NOVA SCHOOL OF
BUSINESS & ECONOMICS

A Work Project, presented as part of the requirements for the Award of an International Master's Degree in Management from the NOVA – School of Business and Economics.

Algorithms: The end of traditional competitive markets?
The Case of Partneo

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A Project carried out on the Master in International Management Program, under the supervision of:
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January, 2019

Abstract

This thesis analyses how the development of machine learning and pricing algorithms is affecting competition between undertakings by facilitating collusive behaviours and how this issue should be addressed by competition authorities. Combining the insights given by the existent literature on the topic with the analyse of the recent case of Partneo, findings suggest that algorithms are indeed changing the competitive landscape. Although current EU law can deal with some cases, others fall out of its reach. The boundaries of competition law are strongly challenged on the case of Partneo in which carmakers were able to increase their revenues by over one billion dollars by using a sophisticated pricing software. The use of this algorithm leads to a parallel price increase of spare car parts on the aftermarket, which significantly harms "lock in" customers. In addition, the use of Partneo also affects the competition on the primary market as it creates incentives for dominant firms to decrease prices to capture more market share.

Keywords: Algorithmic Collusion, Competition, Regulation, Partneo

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1. Introduction

The rise of a Digital Era and the increasing amount of data available have led technology to develop an efficient way to process all this information: algorithms. An algorithm is defined as being a set of rules or mathematic instructions that will use data in order to process an answer for a specific problem. "*Though capable of great feats, they are simply lists of instructions."* (The Economist). In fact, algorithms are considered to be one of the key instruments for companies' success in a digitalized economy (Oxera, 2017). Nowadays, algorithms can be inserted in three main categories: (1) Artificial Intelligence - Detailed algorithms that mimic human intelligence, (2) Machine Learning - Algorithms that interactively learn from data and (3) Deep Learning - Artificial neural networks that replicate the activity of human neurons (OECD, 2017).

It is now possible to process a large amount of data about costumers, make predictions about the market and/or competitors' actions and take efficient decisions towards a certain goal, for example profit maximization. Amazon, one of the most successful online-retailers, is all about algorithms. All the shopping experience a costumer has on their website relies in algorithmics' decisions: "Amazon analyses customers' shopping patterns, competitors' prices, profit margins, inventory, and a dizzying array of other factors every 10 minutes to choose new prices for its products. This way they can ensure their prices are always competitive and squeeze out ever more profit." (Mehta N., Business Insider, 2018). The use of some of these algorithms by Amazon can lead to prices which are clearly not established by free competition. For example, a copy of Peter Lawrence's *The Making of a Fly* was being advertised for 23,698,655.93.3 US Dollars, which was clearly a case in which the algorithm led the price to spiral out of control.

Humans' decisions are being replaced by computer's decisions and although algorithms bring many efficiency advantages (Weiss and Mehrotra, 2001), they are also raising issues

concerning whether illegal pricing practices are being made or not. More precisely, the power algorithms have to change market conditions together with the less Human needed for decision making may facilitate undertakings to engage in collusive behaviours.

The aim of this research is to broaden current knowledge of how these developments in technology may be requiring changings on a legal level of competition. Therefore, this thesis starts by performing an in-depth analysis of the available and relevant literature regarding the effects that algorithms have on the competitive markets. Then analyses a recent real-life case in which carmakers including Renault, Jaguar, Land Rover and Peugeot have increased their revenues by over one billion dollars in the past decade by using a sophisticated pricing software, sold by Accenture. This case can be seen as a great evidence of the current limits of competition law practices when dealing with parallel use of price algorithms.

The paper will focus on answering the following question:

"How is the implementation of pricing algorithms facilitating collusive behaviors? And how can competition law enforcers deal with this issue?"

2. Methodology

Firstly, this thesis will be approached by researching and analysing books and articles by academia, technical documents and competition policy documents. Some case law is used to explore and support definitions in competition law. The debate on algorithmic collusion has gained academic relevance when Ezrachi & Stucke have set out the theories of harm for algorithmic collusion in their book *Virtual Competition* and other articles. The authors explain that the introduction of some type of algorithms will force competition law to evolve in the field of tacit collusion. In fact, this recent topic is becoming more and more discussed as technology and digital markets keep evolving and so does the capabilities of algorithms.

After setting out the general structural conditions for collusion and how they are affected by algorithms, a case study will be presented. The goal is to translate the previous studies and conclusions into concrete real-life events. This way it will be easier to answer the research question with more realistic conclusions and recommendations.

3. Literature Review

3.1. The concept of Tacit Collusion and "The Oligopoly Problem"

As the power of algorithms increases, so does the suspicions that those may have a negative impact on competition and consumers' welfare. For the past three years many studies have been published addressing the potential harm they might be causing and will possibly continue to cause in the future. Collusion is one of the anti-competitive conduct that might be largely facilitated by the use of pricing algorithms. In common literature, the term "collusion" refers to any form of co-ordination or agreement among competing firms with the objective of raising profits to a higher level than the non-cooperative equilibrium resulting in a deadweight loss (O'Sullivan and Sheffrin, 2003). Although explicit collusion is prohibited in Article 101 of the TFEU, it is difficult to see where tacit collusion fits into the legislative framework. Tacit collusion is a phenomenon that arises in markets where few operators act in a parallel manner as a result of the characteristics of the market, being able to earn supra-competitive profits without entering into an agreement or a concerted practice in the legal sense (Whish & Bailey). This type of collusion is a relevant issue for authorities, being also referred to as the "oligopoly problem". The "oligopoly problem" suggests that high interdependence and mutual self-awareness in oligopolistic markets might result in tacit collusion, an outcome which is socially undesirable as explicit collusion but that falls out of the reach of competition law (OECD, 2017). Considering algorithms' ability to change market conditions, which will be examined below, OECD's paper questions their ability to amplify this problem.

Consequently, the issue started to be strongly addressed by OECD: “Finding ways to prevent collusion between self-learning algorithms might be one of the biggest challenges that competition law enforcers have ever faced.”. On June 2017, the economic organisation held a conference - Algorithms and Collusion - in order to discuss some of the challenges raised by algorithms. The concept of *Algorithmic Collusion* was there defined as consisting “in any form of anti-competitive agreement or coordination among competing firms that is facilitated or implemented as means of automated systems.”.

3.2. Relevant factors for collusion – Structural Characteristics of the market (Appendix 1)

“The number of firms and barriers to entry are traditionally identified as two of the most important structural characteristics that affect the risk of collusion” (OECD, 2017). It is well known that as the number of firms increases the incentives for collusion will decrease. Coordination between firms becomes more complex and the profits extracted from this behaviour will also became smaller. Logically, if barriers to entry are inexistent collusion will also hardly be sustained since profits will attract new entrants into the market and over time supra-competitive gains will erode. As observed in OECD’s paper, algorithms might be changing this traditional knowledge since they have the ability for co-ordination, monitoring and punishment to take place also in less concentrated markets. The small number of firms, in this case, “is an important but not a necessary condition for algorithmic collusion to take place.” (OECD). Another perspective is also that algorithms may leave some “slower” companies outside the market, thus creating barriers to entry. Thus, it is not clear yet the overall effect of algorithms in these structural characteristics.

OECD’s paper also refers to market transparency and frequency of interaction as relevant factors for collusion, admitting that unlike the number of firms and entry barriers, algorithms

are very likely to enhance these two factors, posing therefore a threat to competition. As a result of the amount of data available, combined with the power of algorithms to process it, some markets are increasingly becoming more transparent. Collusion is easier in this environment since companies are able to monitor each other's actions and easily detect deviations from an agreement. Participants are now able to constantly collect and observe in real-time rivals' actions, consumers' choices and changes in the market environment, creating thus a transparent environment that is prone to collusion. Markets are typically more vulnerable to coordinated conduct when a firm's "significant competitive initiatives can be promptly and confidently observed by that firm's rivals." (2010, Merger Guidelines).

In addition, models of collusion have proved that more frequent interaction between competitors make collusion easier to sustain. As Ezrachi and Stucke (2015) suggested, the fact that algorithms allow competitors to share their data stream online, allows interactions to happen in almost real time. Consequently, deviations and retaliation are easily detected between parties. From this, the authors conclude that collusion with algorithmic pricing becomes more likely.

As all these factors are being influenced and the competitive landscape is changing, the major question posed is if competition law is up to the job of regulating algorithms?

3.3. The collusion analytical framework by Ezrachi and Stucke (Appendix 2)

Algorithmic collusion was also strongly addressed by Ariel Ezrachi and Maurice E. Stucke (2015, 2016, 2017), whose research came up with a collusion analytical framework consisting in four scenarios.

In the first one – *Messenger Scenario* – competitors agree to collude and use algorithms to help perfect that intent. The illegality here is the agreement to collude itself. This scenario is

considered to be the easiest for competition regulators to deal with, since current competition law already covers this type of situation. One example occurred in 2015, the DOJ successfully prosecuted David Topkins and other participants for agreeing to adopt specific pricing algorithms to coordinate prices for wall posters that were sold through the Amazon market place.

> "In furtherance of the conspiracy, the defendant engaged in pricing discussions with representatives of other poster-selling firms. During these discussions, the defendant and his co-conspirators agreed to fix, increase, maintain, and stabilize prices of certain posters sold in the United States on Amazon Marketplace ("agreed-upon posters"). In order to implement these agreements, the defendant and his co-conspirators agreed to adopt specific pricing algorithms for the sale of the agreed upon posters with the goal of coordinating changes to their respective prices.".

In this specific case, the algorithm included lines of coding that revealed "collusive intent" and an agreement between the parties was easily proved. This contributes to generate the "hard" evidence that antitrust authorities look for. Calvano's research (2018) uses this case to point out that in some cases pricing collusion is easier to detect than human collusion.

The second scenario is the *Hub and Spoke* which consists in allowing one entity to use its algorithm to set the price of multiple market participants. Uber can be used as an example since drivers could be competing among themselves, but they are not, Uber company (the Hub) sets the price for all the drivers according to its demand. This is not necessarily an anticompetitive behaviour. However, the evidence that the algorithm can push the price up raised some concerns regarding possible manipulation of the perceived market price. Ezrachi and Stucke question themselves: what if Uber's market power increases? And instead of responding to market forces, it starts determining what the market price is? "From the enforcement perspective, (…) if the algorithm is designed to facilitate collusion among its users, then we have a classic hub-

and-spoke conspiracy.". There is also an interesting case law (JJB Sports vs Office of fair trading, 2013), not related to digital markets, but where hub and spoke is defined to exist if:

(1) retailer A discloses to supplier B its future pricing intentions in circumstances where A may be taken to intend that B will make use of that information to influence market conditions by passing that information to other retailers (of whom C is or may be one);
(2) B does, in fact, pass that information to C in circumstances where C may be taken to know the circumstances in which the information was disclosed by A to B;
(3) C does, in fact, uses the information in determining its own future pricing intentions;

Evidently, the exchange of sensitive information between parties is what constitutes the evidence of anti-competitive behaviour in most cases.

In the third scenario – the *Predictable Agent* – each firm unilaterally decides to adopt pricing algorithms, being aware that competitors might be also using similar algorithms strategies. By doing so companies understand that the speed in which these algorithms can respond to one another and the increase of market transparency may lead to anticompetitive outcomes, namely tacit collusion. Salcedo (2015) has also found theoretical support for the idea that pricing algorithms can be "an effective tool for *tacit* collusion". In his model the author assumes that firms are able to "decode" their competitors' algorithm and included the option in which firms were able to mask their algorithms to prevent decoding. The conclusion is that firms chose to allow their algorithms to be decoded after a time by their competitors. "Tacit collusion on steroids" is called, given the fact that it presents a more complex scenario because "there is insufficient evidence of any agreement (either vertical or horizontal)". Although no anticompetitive agreement among competitors to fix price can be confirmed, there is an evidence of anticompetitive intent. Thus, Ezrachi and Stucke question themselves: "is there a tool that the agency can use to go after that?".

In the fourth and last scenario – *Digital eye* – algorithms are not used as tools that facilitate collusion by changing market conditions. Here algorithms are a direct device to achieve a certain target. These are called self-learning algorithms, which are able to maximize profits while recognising mutual interdependency and readapting behaviour to the actions of other market players (OECD, 2017). "The machines, through self-learning and experiment, determine independently the means to optimise profit." (Ezrachi and Stucke). As a consequence of algorithms working as autonomous agents there are neither evidence of any agreement among the competitors, nor any evidence of anticompetitive intent.

3.4. Enforcement challenges

Market conditions under which tacit collusion is likely include: transparent prices, frequent interaction, entry barriers and low number of competitors. Realistically these conditions are rarely observed in traditional markets and tacit collusion is hardly sustained (OECD, 2017). Nevertheless, as mentioned above, the conditions required to sustain tacit collusion arise more easily with the emerge of algorithms in digital markets.

Nowadays competition policy requires not only coordination on supra competitive prices, but also some conscious and mutually accepted agreement among parties to prosecute them. That is, prohibits explicit collusion but "can´t go after" tacit collusion, which has not a desirable outcome for competition either. As pointed out by Ezrachi and Stucke, enforcement challenges are greater when dealing with the last two scenarios, for the reason that they allow collusion to take place without a necessity for any contact between the parties. Therefore, OECD reflects whether there should be a change on the notion of agreement, which is generally broadly defined, applied to digital markets or not. Article 101 of the TFEU applies to all "agreements" and "concerted practices".

> The proof of an agreement "must be founded upon the direct or indirect finding of the existence of the subjective element that characterises the very concept of an agreement, that is to say a concurrence of wills between economic operators on the implementation of a policy, the pursuit of an objective, or the adoption of a given line of conduct on the market, irrespective of the manner in which the parties' intention to behave on the market in accordance with the terms of that agreement is expressed." (Bayer AG v Commission of the European Communities).

The fact that the parallel use of an algorithm, which can enable companies to reach the same outcome as collusion, is insufficient to prosecute companies may be requiring a new definition of "agreement" adapted for digital markets. In fact, there are cases where the concept of agreement was "extended" when parallel conduct was accompanied by other factors as "communications revealing an intention to collude or engagements in facilitating practices, such as information exchanges." (OECD, 2012).

Furthermore, The German Monopolies Commission (*Monopolkommission*), an independent body advising the German federal government and legislature on competition law and policy, recently pointed out another important factor regarding the fact that price algorithms are often not designed by the companies themselves. As in the case analysed in section four, algorithms can be provided by a third party with special expertise.

> "Whether such a third party is liable for violations of competition law typically depends on the responsibility of the companies using the price algorithm. This means that IT service providers can either be subject to particularly far-reaching liability or, conversely, benefit from liability gaps, depending on whether the decision on the design of the price algorithm in question lies more with the user or with the respective IT service provider. The liability of such third parties should be generally reviewed.".

As many authors have highlighted, collusion through the use of algorithms is a practice which is posing some new questions for antitrust enforcement. However, some literature has found that collusion among algorithms is possible but "rather unlikely" (Xie and Chen, 2004; Waltman and Kaymak 2008). In Calvano's (2018) research paper he mentions that some previous literature consider collusion to occur with "relatively low probability, in the range of 30%", but that his own research "(…) observed collusion to emerge in more than 60% of the cases (more than 80% after enough repetitions that the algorithmic learning may be regarded as completed).

A very recent case, that might just be the one to prove sceptics wrong about the power of algorithms, has been gaining some attention from the media and will be analysed in Section 4. Confidential documents relating this case were obtained by Mediapart, a French news website, and shared with Reuters and EIC, a network of European investigative collaborations.

4. Case – Partneo

4.1. Background

From the year of 2008 to about 2015, five major French carmaker groups, among them Renault and PSA, were able to keep their spare car parts prices "artificially" high. The companies' market power on the secondary market is really high, given that consumers are locked in to the brand from which they bought the car. This happens because customers develop switching costs like the need for compatibility of equipment or/and costs of learning about new brands (Klemperer, 1995). Confidential documents have shown a hike of 15% of the price of spare car parts. Consequently, this led to a boost in revenues of more than one billion dollars for each group and was the result of the adoption of a price algorithm named Partneo. Partneo is a highly/sophisticated software, created by Laurent Boutboul and supplied by Accenture to the French car manufacturers. The software was designed to be able to identify the maximum

consumers would be willing to pay for the car parts, providing criteria that could be used to fix the price of the parts instead of determining the real manufacturing cost plus profit margin. According to Laurent Boutboul "Acenture convinced carmakers to adopt Partneo by showing them the increases of prices and revenue Partneo secured for their respective competitors (…)". Being considered shocking on an ethical level, this also raises issues regarding competition law. Meanwhile, the French competition authority, the Autorité Française de la Concurrence, immediately opened an investigation but ended up closing it after several months without carrying out further investigations or questioning potential witnesses. Contacted by Mediapart, the competition authority concluded that the "information brought to its attention" did not justify the opening of an "in-depth investigation" however reserved the possibility of doing so if new information was provided.

4.2. How it works

The parts are weighed, measured, photographed and analysed in a warehouse laboratory in order to create a database. Then the algorithm increases the price of similar parts according to the price of the most expensive component in that "family". Many are raised between 20% and 300%. However, the prices are not "shocking" to consumers as the components are all of similar size and appearance (see appendix 3 and 4). Documents obtained by Mediapart show, for example, that the price of a mirror on a Renault Clio III, which cost 10 euros to produce and was already being sold for nearly eight times that amount, 79 euros, increased to 165 euros, after the use of Partneo.

4.3. A matter of ethics

Accenture easily sold Partneo to Renault with the promise that the company would be able to increase its prices "between 10% and 20%". The use of this software is not an illegal practice

by itself, but some question the ethics behind it. The service business (maintenance and repair of vehicles) generates about 45% of total car aftermarket revenues in Europe, while retail and wholesale of vehicle parts make up the remaining around 55% (McKinsey, 2017). The automotive aftermarket is a tricky industry where consumers have very little or no power over prices. When buying a car, they may not be taking into account future costs, mainly repair or upgrade costs. And if needed, there are not many options but to take the car to the dealership's service department for repairs, and getting Original Equipment Manufacturer (OEM) car parts. This means that the consumer will have to stick with the brand from which he first bought the car. Renault, Jaguar Land Rover (JLR) and Peugeot said their pricing strategies for spare parts were "legal, did not take advantage of car owners (…)", plus that they use Partneo in order to "deliver consistency in pricing across our spare parts range to ensure that we are appropriately priced against our competition".

4.4. Parallel Behaviour

The situation started to raise some concerns regarding its legality when the software was also adopted by PSA. "In theory, if all or several competitors in a specific sector make use of the same pricing software that relies on the same price calculation algorithm, they will experience very similar relative changes in price once the software is implemented." (Mandrescu D., 2017). In fact, Mediapart found that on December 17th, 2009, a sales executive at Accenture wrote to PSA announcing the software Partneo, that would enable the company to raise its prices "between 10% and 20%, representing 70 million to 140 million euros extra revenue a year", and mentioned that the values came from recent experience with other automobile manufactures.

On June 2010, Accenture started to recognize some concerns regarding the use of the algorithm by more than one company: Anthony Rice, Accenture's legal counsel based in London, stated

that “Accenture believes that there are competition law risks” linked to Partneo and that its “pricing solutions may be identified as a facilitating practice if two or more competitors adopt similar rates or pricing strategies”. According to court records, Accenture had "informed PSA that Renault uses the same algorithms and formulas for price definitions as PSA", and then Accenture "helped PSA increase its prices in the same proportion as Renault's". Although there is no proof of a “meeting of the minds” between the two companies, PSA was aware that the algorithm was already being used by others thanks to Accenture. For this reason, competition authorities suspected that the parallel use of the identical pricing algorithm might have led to a horizontal price agreement between the companies and the company Accenture as an intermediary.

A key factor that should be taken into consideration is whether customers really see Renault and PSA as competitors on the aftermarket. Looking at a consumer decision making process when buying a car, he will search between brands for the one that has the best offer. Depending on the type of consumer the customer will look for safety, comfort, fuel efficiency, fair price, etc. Therefore, without a doubt that PSA and Renault can be considered competitors at the stage of deciding which car to buy. However, as mentioned before, customers in the after-sales are tied up to the brand they chose to buy the car from. Will a consumer care about the price of the spare parts of PSA if they have a Renault? That is, does it matter if Renault and PSA are aligning their prices on the aftermarket if these are considered separate markets? The answer would depend on the type of customer considered. The ones that take into consideration repair/maintenance costs when deciding which car to buy, will care about the price spare part that each brand offers. The fact that this type of consumer exists should be enough to state that the parallel pricing in this case can be considered harmful to consumers and competition. In addition, in the case of customers that only care about the spare part price until they need to replace them, the price may play an important role when considering insurance companies that

may notice a substantial difference between the car brands. Furthermore, there are also customers who purchase not only one car but who make big orders of cars, for example big corporations, leasing companies, taxi's drivers' companies. In these cases, companies may take into account the price of spare parts when making their choice since it can have significant impact on their costs. Thus, one must conclud that the significant increase of spare car parts and its parallel pricing should be seen as harming to competition and consumers.

4.5. Concerted Practices

Emmanuelle Claudel, professor of competition law, stated that while the operation in place does not constitute a "classic cartel" where manufacturers fix the prices together, the documents in the court proceedings that relate to the use of Partneo software seem to show a "concerted practice". Keeping in mind previous case law (Case T-Mobile Netherlands), is known that concerted practices "require finding the existence of contact among two or more competing undertakings with the objective of parallel business practices". If in this case there is proof of contact among Renault and PSA, competition laws can be used straightforward. Assuming the information provided by Mediapart is correct, there is evidence of communications between the two: Accenture is said to have proposed to the head of the project at PSA that he should meet his Renault counterpart. According to a witness it was confirmed that "the head of the project at PSA had indeed contacted his counterpart at Renault and that he'd had very positive feedback about the use of Partneo". However, Renault denies any contact and stated that the "contact" described by the witness "was never organised" or taken up.

The case might be more complicated than that if it is hard to prove a "meeting of the minds" between the two companies. If a certain pricing software is created and it is shown to increase efficiency for companies, gaining popularity in a certain sector, its parallel use cannot be prohibited using current laws. This is the case of other carmakers that were simply contacted

by Accenture and decided to adopt the software in order to increase their profit, without any exchange of information about whether their competitors were using the same strategy or not. Competitors have the right to adapt to market conditions, and "supra-competitive pricing strategies may be the normal outcome" in order to survive on the market (OECD, 2017). However, from a welfare perspective, such an outcome should be prevented since the raise prices leads to the detriment of consumers.

The third party, Accenture, may also have an important role when determining whether there was an agreement/intent to coordinate prices or not. If when contacting the companies, promoting Partneo, "Accenture included an exchange of sensitive pricing information of competitors or indications of the possibility to coordinate prices without contacting competitors directly, adopting Partneo may constitute an infringement of competition law" (Coreblog, 2018). The consultancy company says that it "helps manufacturers to take appropriate tariff decisions" and "doesn't exchange sensitive and/or confidential information between its clients", respecting all its legal obligations. In fact, this may just be the third scenario mentioned on section two, the Hub and spoke, in which Accenture is the Hub and Renault and PSA the spokes. If Partneo was adopted by Renault and PSA after being exposed to sensitive pricing information, this "would entail a certain degree of conscious coordination among competitors (or at least among the carmakers which received such information)". Given that Accenture is suspected of having provided such sensitive information, the consultancy may be considered to have acted as a facilitator of such an anti-competitive practice.

4.6. Market Imperfections

In many markets, like the car industry, manufacturers of the primary good may have incentives to exploit its market power in the aftermarket by charging prices above competitive level (Klemperer, 1995). Being aware of the ability to charge what consumers are willing to pay for

spare parts by using Partneo, these companies might have also incentives to increase the range of "locked in customers" on the aftermarket. To do so, they might enter price wars on the primary market in order to capture more market share. Thus, Renault, PSA and other companies might recognise that they should lower the prices on the primary market, in order to increase their profits on the aftermarket by acquiring more locked in customers. Additionally, more imperfections arise because this strategy will affect "short-sighted" customers, those who are not able to take into account the costs on the aftermarket when choosing the purchase on the primary one. In such cases there is no protection from abusive aftermarket prices and customers are likely to be harmed by aftermarket monopolization. Customers already present in this secondary market will keep paying the high price of spare parts as long as the switching costs are higher.

These circumstances should justify the intervention of the competition authorities given that Renault and PSA have already a dominant position on the French market, plus the fact that other imported brands admit to use Partneo as well. When adopted by most firms, the use of this algorithm will lead to parallel pricing of spare parts on the secondary market. Even for rational consumers, that do not own the car yet and will take into account the cost of repairs/maintenance, few cheaper choices seem to be available given this parallel pricing. Furthermore, both the primary and secondary market should be considered given that if the dominant firms decide to set their primary product's price low to gain market share, as mentioned above, some competitors might leave the market unable to match those prices and others might be deterred from entering. In addition, new entrants and smaller companies, are also in greater disadvantage given the absence of a developed dealer/maintenance network in the aftermarket.

5. Conclusion and final recommendations

The discussion related to algorithmic collusion seems to be far from over. Algorithms are becoming part of competition and for tech companies the goal is to have the "best one". This research began with the following question: "*How is the implementation of pricing algorithms facilitating collusive behaviors?".* In order to answer this question, the paper begins with an evaluation of which structural market factors influence collusion, then distinguishes different scenarios in which algorithms are used and the possible enforcement challenges they might bring. The paper recognises two mechanisms through which algorithms are facilitating collusion. Firstly, by allowing companies to react fast to market changes given the ability to create markets with price transparency and high-frequency trading. Secondly, by giving companies the ability to implement common policies, send market signals or optimise joint profits with the aid of deep learning algorithms. Although current competition policy may be prepared to deal with some infringements companies incur using algorithms, it does not seem to be prepared to cover all of them. As mentioned previously, collusive scenarios like *Messenger* and *Hub and Spoke* (Ezrachi & Stucke) are easier to deal with from an enforcement perspective due to the fact that these are the cases in which the algorithms are used for explicit collusion or for price discrimination, respectively.

The issue is dealing with algorithms that lead to collusive arrangements and do not fall within the traditional reach of competition rules on anti-competitive agreements. It is known that tacit collusion is legal, meaning that current competition policy does not prohibit this practice, even though it is undesirable. For tacit collusion to function, transparency of the market, stability of the collusive behaviour and a lack of competitive restraints are essential. Until now, the only market structure which could support tacit collusion was the oligopoly, however, the fact that communication between competitors not allowed makes it harder to sustain such practice. At

this point, it is clear that algorithms can establish some kind of communication and thus have the ability to facilitate tacit collusion, harming consumers and competition, and competition law might not be ready for it. The problem stems from the use of autonomous algorithms, mentioned in cases like the *Predictable Agent* and *Digital Eye* (Ezrachi & Stucke). The unilateral use of the same autonomous algorithm increases transparency, which makes it quicker to observe price and demand changes, and to respond by adjusting prices. Thus, since no humans are directly involved, no agreement or meeting of the minds can be proved. Furthermore, the widespread implementation of these algorithms can lead to a nearly perfectly transparent market, a strong mutual understanding of competitors' actions and highly parallel behaviour. It will also enable companies to retaliate efficiently. Recent cases are online markets which are transparent in ways unimaginable a few years ago. When a vendor raises the price of an item in an online marketplace, his competitors have the ability to find out instantly thanks to all sorts of cookies and monitoring mechanisms incorporated in online technologies.

Competition authorities always had difficulties in prosecuting cases where mutual understanding or conscious parallelism does not reach the level of explicit collusion, lying in the grey area between what is legal and what is not. However, as this paper concluded that algorithms have the power to increase the number of these cases, we make recommendations for changing/adapting how law is enforced. Firstly, the rise of algorithms can be perceived as a way to finally prosecute tacit collusion. Maybe this can be seen as companies "biting their own tail". That is, since some algorithms are created with the potential to help sustain tacit collusion, wouldn't it be wise for competition authorities to use them to go after this practice by denoting algorithms of these nature as a concerted practice? Tacit collusion should be dealt with the same way as explicit collusion, not be legal, when facilitated by algorithms that artificially create market characteristics necessary for collusion, such as transparency and stability of the cartel. In fact, it is known that information exchange can be considered a concerted practice when it

facilitates parallel behaviour by increasing transparency in the market. Knowing that algorithms have also that effect on the market, it makes sense to consider their use also as a concerted practice when the ability to alter market conditions and facilitate coordinated conducts is proved. For that to happen, it is important to have a real-life case to support the position that the anti-competitive effects have a causal link to the use of algorithms. Looking at the case of Partneo, the absence of an agreement between the companies stops authorities to consider the practice illegal. However, the use of the algorithm leads to a parallel price increase on the aftermarket, which significantly harms consumers and takes advantage of the lack of power they have on this market. Even in the absence of information exchange, both companies are able to coordinate prices leading to anti-competitive effects. These are, the same effects that would have happened in the presence of information exchange, but the difference is that in the latter competition authorities would more easily prosecute these companies. In addition, the use of Partneo affects the competition on the primary market, as it creates incentives for dominant firms to decrease prices to capture more market share. In this case enforcers should be able to intervene and prosecute PSA and Renault for the use of an algorithm that allows them to increase the price of spare car parts. This supports the recommendation to consider the use of algorithms, when leading to the same economic effects as the exchange of information, to be considered as concerted practice.

Secondly, it seems reasonable to recommend an improvement of regulatory interventions regarding the use of algorithms by companies. For example, by creating criteria for how algorithms are design that block the access to some market information. It is not the aim (and seems difficult) to completely prevent the use of algorithms given its efficiencies. However, pre-adoption evaluations should be made by independent audit companies in order to understand what are the capabilities of each specific algorithm. For example, tests to verify the responses of the software under changes to market conditions before the company is allowed

to use it. In the case the algorithm is found to tacit collusion and to harm competition, changes should be performed by its creator in order to inhibit it from reacting to particular features or market variables that are necessary to sustain this practice. Regarding the Partneo case, competition authorities could have prevented the use of the software by the carmakers with a pre-evaluation of the effects on the price of the spare car parts.

6. Limitations and Further Steps

6.1. Limiting Innovation

"There is no doubt that automated computer algorithms can be a powerful tool to extract value from the increasing amount of data collected in the digital economy, potentially fostering market efficiency, innovation and even promoting competition." (OECD, 2017). To avoid the issue of algorithmic collusion altogether, one may think about prohibiting the use of self-learning algorithms in general. However, this will eliminate all the efficiency algorithms bring that will not lead necessarily to collusion. Even the recommendation of treating collusion facilitated by some algorithms as explicit collusion and of improving regulation of the use of algorithms by companies, might be perceived as competition policies that limit innovation.

6.2. Who has the intent?

As Mehra (2016) stated, "in dealing with a robo-seller that takes anticompetitive actions there are three choices in attributing responsibility: to the robo-seller itself, to the humans who deploy it, or to no one.". If there is indeed a change in regulation for the use of algorithms, it is important to understand who has the liability for their adoption. As it doesn't make sense to assume no liability: Is it the programmer of the algorithm or is it the company itself, as represented by the robot? Gun manufactures are not usually held responsible for murders made using their guns. It seems reasonable to admit that companies are held responsible for adopting

and using an algorithm for unlawful purposes. However, regarding deep-learning and artificial intelligence some companies might not have enough knowledge to understand how and why that algorithm came to a particular conclusion. In this case, we believe that it is more prudent to recognize that the creator of the software will better understand the capabilities of the algorithm and should be responsible at least for informing about the consequences of its adoption. For now, artificial intelligence has not yet completely removed the need for human intervention, however it is requiring less and less as it evolves. For that reason, it will become more difficult to prove liability for illegal business practices involving these types of technology. Meanwhile, it seems reasonable to evaluate the responsibility case by case.

6.3. Understanding the algorithm

Another limitation that arises regarding the complexity of some algorithms is that competition authorities might as well have difficulties in decoding them. It is crucial that authorities understand the algorithm in order to apply the recommended measures. Thus, some improvement in technologic expertise is necessary in order to analyse the algorithm source code and the way it behaves under various circumstances. However, as Artificial Intelligence is developing further it becomes harder to understand computer's decisions given that these are not always represented in the code. There is a recent example of a Google's program, named AlphaZero, that became known for defeating the world's best chess computer program. What is fascinating is that the computer was not taught to play chess itself, it was only provided with data and the basic rules and ended up learning by itself the optimal strategies in four hours. Its creators themselves were not able to understand why the computer took some decisions. "Starting from random play, and given no domain knowledge except the game rules, AlphaZero achieved within 24 hours a superhuman level of play in the games of chess (…)" (Gibbs Samuel, The Guardian, 2017)

How competition policy will deal with algorithmic decision making and its evolution still requires some investigation. Markets are going through enormous changes and as Margrethe Vestager, Commissioner for Competition, stated "There is a need to start shaping the rules that we need to deal with fair competition in Digital Ages".

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7. Appendices

Appendix 1-Structural Conditions

Relevant factors for collusion		Impact of algorithms on the likelihood of collusion
Structural characteristics	Number of firms	±
	Barriers to entry	±
	Market transparency	+
	Frequency of interaction	+

Legend: + positive impact; - negative impact; ± ambiguous impact.
Source: OECD (2017), "Algorithms and Collusion, Background note by the Secretariat, DAF/COMP(2017)4.

Appendix 2 - Collusive Scenarios

	Agreement	**Intent**
Category 1: *Messenger*	Strong evidence	Limited role
Category 2: *Hub & Spoke*	Mixed evidence	Evidence used to clarify purpose and likely effect
Category 3: *Predictable Agent*	No evidence	Evidence used to show motive and awareness in facilitating tacit collusion
Category 4: *Digital Eye*	No evidence	No evidence

Source: Ezrachi, A., Stucke, M. (2015), Artificial Intelligence and Collusion: When Computers Inhibit Competition, University of Tennessee, Legal Studies Research Paper Series
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Appendix 4

Pictures	Part number	Car model	Technical characteristics	Current French Selling price € (without VAT)	Recommended selling price
	7810K3	C2	Surface : 167,48 cm2	10,54 €	23,68 €
	7810N8	C1	Surface : 167,61 cm2	23,69 €	23,69 €
	7810W1	Nemo	Surface : 202,95 cm2	32,73 €	25,69 €

Source: “How Renault and PSA Peugeot Citroën secretly hiked global cost of spare parts by €1.5bn”. *MediaPart*
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Appendix 3

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PSA Example 4 : Pinion - Consistent price list with benchmark

Pictures	Part number	Car model	Technical characteristics	Current French Selling price € (without VAT)	Recommended selling price after benchmark
	0805F0 Pivot	Partner Tepee	Diameter : 11,6 cm Weight : 488 gr	27,08 €	74,47 €
	0805K0	5008	Diameter : 12,5 cm Weight : 508 gr	22,79 €	77,56 €
	0805H2	Bipper / 3008 / Partner Tepee / 5008 / 407 / 308	Diameter : 13,4 cm Weight : 656 gr	14,42 €	87,49 €
	0805E7	807 / Expert Tepee / 407 / 308	Diameter : 12,8 cm Weight : 747 gr	36,52 €	91,00 €

Price rise proposals made by Accenture for PSA on pinions. © Mediapart/EIC

Source: “How Renault and PSA Peugeot Citroën secretly hiked global cost of spare parts by €1.5bn”. *MediaPart*
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