ALGORITHMIC PRICING & COLLUSION; THE LIMITS OF ANTITRUST ENFORCEMENT

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ABSTRACT

The combination of big data, large storage capacity and computational power has strengthened the emergence of algorithms in making myriads of business decision. It allows business to gain a competitive advantage by making automatic and optimize decision making. In particular, the use of pricing algorithms allows business to match the demand and supply equilibrium by monitoring & setting dynamic pricing. It benefits consumer alike to see and act on fast changing prices. However, on the downside, the widespread use of algorithm in an industry has the effect of altering the structural characteristic of market such as price transparency, high speed trading which increases the likelihood of collusion. The ability of pricing algorithm to solve the cartel incentive problem by quickly detecting and punishing the deviant further strengthen the enforcement of price fixing agreement. In addition, the use of more advance forms of algorithm such as self-learning algorithm allows business to achieve a tacitly collusive outcome in limited market characteristic even without communication between humans. This raises the fundamental challenge for anti-cartel enforcement as the current law in most jurisdictions is ill-equipped to deal with algorithmic facilitated tacit collusion. The legality of tacit collusion is

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questionable primarily because the pricing algorithm has the ability to alter the market characteristics where the tacitly collusive outcome is difficult to achieve; thus widening the scope of the so-called 'oligopoly problem'.

This paper studies the usages of pricing algorithms by business in online markets. In particular, the paper identify the conditions under which the algorithm prices causes the harm to consumers. It seeks to analyze how algorithms might facilitate or even causes the collusive outcome without human interventions. Further, it looks at the legal challenges faced by the competition authorities around the globe to deal with the algorithmic let collusion and examine the various approaches suggested to counter act it.

Keywords: *Big data, algorithm, ill-equipped, transparency, enforcement*

I.   INTRODUCTION

Gone are the days when people traveled from one place to another in search of goods and services. The advent of the internet has not only changed the traditional definition of the economy but also narrowed the world. From daily shopping to wars, the internet has revolutionized each and every aspect of our life, making a mouse click more powerful than the trigger of a gun. This unfettered technological advancement has led to the creation of digital or internet economy where the algorithm is the cynosure of the market.

The combination of big data, large storage capacity, and computational power have further strengthened the emergence of algorithms in making myriads of business decisions. This rise in algorithms has offered many competitive advantages to the business and consumer alike to optimize their decision making. However, at the same time, it has caused novel competition problems. One of the area which receives much attention from Competition authorities across the jurisdictions is algorithmic price-fixing. European Commission sectoral enquiry in e-commerce found that about half of the online retailers uses pricing algorithmic to track the prices of the competitors. While pricing algorithms has offered various benefits allowing

business to monitor prices more efficiently and to respond to changing market dynamics, it has also increased the ability of competitors to achieve novel form of coordination which may go beyond the traditional competition law tools. In this paper, the authors have attempted to identify the condition under which algorithmic pricing might facilitate tacit or express collusion in the markets. Further, it seeks to identify the enforcement challenges and counter-measures.

Part II of the paper document how the rise of algorithms has changed the way human lead their life. It also discusses the rise of pricing algorithms and its benefits to the consumer and business. Part III of the paper seeks to identify the circumstance under which pricing algorithms facilitate express or tacit collusion and whether it required rethinking of competition law framework, while part IV discuss the enforcement challenges and the proposed counter measures. Part V concludes the paper.

II.   THE RISE OF ALGORITHMS & CHANGING MARKET DYNAMICS

The advent of the digital economy has widened the traditional definition of the consumer to include algorithmic consumers.[1] Their life is pedaled by the algorithms, a kind of Artificial intelligence, in an algorithmic-driven economy.[2] From setting an alarm for the next morning to buying t-shirts,the presence of algorithms cannot be overlooked. Their choices, preferences, like, dislike everything is being tracked to determine our future choices.[3] Thus, such deference on algorithms has not only imperiled the privacy aspect of our life but also fettered the way we make our choices. Algorithms are in reality the combination of computer science, mathematics, and the Internet.

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[1] Elkin-Koren, Niva& Gal, Michal, *Algorithmic Consumers*, 30 Harv. J. Law. & Technology 309 (2017)

[2] Minghua He, Nicholas R. Jennings & Ho-Fong Leung, *On Agent-Mediated Electronic Commerce*, 15 IEEE TRANSACTIONS ON KNOWLEDGE & DATA ENGINEERING 985, 985–90 (2003).

[3] Salil K. Mehra, *Antitrust and the Robo-Seller: Competition in the Time of Algorithms*, 100 MINNESOTA L. REV. 26 (2015).

The Algorithm era has bolstered the human's tendency of delegating work and has further increased the need of the Internet in our life.[4]

There is no single definition of algorithms,[5] some define it as a mathematical recipe,[6] whereas some call it a set of specific rules and instructions.[7] In simple words, it's a systematic set of finite rules (inputs) which produce results (output) on the basis of inputs. Algorithms are not a new phenomenon in human's life, they have always existed and were used by humans while making decisions. However, the burgeoning use of the internet and digitalization of economy have changed the way people lead their life and eased the task of decision making by hinging on algorithmic tools. The use of algorithms allows people to save their time and energy for making day-to-day choices.[8] Furthermore, it is also argued that such usage has minimized information and transaction costs thereby improving our decisions making capacity.[9] As algorithms are devoid of human biases, therefore, they are said to be better at decision making.

III. PRICING ALGORITHMS & BENEFITS

Pricing algorithms are the algorithms that use price as an input, and/or uses a computational procedure to determine price as an output.[10] The definition of pricing algorithms includes price monitoring algorithms, price recommendation algorithms, and price-setting algorithms.[11] The data

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[4] Maria Bakardjieva, *The Internet in Everyday Life: Exploring the Tenets and Contributionsof Diverse Approaches*, in THE HANDBOOK OF INTERNET STUDIES 59-82(2009).

[5] Yuri Gurevich, *What is an algorithm?* (16 Feb, 2019; 12:44 PM), https://pdfs.semanticscholar. org/762f/178c7983d7431d04919453c043760d691366.pdf.

[6] N. WIRTH, ALGORITHMS AND DATA STRUCTURES,10-11 (2004).

[7] STEVEN S. SKIENA, THE ALGORITHM MANUAL, 12 (2008).

[8] Peter Georg Picht& Benedikt Freund, *Competition law in the era of algorithms*, (MaxPlanck Institute for Innovation and Competition Research Paper No. 18-10, 2018) https://www.ius.uzh.ch/dam/jcr:e020bc7845b44e27a08d87a5a0ac902b/Picht%20Freund___C ompetition%20law%20in%20the%20era%20of%20algorithms___MPI%20Research%20Paper% 20no%201810___SSRN-id3180550.pdf.

[9] ARIEL EZRACHI, MAURICE E. STUCKE, VIRTUAL COMPETITION THE PROMISE AND PERILS OF THEALGORITHM-DRIVEN ECONOMY, 24 (2016).

[10] Competition and Markets Authority (2018)**,** *Pricing Algorithms*, https://assets.publishing. service.gov.uk/government/uploads/system/uploads/attachment_data/file/746353/Algorithm s_econ_report.pdf.

[11] Id.

required to calculate prices includes factors such as demand of consumers, prices of other competitors, purchase history of consumers and their preferences, past profits/revenue data or cost of production, storage etc.[12]

The advent of big data & analytics, algorithms can monitor prices more efficiently than human being and are able to respond to market changes more quickly and accurately.[13] The increase price transparency reduces search cost thereby enabling consumer to compare price, quality and choose the best.[14] Reducing search cost, low barrier to entry, and increasing information follows can increase the competitive pressure to innovate thereby promising dynamic and allocative efficiency.[15] Search engines, online marketplaces, discount stores, booking agencies, airlines, road transport, and social networks are some market industries which are currently pedaled by such algorithms.[16]

IV. ALGORITHMIC PRICING & COLLUSION

The increased use of algorithms in making pricing decisions has indeed offered many competitive advantages to the business, allowing them to gain efficiency and promoting consumer welfare.[17]At the same time, technological advancement allowed competitors to use pricing algorithms to achieved collusive outcome. The academic literature on the subject has identified two broad ways in which algorithms may be used to reach anti-competitive collusion.[18]*First,* the algorithms are being used to facilitate an already existing price-fixing agreement between competitors. Here algorithms are

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[12] Gintare Surblyte, *Data-Driven Economy and Artificial Intelligence: Emerging Competition Law Issues*, 67 IN: WIRTSCHAFT UND WETTBEWERB (WUW), 120 (2017).
[13] Algorithmic price fixing under EU Competition law: how to crack robot cartel? by INGE GRAEF.
[14] George J. Stigler *The Economics of Information*, 69 J. OF POLITICAL ECONOMY 213—225(1961).
[15] Supra Note 7 at ¶15.
[16] Id.
[17] Elkin-Koren, Niva&Gal, Michal, *Algorithmic Consumers*, 30 HARV. J. LAW. & TECHNOLOGY 309 (2017).
[18] Antonio Capobianco& Pedro Gonzaga, *Algorithms and Competition: Friends or Foes?'*, CPI ANTITRUST CHRONICLE (14 Feb, 2019; 04:51 PM) https://www.competition policyinternational.com/wp-content/uploads/2017/08/CPI-Capobianco-Gonzaga.pdf.

merely employed as intermediary as an extension of human will.[19]*Second,* algorithms are designed in a way to achieve tacitly collusive outcome. Here the unilaterally designed algorithm learns to tacitly collude among themselves in certain limited market characteristic.[20]

The former category is straightforward and there is general consensus among legal practitioners and academician regarding adequacy of current antitrust tools to deal with such anti-competitive collusion. When algorithms are being usedas an extension of human will, such human will is manifests in the concept of 'agreement' recognized in the cartel enforcement. However, the latter category raises many legal challenges for antitrust enforcement. Here advance self-learning algorithms may learn to collude among themselves without human intervention. To date, such an eventuality exists only in theoretical and experimental studies.[21] As Professor Nicolas Petit puts it, "Antitrust and Artificial Intelligence literature is the closet ever our field came to science fiction."[22] Others have even denied the possibility of algorithmic tacit collusion.[23] However, the authors believes that ability of self-learning to reach to a collusive outcome cannot be denied which are beyond the reach of traditional antitrust enforcement.[24]

While algorithms as a tool to facilitate express collusion can be dealt under the available tools, the algorithmic tacit collusion represent the most

[19] Ariel Ezrachi& Maurice E Stucke,*Artificial Intelligence & Collusion: When Computers Inhibit Competition*, 18 (Oxford, Working Paper CCPL (L) Paper no. 40, 2015), http://ssrn.com/abstract=2591874.

[20] Ezrachi, Ariel&Stucke, Maurice E., *Two Artificial Neutral Networks Meet in an Online Hub and Change the Future (Of Competition, Market Dynamics and Society)*, (Oxford Legal Studies Paper No. 24,2017), https://ssrn.com/abstract=2949434.

[21] Ai Deng , *When Machines Learn to Collude: Lessons from a Recent Research Study on Artificial Intelligence*, (17 Feb, 2019; 05:38 PM), https://ssrn.com/abstract=3029662.

[22] Ashwin Ittoo& Nicolas Petit, *Algorithmic Pricing Agents and Tacit Collusion: A Technological Perspective* (21 Feb, 2019; 03: 18 PM), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3046405.

[23] Ulrich Schwalbe,*'Algorithms, Machine Learning, and Collusion'; Thibault Schrepel, Here's why algorithms areNOT (really) a thing, Concurrentialiste*, (16 Feb, 2019; 12:48 PM),http://www.cresse.info/uploadfiles/2017_sps5_pr2.pdf.

[24] Joseph E. Harrington, Jr., *Developing Competition Law for Collusion by Autonomous Artificial Agents* (The Wharton School Working Paper,2018),http://assets.wharton.upenn.edu/~harrij/pdf/Collusion%20and%20Autonomous%20Pricing%20Agents.pdf.

challenging category where competition law tool may not be sufficient. There is debate on the ability of algorithms to reach tacitly collusive outcome.[25] However, this is not subject matter of this paper. In this chapter, the authors will discuss the ways in which algorithms are being employed to reach express or tacit collusion.

V.   ALGORITHMS TO FACILITATE EXPRESS COLLUSION

1.   Monitoring Algorithms

The pricing algorithms are being employed to monitor competitor's action and detecting and punishing any deviant behaviors in order to effectively enforce the cartel agreement. The ability of monitoring algorithms to quickly detect deviation and retaliate immediately reduces the incentive to cheat by individual competitors thereby stabilizing the cartel agreement.Thus, unlike traditional cartels, the use of price monitoring algorithms may makes cartels more durable and easier to sustain.

The role of algorithms in such scenario is merely to facilitating the already existing cartel among humans. The process involves collection of data regarding prices in a easy to use format which can be regularly updated. In online markets, such data is generally available publicly. The use of monitoring algorithms can strengthen the cartels by reducing the chances of errors based on imperfect pricing information. The ease and availability of the mass data collection allows the entities to understand the pricing behaviors of competitors.[26]As a result, colluding companies will be able to increasingly monitor each other's actions using sophisticated algorithms and can detect and deviation from the agreed prices on real-time basis.[27]

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[25] Deng, Ai, *What Do We Know About Algorithmic Tacit Collusion?* (September 16, 2018), 33ANTITRUST 16(2018). https://ssrn.com/abstract=3171315.
[26] Supra Note 10 at ¶15.
[27] ORG. ECON. CORP. DEV., ALGORITHMS AND COLLUSION – BACKGROUND NOTE BY THE SECRETARIAT(2017),https://one. oecd.org/document/DAF/COMP(2017)4/en/pdf.

The use of such price monitoring algorithms to implement cartel agreement may be illustrated by prosecution by United States (US) Department of Justice (DOJ) in the case *U.S. v. David Topkins*, where the parties are involved in horizontal price fixing for the poster sold on the amazon marketplace.[28] The modus operandi was that the parties has adopted specific pricing algorithms which is monitoring the pricing information of the competitors for the purpose of aligning the prices and coordinating any changes to their respective prices.[29] Similarly, in *Trod Ltd/GB eye*,[30] two parties are charged for horizontal price-fixing agreement. The cartel is implemented by using an automated repricing software which monitored and adjusted each other prices to prevent undercutting by each other. The Competition Market Authority, United Kingdom (CMA) found infringement of chapter I of the prohibition on finding clear evidences of communication between parties to use software to police cartel.

From an enforcement perspective, the use of price monitoring algorithms to facilitate a cartel can be prevented by using current antitrust tools. The role of pricing algorithms as a cartel facilitators does not eliminate the need for the explicit communication which is the source of primary illegality.[31] The competition authorities may rely on the case laws related to the concept of agreement or concerted practice to establish the collusion.[32] The stronger the evidence of anti-competitive agreement or communication among competitors, the less the need for the evidence of intent to establish the conduct.[33]

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[28] United States v. Topkins, CR 15–00201 WHO (N.D. Cal. Apr. 30, 2015).

[29] U.S. Department of Justice, *E-Commerce Exec and Online Retailer Charged with Price Fixing Wall Posters* (10 Feb, 2019; 10:29 AM), http://www.justice.gov/opa/pr/e-commerce-exec-and-online-retailer-charged-price-fixing-wallposters.

[30] UK CMA*, Decision of the Competition and Market Authority: Online sales of posters and frames Case 50223,* (10 Feb, 2019; 07:34 PM),https://assets.publishing.service.gov.uk/media/57ee7c2740f0b606dc000018/case-50223-final-non-confidential-infringement-decision.pdf.

[31] George Alon Hay, *Anti-competitive Agreements: The Meaning of 'Agreement*, (Cornell Law Faculty Working Paper No. 105, 2013),http://scholarship.law.cornell.edu/clsops_papers/105.

[32] United States v. Socony-Vacuum Oil Co., 310 U.S. 150, 221 (1940).

[33] Supra Note 9 at ¶52.

2.   Parallel Algorithms

The use of parallel or common algorithms by competitors in the markets may facilitate a horizontal cartel in the market. This conduct is also described as hub & spoke conspiracy.[34] Sustaining a cartel in dynamic markets is laden with enormous difficulties owing to frequent changes in supply and demand and other trading conditions requiring continuous adjustment in pricing and output decisions. In such circumstances, the use of similar algorithms to automatize the pricing decisions of the competitors may help sustaining anti-competitive cartel.[35]Dynamic pricing algorithms are generally used in industries such as hotel booking, transportation and network companies to set the efficient prices by adjusting the constantly changing demand and supply.[36]

As the pricing decisions in the online markets have become dynamic and data driven, there is an increase growth third party companies offering pricing algorithms. For example, Boomerang Commerce is a third party vendor which 'analyzes over 100 discrete data points per SKU, including competitors' prices" to help "retailers re- price millions of products in real-time.[37] It provides various relevant factors to make the pricing decision more efficient. The competitors have greater incentive to use such third party algorithms as it would be too costly or time consuming to develop independent price algorithms. Even if it is developed, it is very difficult to match the specialized sophistication provided by third party vendors.

Having an industry wide use of similar pricing algorithms develop by a third party vendor may help in stabilizing prices. Here the third party vendor

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[34] *Id*, at ¶47.

[35] ORG. ECON. CORP. DEV., ALGORITHMS AND COLLUSION: COMPETITION POLICY IN THE DIGITAL AGE, (2017), http://www.oecd.org/daf/competition/Algorithms-and-colllusion-competition-policy-in-the-digital-age.pdf.

[36] Schumpeter, *"Flexible Figures, A Growing Number of Companies are Using 'Dynamic' Pricing"*, THE ECONOMIST, (12 Feb, 2019; 05:24 PM),www.economist.com/news/business/21689541-growing-number-companies-are-using-dynamic-pricing-flexible-figures.

[37] Boomerang Commerce, *Our Story*, http://www.boomerangcommerce.com /about/.

collects the data from individual competitors to set the optimal pricing. As the vendor has the incentive to maximize the profits of the competitors, each retailer may aware about the potential use of rival data in determining prices. In such circumstances, the third party vendor may become a hub to facilitate the classic hub & spoke conspiracy among the competitors.

However, industry wide use of similar algorithm by a third party vendor*ipso facto* cannot result in a hub & spoke conspiracy leading to horizontal cartel. As U.S. Supreme court noted that "there must be overall awareness about the conspiracy and that each defendant knew or had the reason to believe that their own profits were dependent upon the success of the entire venture"[38] Thus, merely having vertical agreement with the similar third party vendor does raises any anti-competitive concern, the competitors must be aware of the concerted efforts to stabilize the prices.[39] The evidence related to intention of the spokes to communicate or awareness of the conspiracy are relevant.[40]

The use of electronic computer algorithms to facilitate hub & spoke conspiracy was once condemned by Court of Justice of European Union in case of *Eturas& Others*.[41] In this case, Eturas is an online travel booking system developed for the travel agents to book the tickets. The administrator of the system by a notice has imposed a discount cap on the travel agent. The court has presumed the existence of conspiracy among travel agents who are aware of contents of the message unless they publicly distance themselves from implementing the decisions.[42]

Further, the evidence related to the design of the algorithm may be relevant. If algorithm is developed specifically to collude among competitors, an hub &

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[38] Interstate Circuit v. United States, 306 U.S. 208, 227 (1939).
[39] Tesco v. Office of Fair Trading, [2012] CAT 31, para. 57, 58.
[40] Maurice E. Stucke, *"Is Intent Relevant?"* 8 JOURNAL OF LAW, ECONOMICS & POLICY 801 (2012).
[41] Eturas and Others, Case C-74/14 (2016).
[42] Rusu, Catalin S, *'Eturas: Of Concerted Practices, Tacit Approval, and the Presumption of Innocence'*, 7 JOURNAL OF EUROPEAN COMPETITION LAW & PRACTICE 396-398 (2016).

spoke conspiracy can be established. Absent such evidence, the competition authority may look at the adverse effect of vertical agreement under the 'Rule of Reason' analysis.[43]

3.   **Uber's Hub & Spoke Conspiracy**

The growth of digital economy has witness new forms of doing business, innovation and consumer welfare. Online platform in digital markets are often characterized by multi-sidedness, network effect, low sunk cost/operating cost.[44]The success of the online platform such as Amazon, Facebook, Google and Uber has unprecedently changed the market dynamics and has increasingly invited attention of competition authorities.[45] Online platforms may act as a hub in facilitate cartel when competing operator's prices are determined by algorithms provided by platform.

The online taxi aggregators such as Uber & Ola provides classic example of such type of conspiracy. Uber claims that it is merely a technological platform which connects consumer with independent services providers.[46] However, the Uber's business model does not allow individual taxi operator to charge its own prices. The prices charged by competing drivers are determined by an algorithm designed by the Uber on the basis of distance, availability, timeand other undisclosed factors. Uber takes between 20% to 25% commission on the price charged; rest is given to the drivers.[47] According to some, the conduct of drivers to enter into an agreement to determine sale price with Uber, knowing the fact that other driver have

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[43]Gal, Michal, *'Algorithmic-facilitated coordination: Market and Legal Solutions'*, CPI ANTITRUST CHRONICLE, (18 Feb, 2019; 07:41 PM) https://www.competitionpolicy international. com/wp-content/uploads/2017/05/CPI-Gal.pdf.

[44] Newman, John M., *'Complex Antitrust Harm in Platform Markets'*, CPI ANTITRUST CHRONICLE, (14 Feb, 2019; 02:34 PM), https://www.competitionpolicyinternational.com/wp-con tent/uploads/2017/05/CPI-Newman.pdf.

[45] EUCOM., 'Staff Working Document on Online Platforms Accompanying the document Communication of Online Platforms and the Digital Single Market', COM(2016) 288, https://ec.europa.eu/digital-single-market/en/news/commission-staff-working-document-online-platforms.

[46] UBER, *Legal terms and Conditions*, https://www.uber.com/en-IN/legal/terms/in/.

[47] Sarah Ashley O'Brien, *"NYC Uber Drivers Protest Rate Cuts,",*CNN MONEY (1 Feb, 2019; 06:43 PM), http://money.cnn.com/2016/02/01/technology/uber-nyc-protest/index.html?sr= twCNN020116ubernycprotest0317PMVODtopPhoto &linkId=2084963.

entered into a similar arrangement amounts hub & spoke conspiracy leading to horizontal cartel.[48]

Such price fixing by platform hurts the most when the platform achieve a dominant position in the markets. As the market is characterized by the network effect as well as indirect network effect, the market is likely to tip favor of one or few players. When this occurs, the consumer or drivers have no choice but to accede to the conditions such as prices set by platform. As the size and market power of platform increase, the possibility of exploitation by charging supra-competitive prices increases. Here the competition authorities must identify the tipping point at which platform obtain market power and the algorithms can likely increase prices.[49]

The Competition Commission of India (CCI) has recently rejected the similar price-fixing allegation against Uber.[50] The informant alleges that algorithmic pricing adopted by Uber takes away liberty of individual driver to compete with each other thereby amounting to price-fixing. Further, the pricing algorithm artificially manipulates supply and demand thereby guarantees higher fares to the driver who are otherwise compete against each other. However, the commission held that unilateral decision of individual driver to adopt algorithmic pricing determined by Uber does not raises anti-competitive concern without collusion among the drivers. Further, unlike Zomato, Airnub, Amazon, Uber is not merely a platform operator but it is a radio taxi operator owing to control exercised over the operators.[51]

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[48] Chanakya Basa, *Does price fixing, by app based on-demand taxi services pose a competition law concern in India?*, CPI, (11 Feb, 2019; 08:11 PM), https://www.competitionpolicy international.com/does-price-fixing-by-app-based-on-demand-taxi-services-pose-a-competition-law-concern-in-india; Anderson, Mark&Huffman, Max, *'The Sharing Economy Meets the Sherman Act: Is Uber a Firm, a Cartel or Something in Between?'*, (Indiana University H. McKinney School of Law Research Paper No. 8, 2017), https://ssrn.com/abstract=2954632; Lougher, Guy&Kalmanowicz, Sammy, *'EU Competition Law in the Sharing Economy'*, 7 JOURNAL OF EUROPEAN COMPETITION LAW & PRACTICE 87-120(2016).
[49] Ezrachi, Ariel&Stucke, Maurice E., *'Artificial Intelligence & Collusion: When Computers Inhibit Competition'*, Oxford, Working Paper no 40, 2015) http://ssrn.com/ abstract=2591874.
[50] Samir Agarwal v. ANI Technologies Pvt. Ltd., Case No. 37/2018.
[51] Id. *See also, AsociaciónProfesional Élite Taxi v. Uber Systems Spain SL,* C-434/15.

Interestingly, one United States (US) federal district court find the prima facie existence of hub & spoke conspiracy between Uber and its driver to fix the sale prices by using the algorithm designed by Uber.[52]

4.   Algorithms To Facilitate Tacit Collusion

The previous chapter explored the use of algorithms to facilitate an express collusion among humans where it was observed that current antitrust tools are sufficient to cope with such situation. However, with the technological advancement, the rise of the more sophisticated self-learning algorithms allows companies to achieve a tacitly collusive outcome in certain market characteristic without there communication between humans.[53]The risk of algorithmic tacit collusion has been recognized by various competition authorities.[54] As Organization of Economic Cooperation and Development (OECD) roundtable conference on Algorithm & Collusion noted:

> *Firstly, algorithms are fundamentally affecting market condition resulting in high price transparency and high-frequency trading that allows companies to react fast and aggressively. These changes in digital markets, if taken to a certain extend could make collusive strategies stable in virtually any market structure. Secondly, by providing companies with powerful automated mechanism to monitor prices, leaning technique, algorithms might enable firms to achieve the same outcomes of traditional hard core cartels through tacit collusion.[55]*

Tacit collusion represent as the most challenging area for the competition law enforcement. The conduct is legal; however, it harm consumers to the

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[52] Spencer Meyer v. Travis Kalanick, No. 16-2750 (2d Cir. 2017).

[53] Mehra, Salil K., *'Antitrust and the Robo-Seller: Competition in the Time of Algorithms'*, 100MINNESOTA L. REV., 1323–1375 (2016).

[54] OECD, *Algorithms and Collusion - Note by the European Commission*, submitted for the OECD Competition CommitteeHearings on 21-23 June 2017, DAF/COMP/WD(2017) (14 June 2017); *Algorithms and Collusion - Note bythe United States*, submitted for the OECD Competition Committee Hearings on 21-23 June 2017,DAF/COMP/WD(2017)41, at 6 (26 May 2017).

[55] Supra Note 35.

same extent as hardcore price fixing cartel.[56] The conduct occurs in highly concentrated market where the participant recognize their shared economic interest and interdependence with respect to price and output decision and subsequently unilaterally set their prices above the competitive level.[57] The condition under which tacit collusion occurs "need not involve any 'collusion' in the legal sense, and in particular need involve no communication between parties."[58]

To examine the ability to algorithms to facilitate tacitly collusive outcome, it is important to understand the characteristic of markets under which tacit collusion is possible and how algorithms can affect those characteristics. The tacitly collusive outcomes occurs particularly in oligopoly market structure. The characteristic of such markets are: *First*, markets with few competitors involving homogenous products. *Second,* transparent markets where deviation can be punished quickly. *Third,* the markets characterize my high barriers to entry and low buyer power. *Fourth*, large frequency of interaction.[59]

To illustrate this scenario, consider a market with few petrol pump situated close to each other. The products are homogenous so that consumer demand is primarily based on the prices and convenience. Also, the market is sufficiently transparent so that each petrol pump can quickly observed the prices charged by the others. Further market is characterized by high barriers to entry (regulatory and costs) and low buyer power in terms of no substitute for petrol. Such market is highly susceptible to non-competitive tacit collusion. For instance, none of the competitors would have the

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[56] Green, E. J., R. C. Marshall and L. M. Marx, *Tacit Collusion in Oligopoly*, in THE OXFORD HANDBOOK OF INT'L ANTITRUST ECON., (R. D. Blair and D. D. Sokol eds. 2013), https://faculty.fuqua.duke.edu/~marx/bio/papers/tacitcollusion.pdf.

[57] Brooke Group Ltd. v. Brown & Williamson Tobacco Corp., 509 U.S. 209 (1993).

[58] IoannisLiannos and Damien Geradin, *The 'Oligopoly Problem' in EU Competition Law*, in RESEARCH HANDBOOK IN EUROPEAN COMPETITION LAW, (Edward Elgar Publishing, eds., 2013).

[59] J. E. Jr. Harrington, *A Theory of Tacit Collusion*, Economic Working Paper, The John Hopkins University,http://www.tsefr.eu/sites/default/files/medias/stories/SEMIN_11_12/ECONOMIC_THEORY/harrington.pdf.

incentive to discount when price transparency allows competitors to quickly match the prices. Therefore, the increased interdependence left only rational alternative to follow a price leader or to suffer losses. Sufficient transparency and homogeneity tends to create symmetry and allow competitors to predict the behavior more efficiently and reduce strategic uncertainty.

However, real markets often do not characterize by transparency regarding prices or other factors of demand; thus making tacitly collusive outcome difficult to achieve. For instance, in our above example, consider that markets are not transparent and it takes time for the competitors to find out what other competitors are charging and to respond accordingly. The longer time required to respond to market changes increases the incentive to discount and allow competitors to gain image as a discounter. This strategic uncertainty makes tacit collusion unlikely.[60] As an European court noted, "there must be an incentive not to depart from the common policy on the market."[61]

The use of pricing algorithms in such market cause the tacit collusion in a superior manner than human. Here the human unilaterally design algorithms to reflect a pricing strategy which assumes interdependence or is geared to push towards such interdependence.[62] As the legal literature accepts that conscious parallelism can be established unilaterally without communication between competitors,[63] algorithms can help to further stabilize such parallelism even beyond strict oligopoly.[64]

To ability of algorithms to optimizing pricing decisions also increases the price transparency in the market. This coupled with the speed of algorithms

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[60] Edward J. Green, Robert C. Marshall, & Leslie M. Marx, 2, *Tacit Collusion in Oligopoly, in* THE OXFORD HANDBOOK OF INTERNATIONAL ANTITRUST ECONOMICS (Roger D. Blair & D. Daniel Sokol, eds., 2014).

[61] Airtours plc v Commission of the European Communities, Case T-342/99 (2002).

[62] Ezrachi, Ariel &Stucke, Maurice, *Sustainable and Unchallenged Algorithmic Tacit Collusion,* SSRN Electronic Journal(2018).

[63] Eastman Kodak Co. v. Image Tech. Servs. Inc., 504 U.S. 451, 466–67 (1992); Brooke Group Ltd. v. Brown & Williamson Tobacco Corp., 509 U.S. 209 (1993). Also, *see* Phillip E. Areeda, Herbert Hovenkamp& John L. Solow, Antitrust Law, (1998).

[64] Supra Note 62.

in detecting and punishing the deviation foster tacit collusion in concentrated market with homogenous goods. This can be established by two examples. *First,* In 2012, Chile government with the objective of benefit consumers regarding prices required petrol station to post fuel prices on government website and update it regularly. However, an economic study found that such regulation has led to an increase in prices by 10% on average.[65]*Second*, German government with the objective of promoting competition requires five market participant of an oligopoly to post price changes on real time basis and then transferring it to the consumer. Instead of promoting competition, the economic study found that petrol price increased by 1.2 to 3.3 euro cent, and diesel prices by 2 euro cent.[66]

The speed of algorithms to quickly detect and retaliate deviation further causes price signaling more effective. Earlier, the competitors usually signal price increase at least 30 days prior which also subject them to antitrust scrutiny. Now computer with increase ability to observe price and adapt changes can signal price increase to rivals in real time basis. Algorithms may be specifically designed to follow the price leader or to imitate price decision by rivals. Such a unilateral action posit significant challenges to competition law enforcement as it is very difficult to bring them under the ambit of 'agreement' or concerted practice.

To this date, the possibility of such algorithmic tacit collusion exist only in theoretical or experimental studies.[67] The simple 'win-continue lose- reverse' & 'tit-for-tat (price matching algorithms) have shown the capability to collude.[68] In one such experimental study where independently designed algorithms by firm commit to pricing algorithmic to allow it to decode other

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[65] Bundeskartellamt, *Final Report on the Fuel Sector Inquiry*, (May 2011), https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Sector%20Inquiries/Fuel%20 Sector%20Inquiry%20-%20Final%20Report.pdf?__blob=publicationFile&v=14.

[66] Ralf Dewenter, Ulrich Heimeshoff, and Hendrik Lüth, *The Impact of the Market Transparency Unit for Fuels on Gasoline Prices in Germany* (2016), http://www.dice.hhu.de/fileadmin/redaktion/Fakultaeten/Wirtschaftswissenschaftliche_Fakul taet/DICE/Discussion_Paper/220_Dewenter_Heimeshoff_Lueth.pdf.

[67] Ai Deng, *What Do We Know About Algorithmic Tacit Collusion?*,Antitrust, Vol. 33, No. 1 (2018).

[68] Supra Note 10.

pricing and revise it accordingly.[69] It was found out that if customers arrive frequently, and revision opportunities are infrequent, then any equilibrium will have long-industry profits that will be arbitrarily close to monopolistic level.[70]

VI. CHALLENGES & COUNTER MEASURES

Although the pricing algorithms have their own virtues yet their negative impact on the market should be overlooked. As we have seen, complex algorithms allows to achieve novel forms of coordination where the current competition tools may not be sufficient. While the use of algorithms to facilitate an express collusion can be tackled by current antitrust tools, the algorithmic tacit collusion represent the most challenging task before competition authority.

Interestingly, tacitly collusive outcome takes place both at the humans and machine levels. Market participant design machine unilaterally to reflect a interdependent price strategy. At human level, the intent lies in the design of the machine which support conscious parallelism. Algorithmic tacit collusion reflect an artificial alteration of market characteristic viz. market transparency to sustain enhance conscious parallelism. Whether such conduct trigger antitrust intervention? Under the current law as it stands, such anti-competitive intent to enhance tacit collusion cannot be challenged absent illegality of tacit collusion.

Does this calls for revisiting the concept of 'agreement' to include conscious parallelism? This question opens the half a century debate between Richard Posner and Donald Turner. Richard Posner has advocated an approach to widen the scope of agreement to include conscious parallelism. In his words:

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[69] Bruno Salcedo, *Pricing Algorithms and Tacit Collusion* (2016), http://brunosalcedo.com/docs/collusion.pdf.
[70] Id.

> *Tacit collusion is not a unconscious state. If the sales division of a company recommends that it offer a wider variety of products in order to exploit consumer demand more effectively, and the financial division recommends against that course on the ground that it will make it more difficult for the industry to maintain 'healthy' prices, top management can be in no doubt of the significance of its actions if it adopts the financial division's recommendation.[71]*

Similarly, Turner also believes that concept of 'agreement' should not be limited to explicit communication or meeting of mind and it includes the interdependent action of competitors in the market. However, unlike Posner, Turner thought that punishing competitors for independent rational action unlikely to serve any purpose.[72] Later, Posner himself walked back from his argument.[73]

Today, the advent of algorithm has rekindle the debate on the legality of conscious parallelism. The algorithms comes with enhance ability to sustain tacit collusion in a way better than human. At this stage, it is very difficult to conclude that algorithmic tacit collusion should be included in the definition of agreement.

In EU Competition law, the supra-competitive prices as a result of conscious parallelism can be challenged under the collective dominance. The criteria to establish collective dominance includes transparency, easily monitored market, the existence of a 'retaliation' mechanism detaining attempt to unilaterally divert from parallel strategy.[74] This criteria correspond to a market condition resulted through use of pricing algorithms. While the

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[71] Richard A Posner, *Oligopoly and the Antitrust laws: A suggested Approach,* 21 STAN. L. REV. 1562, 1576-92 (1969).

[72] Donald F. Turner *The Definition of Agreement Under the Sherman Act: Conscious Parallelism and Refusal To Deal,* 75 HARV. L. REV. 655, 671 (1962).

[73] Richard Posner, *Review of Kaplow,* Competition Policy and Price Fixing, 79 ANTITRUST L.J. 761, 763 (2014).

[74] Airtours plc v. commission, Case T-342/99; P Bertelsmann AG and Sony Corporation of America v. Independent Music Publishers and Labels Association, Case C-413/06.

United States now considering use of Section 5 of the Federal Trade Commission Act to prohibit unfair competition which may be the result of algorithm design to facilitate tacit collusion.

What about the cases which do not fulfill the above provisions. One of the approaches suggested was to push companies to 'compliance by design'.[75] Here companies would be held liable for designing algorithms which can facilitate information exchange among competitors. However, without a well-developed practice, it is very difficult for competition authority to audit PC algorithms.[76] Other approaches includes to create a new offence. However, it is very difficult to determine what to prohibit. Whether *abuse of excessive transparency* or *algorithmic tacit collusion.*[77]

The competition authorities can also adopts mechanism to prevent the emergence of oligopolistic markets. One of the way is to prohibit combination which can result in emergence of oligopolistic markets which can facilitate conscious parallelism. Competition authorities may also engage in competition advocacy or attempt to remove structural barriers from the markets.

VII. CONCLUSION

Everything has two facades so does algorithms. The computer algorithms have not only changed the way we transact but also redefined the nature of the market. Deliberating upon the oft-debated issues of Conscious parallelism, the authors attempted to show the possible detachment between the actions of algorithms and the human designers.

The economic rationale behind collusion is complex and nuanced and bringing automated pricing algorithms to such scenario further increases the

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[75] Margrethe Vestager, *Algorithms and Competition,* 18th Conference on Competition, Berlin, (Mar. 16, 2017), https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/bundeskartellamt-18th-conference-competition-berlin-16-march-2017_en

[76] OECD, *it's a feature, not a bug: on learning algorithms and what they teach us – note by Avigrdor Gal,* DAD/COMOP/WD(2017)50, (June 7, 2017).

[77] Vaclav Smejkal, *Cartels By Robots-Current Antitrust Law In Search of An Answer*, 4 J. FOR THE INT'L & EUR. LAW. ECONOMICS & MARKET INTEGRATION (2017).

complexity. As such, it is no surprise that there is no simple black and white binary answer of Yes or No to the question of whether the use of automated algorithms will increase the likelihood of collusion. Collusion, whether between human conspirators or among automated pricing algorithms, can and should be analyzed using the economic theory that has been honed and refined over the decades.

The authors in the paper recognized two major mechanisms through which algorithms can challenge antitrust investigators. Firstly, algorithms are fundamentally affecting market conditions, resulting in high price transparency and high-frequency trading that allows companies to react fast and aggressively. These changes in digital markets, if taken to a certain extent, could make collusive strategies stable in virtually any market structure. Secondly, by providing companies with powerful automated mechanisms to monitor prices, implement common policies, send market signals or optimize joint profits with deep learning techniques, algorithms might enable firms to achieve the same outcomes of traditional hardcore cartels through tacit collusion.

Considering the problems discussed above and applying the current antitrust enforcement techniques, it can be validly said that current competition law needs to be revamped in order to assimilate the technical challenges of the 21st century.