three conditions that should be met in order to find a collective dominance without the existence of an element of agreement. Firstly, the undertakings should all be capable of being aware of how their competitors are behaving, so that the undertakings could monitor whether the common policy is adopted by the other undertakings as well.[118] Essentially, market transparency is a factor that should be sufficient for the undertakings to be able to monitor each other. Secondly, tacit coordination, or tacit collusion, should be sustainable.[119] This means, for instance, that all the undertakings should have a long-term incentive to tacitly collude, and not to depart from this common policy. When it comes to retaliation, it is well noted that there should exist an element of deterrence to discourage deviation. This could happen through the fact that if some of the undertakings are willing to

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[115] Case T-342/99 *Airtours v Commission (Airtours)* EU:T:2002:146, [2002] ECR II-2585.

[116] It should be noted that *Airtours* was not the first case to deal with these matters, but is used as a case that presents a clear list of conditions. For earlier cases, see eg Joined cases C-68/94 and C-30/95 *French Republic and Société commerciale des potasses et de l'azote (SCPA) and Entreprise minière et chimique (EMC) v Commission of the European Communities (France v Commission)* EU:C:1998:148, [1998] ECR I-1375; Case T-102/96 *Gencor Ltd v Commission of the European Communities (Gencor)* EU:T:1999:65 [1999] ECR I-753; Joined Cases C-395 and 396/96 P *Compagnie Maritime Belge Transports and Others v Commission (Compagnie Maritime Belge)* EU:C:2000:132, [2000] ECR I-1365.

[117] *Airtours*, para 61.

[118] ibid, para 62.

[119] ibid

deviate in hope of receiving a greater market share, all the other undertakings would match the deviation, and that way make the attempt unprofitable. Essentially, the undertakings will realise that fierce competition is less profitable than following the common policy to tacitly collude. Thirdly, the results that may be derived from the common policy, such as the fact of reaping excess benefits from maintaining stable supra-competitive prices on the market, should not be compromised by the foreseeable actions of potential and actual competitors, or by consumers.[120] In practice, this could mean, for example, that there are artificial barriers to entry in a form of retaliatory measures, making it discouraging for new entrants to enter the market. After all, they may understand that they will not profit by entering the new market. These three conditions set in *Airtours* were also reaffirmed in later cases by the CJEU.[121] Furthermore, it was also noted in an earlier case of *Compagnie Maritime Belge* how "other connecting factors" may be relevant in finding an anti-competitive effect.[122] This aptly complements the idea that the element of agreement is not always necessary to be considered.

Now, when we consider the usage of pricing algorithms as being the "other connecting factors",[123] we may notice that they fulfil the aforementioned three conditions rather well. For example, if we begin with the first condition, the usage of pricing algorithms is a perfect tool to monitor the relevant market and be aware of how the undertakings are behaving. As we have seen throughout this paper, market transparency is significantly increased in markets where pricing algorithms are used, making it convenient for the undertakings to monitor and punish deviations. When it comes to the second condition, the usage of pricing algorithms do definitely make tacit collusion more attractive and sustainable. For instance, as we have seen from the OECD's analysis, collusion seems dominantly to be more profitable policy to maintain than fierce competition in markets where transparency is high and possibilities for price changes are swift.[124] As can be understood, this is exactly what pricing algorithms do best: increase the transparency in the market and provide a quick method for price changes. Therefore, there does not seem to be many reasons to deviate from this common policy of tacit collusion. For the last condition, the usage of pricing algorithms is a rather convenient

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[120] ibid

[121] See eg Case T-193/02 *Laurent Piau v Commission (Laurent Piau)* [2005] ECR II-209, para 111. See also Joined Cases T-191 and 214-216/98 *Atlantic Container Line AB v Commission* (*TACA*) [2003] ECR II-3275, para 602.

[122] *Compagnie Maritime Belge*, para 45.

[123] ibid

[124] OECD (2017), 'Algorithmic Collusion: Problems and Counter Measures' [Note by A Ezrachi & ME Stucke, Roundtable on Algorithms and Collusion, 21-23 June 2017, DAF/COMP/WD(2017)25], paras 5-15.

method to create artificial barriers to entry making it discouraging for the new entrants. For instance, when a new entrant is willing to enter the market with price reductions, the pricing algorithms can immediately react to these attempts, making the reductions unprofitable. With no doubt, this will create a strong barrier to entry for any new entrant. Therefore, there does not seem to be many foreseeable risks that could compromise the results derived from tacit collusion.[125]

If we now consider the fact that the usage of pricing algorithms do seem to fulfil the aforementioned conditions, and that way create anti-competitive effects, this is certainly worrying. Based on this analysis, it is at least possible to tackle algorithmic collusion *ex ante* through merger review, but the question that remains is whether this is enough. Should this logic of tackling tacit collusion *ex ante* be considered for *ex post* measures as well? With no doubt, as we have discussed earlier, *ex ante* and *ex post* enforcement differ from each other, making it more challenging to tackle tacit collusion *ex post*.[126] However, with the increasing usage of pricing algorithms not only in markets with oligopolistic tendencies but also in varying markets, it will raise the question whether the prohibition of tacit collusion *ex post* would be a solution. After all, *ex ante* merger review can only deal with tacit collusion in the context of mergers, and is therefore, rather limited. The aforementioned list of conditions could at least function as a helpful guidance in tackling tacit collusion *ex post*.

Now that we have analysed the possibility of prohibiting tacit collusion *ex post*, we shall discuss certain views on how to prohibit tacit collusion. Firstly, we may begin with the notion that the topic of tacit collusion is not that novel. In the field of economics, it can be seen that tacit collusion has already been explored since 1929 in the USA.[127] We shall not analyse these earlier articles in great detail, but focus more on articles presented by Turner[128] and Posner[129].

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[125] ibid. See also eg Horizontal Merger Guidelines, paras 39-57; Maurice E Stucke and Ariel Ezrachi, 'How Pricing Bots Could Form Cartels and Make Things More Expensive' (27 October 2016) Harvard Business Review <https://hbr.org/2016/10/how-pricing-bots-could-form-cartels-and-make-things-more-expensive> accessed 28 August 2019.

[126] See eg text to nn 113-114.

[127] Chamberlin (n 45). See also for later discussion more specifically in the legal field: James A Rahl, 'Conspiracy and the Anti-Trust Laws' (1950) 44 Illinois Law Review 743.

[128] Donald F Turner, 'The Definition of Agreement under the Sherman Act: Conscious Parallelism and Refusals to Deal' (1962) 75(4) Harvard Law Review 655.

[129] Richard A Posner, 'Oligopoly and the Antitrust Laws: A Suggested Approach' (1969) 21(7) Stanford Law Review 1562. See also eg Keith Hylton, 'Oligopoly Pricing and Richard Posner' (October 2018) 18(2) Antitrust Source.

Now, it can be seen that in 1962, Turner presented his own views on this matter that were rather sceptical towards prohibiting tacit collusion. Followed by the views of Posner, he saw tacit collusion more as a voluntary outcome that could be prohibited if certain conditions were fulfilled. In other words, Turner approached this issue more conservatively, while Posner proposed a more innovative approach. Although, Turner also presented his own conditions to be fulfilled if tacit collusion would be prohibited. With the help of this discussion, we may analyse certain issues that can be raised, as well as solutions, regarding the prohibition of tacit collusion. Even though the debate regarding the issue of tacit collusion may seem old, it can still be seen relevant especially now with the increasing usage of pricing algorithms and AI overall.[130]

First, we may shortly note the view of Turner. Essentially, Turner does not see tacit collusion as a threat that should be tackled through competition law. First of all, the fact of rational and independent decision making is recognised, which functions as a strong indication that there is no collusion.[131] As an underlying question, Turner asks whether interdependence between the undertakings can be seen as an agreement, and whether this agreement should be unlawful.[132] What Turner wants to say is that in order to prohibit tacit collusion, the individual decisions of undertakings should be recognised as agreements. In order for there to be an agreement, certain conditions presented by Turner should be fulfilled.[133] One of the conditions would be to show that the market decisions taken by the undertakings are not individually construed but would go against their obvious self-interest. This could mean, for instance, that there is some kind of evidence showing that the suspected undertakings took decisions that are not genuinely independent,[134] but rather, benefitting a larger strategy, such as price-fixing in a form of maintaining stable supra-competitive prices. After all, why would an undertaking maintain excessively high prices for its products if it could lower its prices and gain additional profits and market share as a consequence. Indeed, maintaining high prices

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[130] See eg Beneke and Mackenrodt (n 112); Ezrachi A and Stucke ME, 'Sustainable and Unchallenged Algorithmic Tacit Collusion' (10 November 2018) University of Tennessee Legal Studies Research Paper No. 366, Oxford Legal Studies Research Paper No. 16/2019 <https://ssrn.com/abstract=3282235> or <http://dx.doi.org/10.2139/ssrn.3282235> accessed 28 August 2019.
[131] Turner (n 128) overall and especially 663-673, 705-706.
[132] Turner (n 128) especially 657-673.
[133] ibid 681-684.
[134] Turner clarifies that the term "independent" decision refers to a "decision that would have been taken regardless of what competitors decided to do." See Turner (n 128) 681 in this regard.

could be an indication of a market decision that is not individually construed.[135] As an additional condition, Turner notes that an agreement may exist if there is interdependence in a form that all the undertakings' decisions are dependent on each other making the same decision. This is a rather logical condition, since in normal market conditions the undertakings would simply deviate from the collusive price level, making tacit collusion ineffective. Therefore, if the price level is suspiciously stable and excessive, it may indicate some form of agreement between the undertakings in the market. [136] As a third condition, it is argued that the actions of the undertakings should not be restrictive in a manner to simply protect or increase their market power. Again, this can be seen to support the idea of undertakings being allowed to take rational independent decisions even in oligopolistic markets. It seems that Turner wants to emphasise the fact that if for example, the oligopolist is investing in research and development (R&D) or in new factories to improve or maintain their competitive advantage in the market, undoubtedly, this would seem acceptable. Solely restrictive measures, such as refusal to supply or unprofitable predatory pricing aimed to eliminate any new entrant, could function as indications that the oligopolist is not taking fair rational independent decisions.[137] Nevertheless, despite all these conditions, Turner is still seen to resist the idea of actively combatting the threat of tacit collusion. In his opinion, it would be difficult to set an effective remedy against tacit collusion, and an attempt to interfere with it would effectively result in price regulation. Turner sees this as an unsuitable approach, and would rather leave the market to function as freely as possible without unnecessary state intervention.[138]

When it comes to the view of Posner,[139] as shortly mentioned, he saw tacit collusion more as a voluntary choice. In other words, even if an oligopolistic market would exist for instance, it is not automatic that the market prices should be at a supra-competitive level. Instead, this could be seen as a voluntary choice to maximise profits for the undertakings at the expense of the consumers. Posner saw that tacit collusion could have similar effects as a cartel for example, and therefore, it would be reasonable to punish the situations of tacit collusion similarly as those where agreements do exist.[140] It can be seen that the element of "meeting of

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[135] Turner (n 128) 681.
[136] ibid
[137] ibid 681-682.
[138] Turner (n 128) overall and also more specifically 663, 681-684.
[139] Posner (n 129).
[140] Posner (n 129) overall and especially 1575-1576.

the minds" plays a role in the argumentation of Posner. As we have already discussed the signalling techniques for example, similarly, Posner argues that when one undertaking raises its prices, it can be seen as an offer. If other competitors follow this example by raising their prices as well, competitors are seen to accept the offer. The element of "meeting of the minds" is seen to be fulfilled since the undertakings are voluntarily raising their prices even if they would not have to.[141] Therefore, Posner sees tacit collusion as a concert of undertakings to gain excessive profits through monopolistic prices, and should as a consequence, be prohibited as a harmful phenomenon.[142]

Now, in order to prove the existence of tacit collusion, Posner approached this challenge by presenting certain objective indications that could be used by the competition authorities. Firstly, the practice of "systematic price discrimination" by the undertakings could be used as evidence in showing a possible existence of tacit collusion. As can be understood, in normal market conditions the undertakings tend to sell their products at the best price possible for all their clients in the fear of losing sales to other competitors if they price discriminate. Therefore, if systematic price discrimination is seen to exist, it may demonstrate mutual interdependence in the form of tacit collusion.[143] Secondly, the fact of having surplus of capacity over demand for an extended period of time, is seen as an indication of pricing that is not competitive.[144] Thirdly, attention may be drawn to the occurrence of price changes. Essentially, the prices on the market tend to shift more rigorously when competition is healthy. However, when the competition is not healthy, the undertakings are usually less likely to compete with frequent price changes.[145] Fourthly, Posner argues that evidence regarding atypical profits and price leadership may be taken into consideration. For example, if the prices are unusually high and stable compared to the competitive market price, and on the other hand, there are indications that undertakings seem to follow a lead of a certain undertaking, there may be a risk of having tacit collusion between the competitors.[146] Fifthly, for a more traditional way to prove the existence of collusion would be to demonstrate that for an extended period of time the market shares of suspected undertakings are fixed. As can be understood, fixed market shares may be an appropriate indication of the fact that there is not

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[141] ibid 1576-1578.
[142] ibid
[143] ibid 1578-1579.
[144] ibid 1579-1580.
[145] ibid 1580-1582.
[146] ibid 1582.

much competition on the relevant market.[147] Lastly, Posner presents three final indications that may be relevant in tackling tacit collusion. Although, Posner is seen to indicate that his list of conditions is not supposed to be exhaustive, but there may be other indications that are helpful as well.[148] Now, when it comes to these indications, first of them notes that there may be a reason to worry if there is significant excess capacity, but the undertakings are unwilling to grant discounts. As can be understood, inventory that is not swiftly sold may be a costly burden for an undertaking, unless there is something to gain from this practice. Indeed, thanks to tacit collusion, undertakings may sell at supra-competitive prices without worrying for price reductions from other competitors.[149] Secondly, if the undertakings are seen to announce their future prices clearly in advance without reasonable rational justification, this may be seen as a helpful indication for competition authorities to consider. As we have already discussed, this kind of action can significantly decrease the strategic uncertainty in the market, which makes tacit collusion much easier to maintain.[150] As a last indication, quite closely interrelated with the previous one, is the public statements of sellers indicating a "correct" industry price to maintain. Again, these kinds of statements may reduce the strategic uncertainty in the market. Furthermore, by artificially suggesting a "correct" price for specific products, the other undertakings may follow this price-level rather than choosing fierce competition.[151]

We have now analysed two differing views from Turner and Posner to the question whether to prohibit tacit collusion, and how to do it. As can be seen, it is certainly not an easy task to tackle this issue, but at the same time, not impossible either. On the one hand, Turner's approach is understandable representing a more conservative approach. Although, even if Turner was not keen to prohibit tacit collusion, he still presented certain conditions that could be used to tackle this issue in the case undertakings' interdependence would be considered an agreement. In other words, individual decisions of the undertakings could be seen as unlawful agreements if certain conditions were fulfilled. On the other hand, Posner seemingly presents a more radical view to solve the issue of tacit collusion, but in the end, is rather logical and credible. Posner's view can strongly be seen affected by the notion that tacit collusion is a *voluntary* choice taken by the undertakings in the hope of pursuing supra-competitive profits

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[147] ibid
[148] ibid
[149] ibid 1582-1583.
[150] ibid
[151] ibid

(emphasis added).[152] In other words, no-one is forcing the oligopolists to raise their prices to supra-competitive level, but they could rather compete fiercely as in a competitive market. Therefore, the notion of describing the phenomenon of tacit collusion as a voluntary choice is a compelling one.[153]

We shall now analyse more closely the conditions presented by Posner to see how they could fit to our modern world where pricing algorithms are present. Essentially, Posner's indications could function as a legal test. If the goal is to tackle tacit collusion, it seems rather attractive to have clear and objective criteria that competition authorities could follow. At the same time, undertakings would also be aware of these criteria and try to conduct their business activities as independently as possible. After all, many of the indications presented by Posner could be minimised if the undertakings would conduct their activities as far as possible in a rational, independent manner. Furthermore, the notion of avoiding competition that does not correspond with "normal conditions of the market" could function as a helpful underlying principle in questioning whether the relevant market is functioning as it should.[154] As can be understood, having a market with stable supra-competitive prices, as a consequence of tacit collusion, does not seem to correspond very well with this principle.

Now, if we consider the fact of prohibiting tacit collusion with the help of clearly formulated objective criteria, we may ask in which category should tacit collusion fall when considering the evidentiary burden of proof.[155] For example, when it comes to the competition law of the EU, price fixing is often seen as a restriction of competition "by object".[156] If the conduct is recognised as restricting competition "by object", there is not much the alleged perpetrators can do than to invoke article 101(3) TFEU. Essentially, depending on which category the alleged conduct belongs, this fact may greatly affect the willingness of the competition authorities, the EC in our case, to proceed with the enforcement of this particular conduct. Certainly, EC's approach to enforcement is increasingly focusing on a "more economic

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[152] See Posner (n 129) overall and especially 1575, 1578.

[153] More specifically about the dynamics of oligopolies, see also eg David M Mandy, *Producers, Consumers, and Partial Equilibrium* (Academic Press/Elsevier 2017), ch 15; Peter Dorman, *Microeconomics: A Fresh Start* (Springer 2014), ch 13.

[154] See eg *Dyestuffs*, paras 64-68. See also n 42.

[155] See eg ch 3.2. in this regard.

[156] See eg Case C-67/13 P *Groupement des cartes bancaires (CB) v European Commission* EU:C:2014:2204. See also eg Grant Murray, 'In search of the obvious: Groupement des cartes bancaires and "by object" infringements under EU competition law' (2015) 36(2) European Competition Law Review 47-51; Colomo (n 37), ch 3.

approach" rather than formal.[157] Now, the question that can be asked is whether tacit collusion should be considered as a sufficiently serious conduct similarly as price fixing? After all, price fixing is the most worrying anti-competitive effect of tacit collusion. This would mean that tacit collusion would belong to the "by object" category, having the consequence that no further evidence is required of the actual harm to the competitive market, as long as tacit collusion is proved to exist through meeting the pre-determined indications as presented by Posner for instance.[158] Admittedly, this could be a fascinating approach that would make tackling tacit collusion rather convenient. At the same time, it could be sufficiently reasonable for undertakings since the pre-determined indications or conditions should still be proved by the competition authorities through an objective analysis. Alternatively, taking the special nature of tacit collusion into consideration in a sense that there is no concrete traditional "agreement", a stricter approach could be taken to require the competition authorities to prove actual competitive harm to the relevant market, after demonstrating the existence of tacit collusion. With no doubt, this would be a more reasonable approach for the undertakings, but could possibly prove rather onerous for the competition authorities to deal with.[159]

Overall, both approaches have their benefits. Either of them could reasonably be supported with sound reasoning. After all, as we have already partly analysed, the main question that can be seen to arise is how to reasonably balance differing principles. For instance, on the one hand, we have the goal of EU Competition law to tackle harmful anti-competitive conduct as efficiently as possible in order to protect healthy competition and different actors, such as consumers.[160] This does not only mean that the actual competition rules should be effective, but also the rules on enforcement.[161] On the other hand, we have differing countervailing interests, such as the right of undertakings to conduct themselves freely on the market, as well as their right to intelligently respond to differing market situations. These rights have been particularly relevant in the CJEU's case-law when discussing concerted practices for

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[157] See eg Colomo (n 37) 41-44. See also overall Anne C Witt, *The More Economic Approach to EU Antitrust Law* (Hart Publishing 2016).

[158] See text to nn 143-151. See also eg nn 37-38.

[159] See also eg Salil K Mehra, 'Antitrust and the robo-seller: Competition in the time of algorithms' (2016) 100 Minnesota Law Review 1323, especially 1361-1366.

[160] More thoroughly on the goals of EU Competition law, see eg Daniel Zimmer (ed), *The Goals of Competition Law* (Edward Elgar Publishing 2012); Whish and Bailey (n 4) 18-24.

[161] See eg art 19 of the Treaty on European Union (TEU) [Consolidated version of 7 June 2016] OJ C 202/01; art 47 of the Charter of Fundamental Rights of the European Union (CFR) [2016] OJ C 202/389.

example.[162] Taking the debatable nature of prohibiting tacit collusion into consideration, overall, the stricter approach where tacit collusion could be prohibited by proving actual harmful effects, would be a less radical step for the competition authorities and the CJEU to take. It offers a rather balanced view that respects the rights of the undertakings as much as practicable, but still makes the enforcement possible for the competition authorities, even if it would be more challenging. Even though the "by object" approach could be possible, it would be rather radical. Moreover, with the increasing emphasis on a more economics-based approach, "by object" approach would require more convincing from the general public. Therefore, the "by effect" approach could be an easier step for competition authorities, and the CJEU respectively, to adopt which would definitely please the undertakings as well. Naturally, the competition authorities may have their own views on how to approach this question, but obviously, the CJEU will conclusively determine which approach is more reasonable.

5.4. Conclusion

In this chapter, we have analysed certain measures that could be taken to address the challenge of algorithmic collusion. Starting from the notion to expand the understanding of the concept of agreement or concerted practices, to the measure to prohibit tacit collusion overall, we have provided rather fascinating approaches for competition authorities, and the CJEU respectively, to adopt. For example, the fact of expanding the understanding of agreement or concerted practices to tackle algorithmic collusion caused especially by pricing algorithms, would not seem that impossible, taking into consideration the underlying idea of interpreting these concepts as broadly as possible. Indeed, these concepts are intentionally broadly construed within the EU Competition law in order to be able to offer a flexible approach in combatting various harmful anti-competitive conducts. Especially, in nowadays environment where anti-competitive conduct may take new innovative forms, this flexible approach may prove to be helpful. Therefore, it does not seem unreasonable to extend the understanding of the law to cover the usage of pricing algorithms if they are seen to cause harmful anti-competitive effects in a form of supra-competitive pricing for example. When it comes to the prohibition of tacit collusion, this has been a more debatable idea throughout the history of competition law. Certainly, many authors may still be sceptical in supporting the

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[162] See eg ch 3.3.

idea of total prohibition of tacit collusion, but as can be understood, several markets have drastically changed during this history. Especially now with the increasing emergence of electronic markets where products are solely purchased online, the major significance of algorithms cannot be denied. In particular, the usage of pricing algorithms to monitor and set prices in these markets is sophisticated. It would be rather naïve to compare these new markets where various algorithms are freely roaming in maximising profits for their masters to brick-and-mortar markets from the 1920s. Therefore, the discussion of prohibiting tacit collusion may not seem that unreasonable after all.

6. Conclusion

We have now reached the end of this thesis and it is now appropriate to present concluding remarks. As we have witnessed throughout this paper, the challenge of tackling algorithmic collusion is certainly not an easy one. On the one hand, with the remarkable sophistication of algorithms, and especially those of pricing algorithms, it is no surprise why they are used. The way how monitoring and pricing decisions were done before the emergence of pricing algorithms was rather slow and laborious. Now, by using these sophisticated pricing algorithms to monitor and set prices, the efficiency of the price-setting process has exponentially increased. When pricing decisions could take days or even weeks for human labour to perform with data that could already be outdated, pricing algorithms could do this in seconds with always up-to date data. As can be understood, this kind of efficiency is definitely attractive for undertakings seeking to maximise their profits. After all, if the price-setting could be done swiftly with the help of pricing algorithms, and this way save significant amount of time and capital, why would not the undertakings use them. Indeed, as can be seen from the E-Commerce Sector Inquiry for example, the increasing usage of pricing algorithms can be seen as a common trend.

Now, on the other hand, the usage of pricing algorithms do bring certain concerns. With no doubt, the beneficial nature of pricing algorithms cannot be denied, but the fact that they can be used as a tool to make explicit collusion much more efficient, but also tacit collusion a much greater threat, is worrying. With the great sophistication of pricing algorithms, they can even function fully autonomously in monitoring and setting an optimal price based on the market situation. However, the question that can now be raised is whether the optimal price is optimal for undertakings or consumers. As can be guessed, the price may tend to be more optimal for undertakings wishing to maximise their profits. Indeed, pricing algorithms may fully autonomously learn to function in a way to always set a best possible price for their masters by maintaining stable supra-competitive prices for instance. Therefore, some authors see algorithmic collusion as a threat that can become even worse in the future when even more undertakings are adopting the usage of these pricing algorithms. Combined with the fact that computing power and the AI are constantly becoming more sophisticated, undertakings are rather compelled to use these pricing algorithms if they are willing to stay competitive.

That is why an industry-wide usage of pricing algorithms make the fears of harmful effects of algorithmic collusion even worse.

In order to find solutions to this challenge of algorithmic collusion, we presented an underlying research question asking: "How should competition law deal with the challenge of algorithmic collusion caused especially by pricing algorithms?" By presenting this research question we are essentially analysing possible measures to tackle algorithmic collusion from the perspective of competition law. This means that this paper is delimited in finding measures relevant to competition law in addressing the challenge of algorithmic collusion. As can be understood, this does not mean that other measures, such as consumer protection, would be less valuable. Quite the contrary, this paper can function as a source of innovation to approach this challenge from different perspectives. When it comes to this paper, in order to make the analysis of possible solutions more appropriate, certain concepts were examined before. In the second chapter, we started by giving an overview of algorithms by analysing what they are and what kind of benefits do they offer. The purpose of this second chapter was to give an overview to the world of algorithms in order to better understand what is algorithmic collusion, and to realise how especially the usage of pricing algorithms is rather remarkable in automating the process of price-setting.

In the third chapter, we analysed the concept of collusion since it is not as straightforward as one would think. It could be possible to write a whole book discussing the concept of collusion, and therefore, we analysed certain aspects of collusion relevant for this thesis from the perspective of EU Competition law. Therefore, EU law functions as a benchmark for the further analysis.

In the fourth chapter it came time to analyse what exactly is meant by the concept of algorithmic collusion. Through four scenarios, the Messenger, the Hub-and-Spoke, the Predictable Agent, and the Digital Eye, we divided the analysis in smaller parts. Essentially, the first two scenarios are dealing with explicit collusion, where algorithms are helping undertakings to collude in a way that an element of agreement or meeting of the minds is seen to exist. In other words, it is possible to indicate an actual willingness of the undertakings to collude. In these first two scenarios, algorithms are simply used as a helpful tool to make explicit collusion possible. Therefore, the current competition rules of the EU for example, are seen sufficient to tackle these two scenarios as long as there is evidence of the meeting of

the minds between the undertakings. When it comes to the last two scenarios, the Predictable Agent and the Digital Eye, they refer to a form of tacit collusion. As can be understood, these scenarios are not as easy to tackle since there is no element of agreement or meeting of the minds as in explicit collusion. Therefore, there is simply no evidence of cooperation between the undertakings, but harmful anti-competitive effects in a form of supra-competitive prices for instance. We shall not repeat the analysis already done in the fourth chapter by explaining what is meant by these scenarios, but shortly conclude that the current competition rules do require some form of revision or novel interpretation in order to tackle these scenarios. Especially, the Digital Eye is perhaps the most fascinating, and at the same time the most challenging, scenario for the competition authorities to deal with.

Finally, in the fifth chapter we had the possibility to answer the research question and analyse certain measures to address the challenge of algorithmic collusion. First, we analysed the possibility of expanding the concept of agreement, or alternatively, the concept of concerted practices. Even though the analysis had a greater focus on EU Competition law, it does not mean that this analysis would not be relevant for other legal jurisdictions. The challenge of algorithmic collusion is still universally the same in all jurisdictions, even if the terminology or different peculiarities of each legal jurisdiction may vary. Furthermore, the measure to prohibit tacit collusion was analysed. This is a solution that is also relevant for all legal jurisdictions. As we have seen from the analysis from the fifth chapter, the consideration of prohibiting tacit collusion is not that novel. Already from 1950s, the legal scholars have analysed the possibility of prohibiting this concept. Even if the discussion of prohibiting tacit collusion has been lively ever since, it is not as straightforward to completely prohibit tacit collusion. Therefore, there has not been much willingness to prohibit tacit collusion because of its seemingly limited occurrence especially in oligopolistic markets. However, now with the emergence of algorithmic collusion, tacit collusion is seen as a much greater threat that may occur in various markets, not just in oligopolistic ones. Especially online markets where all the transactions are done online, the significance of pricing algorithms in changing the market characteristics is substantial. As a consequence, the measure to prohibit tacit collusion does seem more attractive.

In our analysis, we demonstrated that it could be possible to prohibit tacit collusion, and that way avoid the harmful effects derived from the usage of pricing algorithms. This could be done with the help of clearly formulated criteria, which would provide the competition

authorities a legal test to follow in a case there is suspicion of tacit collusion. At the same time, this would be rather reasonable for the undertakings as well since they would be aware of the criteria and try to avoid fulfilling them by behaving as independently and rationally as practicable. In addition, we analysed the possibility of recognising tacit collusion as a sufficiently harmful conduct to be seen as anti-competitive "by object". This would mean that it would be sufficient to prove the existence of tacit collusion. Alternatively, the effects-based approach may be taken where tacit collusion would be seen as anti-competitive "by effect". This would mean that tacit collusion could not be recognised as *per se* anti-competitive, but there would be an additional requirement to prove actual anti-competitive effects caused by tacit collusion through extensive analysis. As can be understood, the question is about burden of proof which is a significant question both for the competition authorities and the possible infringers. In our analysis, we concluded that both approaches could be possible to adopt. However, the effects-based approach would ultimately seem more reasonable. Certainly, it would be more challenging for the competition authorities to prove the existence of anti-competitive tacit collusion, and that way prohibit the usage of harmful pricing algorithms, but at the same time, it would not be impossible either. It should be remembered that even though the effectiveness of the law should be respected in a way that competition authorities can tackle as many harmful anti-competitive acts as possible, the rights of the undertakings, such as the right to intelligently adapt to the market conditions, should also be taken into consideration. It can be seen that the effects-based approach would strike a rather reasonable balance between these differing competing interests. By object approach would be more radical. Even if it could be accepted as a valid approach to tackle tacit collusion, it would perhaps require more political will from the public.

As a final concluding remark, it can be seen that we have managed to analyse the novel concept of algorithmic collusion and bring certain solutions to tackle it. As indicated throughout this thesis, these solutions are not intended to be exhaustive. In other words, there may be countless of different ways to tackle the challenge of algorithmic collusion, and not only measures relevant from competition law perspective. For example, as can be seen from the progress made in the EU to provide guidelines in relation to the AI,[163] this is a good step

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[163] See eg Commission, 'Ethics Guidelines for Trustworthy AI' (8 April 2019, High-Level Expert Group on Artificial Intelligence); Commission, 'Policy and Investment Recommendations for Trustworthy AI' (26 June 2019, High-Level Expert Group on Artificial Intelligence). See also eg Massimo Craglia (ed) and others, 'Artificial Intelligence: A European Perspective' (2018, Report from the EC).

forward which may, at least indirectly, affect the functioning of pricing algorithms which are powered by the AI. Certainly, as previously indicated, the pricing algorithms may still find a way to tacitly collude and reap supra-competitive profits despite of specific guidelines not to do it.[164] Nevertheless, these guidelines are at least an example of a measure to indirectly limit the harmful effects of algorithmic collusion. Overall, depending on the peculiarities of each legal jurisdiction, combined with a specific political will in mind, each jurisdiction may adopt measures that may be more radical to completely eradicate the risks derived from the algorithmic collusion, or alternatively, something less radical that at least minimise the risks. In the end, it is up to each jurisdiction to decide what approach is most suitable for them since at this stage, there does not seem to be only one correct answer to this challenge of algorithmic collusion.

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[164] See eg nn 70-71.

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