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Artificial Intelligence and Anticompetitive Collusion in EU and the U.S.: From the 'Meeting of Minds' towards the 'Meeting of Algorithms'?

Giuseppe Colangelo

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Abstract

Information technology has affected so many aspects of daily life that an algorithmic society is no longer the stuff of science fiction. When it comes to marketplaces and business strategies, it has been observed that a growing number of firms are using algorithms for dynamic pricing, thereby automatically adjusting their prices to changes in market conditions, including rivals' prices. As a result, the diffusion of algorithmic pricing raises concerns for competition policy and the potential for collusion. Furthermore, some policy makers and scholars are questioning the ability of existing antitrust tools to tackle this new form of collusion effectively. Indeed, current EU and US antitrust rules have been designed to deal with human facilitation of coordination requiring some form of mutual understanding among firms ('meeting of the minds'). However, according to one strand of literature, algorithms could coordinate independently of human intervention and even autonomously learn to collude. Against this background, this paper aims to investigate whether current antitrust rules are suited to confronting these new challenges, whether algorithmic interactions ('meeting of algorithms') could be treated in a way similar to a 'meeting of minds', and whether new regulatory tools are needed.

Keywords: Artificial Intelligence; Algorithms; Antitrust; Collusion

JEL Codes: D43; L13; L41

Contents

1. Introduction.

Within the mass of literature devoted to describing and analyzing the impact of artificial intelligence (AI) in the modern economy and society, a significant part consists of studies addressing the use of algorithms by firms to predict market trends, customize services, and set prices. The potential of prediction machines is considered immense and their success depends on training data, i.e. the inputs needed in order to start getting reasonable outcomes, and feedback data which is obtained by mapping actual outcomes to the input data that generated predictions of those outcomes and enables an algorithm to make better predictions over time.[1] By incorporating feedback data, prediction machines are able to learn from outcomes, hence improving the quality of their next prediction.

We live in the age of algorithms. Indeed, decision-making is increasingly transferred to algorithms. As consumers, we are surrounded by connected devices that make independent decisions and are guided by digital personal assistants. Hence, we should understand how their computational processes works[2] and probably react by becoming algorithmic consumers.[3] On the supply side, the widespread use of algorithms is also affecting the competitive landscape in which firms operate.[4] According to the European Commission's report on the e-commerce sector, a growing number of firms are using algorithms to dynamically price their products, namely to track the online prices of

[1] Ajay Agrawal, Joshua Gans, and Avi Goldfard, 'How to Win with Machine Learning', (2020) Harvard Business Review <https://hbr.org/2020/09/how-to-win-with-machine-learning> accessed 3 September 2020.
[2] Avigdor Gal, 'It's a Feature, not a Bug: On Learning Algorithms and what they teach us', (2017) Background note, OECD Roundtable on Algorithms and Collusion <www.oecd.org/daf/competition/algorithms-and-collusion.htm> accessed 28 August 2020.
[3] Michal S. Gal and Niva Elkin-Koren, 'Algorithmic Consumers', (2017) 30 Harvard Journal of Law and Technology 309.
[4] OECD, 'Algorithms and Collusion: Competition Policy in the Digital Age', (2017) <www.oecd.org/competition/algorithms-collusion-competition-policy-in-the-digital-age.htm> accessed 28 August 2020.

competitors and automatically adjust their own prices according to the observed prices of the latter.[5]

Along with significant benefits and efficiencies, the wide-scale use of algorithms, in particular those used for dynamic price setting, raises competition concerns.[6] Notably, pricing software may facilitate collusive outcomes and even lead to new form of collusion. In particular, pricing algorithms may make explicit collusive agreements more stable, by making it easier to monitor prices, thereby limiting the incentives to deviate and helping to detect deviations, and they may promote new forms of tacit collusion by triggering automatized coordination independent of any human intervention and even autonomously learn to undertake collusive strategies (so-called algorithmic collusion).

Indeed, pricing algorithms show different levels of sophistication ranging from those designed to follow parameters chosen by humans to more advanced types which, rather than being programmed to solve a specific problem, learn from data and use the features at their disposal to perform a task (self-learning algorithms).[7] Within the latter scenario,

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[5] European Commission, 'Final report on the E-commerce Sector Inquiry', COM(2017) 229 final, para. 13. See also UK Competition and Markets Authority, Pricing Algorithms, (2018) 17-18 <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746353/Algorithms_econ_report.pdf> accessed 29 August 2020, founding that pricing algorithms have become prevalent within some online retail markets: "Not only are large retailers such as Amazon taking advantage of algorithms to re-price their goods, but so are smaller online retailers"; and Portuguese Competition Authority, 'Digital ecosystems, Big Data and Algorithms', (2019) 43-45 <http://www.concorrencia.pt/vPT/Estudos_e_Publicacoes/Estudos_Economicos/Outros/Documents/Digital%20Ecosystems,%20Big%20Data%20and%20Algorithms%20-%20Issues%20Paper.pdf> accessed 1 September 2020, reporting that 37% of firms are using monitoring algorithms and 47.4% of firms systematically track the online prices of their competitors. Among the inquired firms that reported using software to systematically track the online prices of their competitors, 78.6% noted they adjust their prices in responses to changes in the online prices of their competitors. However, only 7.9% of the inquired firms reported using software that sets prices automatically.

[6] European Commission (n 5) paras. 13 and 33.

[7] Gal (n 3); UK Competition and Markets Authority (n 5) 9-12. See also Autorité de la Concurrence and Bundeskartellamt, 'Algorithms and Competition', (2019) 9-11 <https://www.bundeskartellamt.de/SharedDocs/Meldung/EN/Pressemitteilungen/2019/06_11_2019_Algorithms_and_Competition.html> accessed 1 September 2020, distinguishing between fixed algorithms and self-learning algorithms; and Spanish National Commission on Markets and Competition and Catalan Competition Authority, 'Artificial Intelligence and Competition', (2020) 8-9 <http://acco.gencat.cat/web/.content/80_acco/documents/arxius/actuacions/20200930_CNMCS-AND-

three categories of machine learning algorithms have commonly been identified, distinguishing between supervised and unsupervised learning, and reinforcement learning. While, in the first two cases, algorithms are provided with a static training set of data (in the supervised learning, the dataset is also annotated with correct answers), reinforcement learning algorithms rely on a process of experimentation receiving feedback from a model of the environment. A specific class of reinforcement learning algorithms are Q-learning algorithms which select the optimal policy learned from their previous actions (trial-and-error process), with no environment model.

Because antitrust rules have been designed to deal with human facilitation of coordination, they require some form of mutual understanding among firms ('meeting of the minds') and focus on the means of communication used by players in order to coordinate. Mere interdependent conduct or collusion without communication (conscious parallelism) is lawful. Hence, competition policy has traditionally struggled with tacit collusion. The main concern is that algorithms (in particular, self-learning algorithms) may amplify the oligopoly problem, expanding the grey area between unlawful explicit collusion and lawful tacit collusion.[8] Indeed, Q-learning algorithms are expected to expand this blind spot by coordinating independently of human intervention and even autonomously learning to collude without communicating with one another.[9]

ACCOS-JOINT-CONTRIBUTION-TO-THE-PUBLIC-CONSULTATION-ON-AI.pdf> accessed 30 September 2020.

[8] OECD (n 4) 25 and 34-36.

[9] Emilio Calvano, Giacomo Calzolari, Vincenzo Denicolò, and Sergio Pastorello, 'Artificial Intelligence, Algorithmic Pricing and Collusion', (2019) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3304991> accessed 2 September 2020; Emilio Calvano, Giacomo Calzolari, Vincenzo Denicolò, and Sergio Pastorello, 'Algorithmic Pricing: What Implications for Competition Policy?', (0291) 55 Review of Industrial Organization 1. See also Zach Y. Brown and Alexander MacKay, 'Competition in Pricing Algorithms', (2020) Harvard Business School Working Paper No. 67, <https://hbswk.hbs.edu/item/competition-in-pricing-algorithms> accessed 2 October 2020, arguing that algorithmic pricing may meaningfully increase prices even in markets with several firms in competitive equilibrium, hence if policymakers are concerned that algorithms will raise prices, then the concern is much more broad than that of collusion; Karsten Hansen, Kanisha Misra, and

Against this background, the risks posed by algorithmic collusion have fueled a lively debate. Two approaches have emerged. Some scholars consider AI collusion to be a realistic scenario and question the ability of current antitrust rules to deal with algorithmic-facilitated coordination.[10] In a world that has dispensed with the need for meetings, conversations, and price announcements, current antitrust rules appear unfit to detect and challenge these new forms of collusion.[11] In short, as tragically foreseen by Ezrachi and Stucke, the increasing use of algorithms will disrupt antitrust law, eventually leading to the end of competition as we know it.[12]

Other scholars point to the lack of evidence, downplaying algorithmic collusion as merely speculative, and consider this scenario to be based on strict underlying assumptions,

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Mallesh Pai, 'Algorithmic Collusion: Supra-competitive Prices via Independent Algorithms', (2020) CEPR Discussion Paper Series No. DP14372, suggesting that collusion is likely even when algorithms do not observe each other's prices; and Timo Klein, 'Autonomous algorithmic collusion: Q-learning under sequential pricing', (2018) Amsterdam Center for Law & Economics Working Paper No. 05, <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3195812> accessed 3 September 2020.

[10] See, e.g., Ibrahim Abada and Xavier Lambin, 'Artificial intelligence: Can seemingly collusive outcomes be avoided?', (2020) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3559308> accessed 4 October 2020; Stephanie Assad, Robert Clark, Daniel Ershov, and Lei Xu, 'Algorithmic Pricing and Competition: Empirical Evidence from the German Retail Gasoline Market', (2020) CESifo Working Paper No. 8521 <https://www.cesifo.org/en/publikationen/2020/working-paper/algorithmic-pricing-and-competition-empirical-evidence-german> accessed 10 September 2020; Francisco Beneke and Mark-Oliver Mackenrodt, 'Artificial Intelligence and Collusion', (2019) 50 IIC 109; Emilio Calvano, Giacomo Calzolari, Vincenzo Denicolò, Joseph E. Harrington, and Sergio Pastorello, 'Protecting consumers from collusive prices due to AI', (2020) 370 Science 1040; Ariel Ezrachi and Maurice Stucke, *Virtual Competition: The Promise and Perils of the Algorithm-Driven Economy*, (2016) Harvard University Press; Michal S. Gal, 'Algorithms as Illegal Agreements', (2019) 34 Berkeley Technology Law Journal 67; Joseph E. Harrington, 'Developing Competition Law for Collusion by Autonomous Price-Setting Agents', (2018) 14 Journal of Competition Law and Economics 331; Andreas Heinemann and Aleksandra Gebicka, 'Can Computers Form Cartels? About the Need for European Institutions to Revise the Concertation Doctrine in the Information Age', (2016) 7 Journal of European Competition Law & Practice 431; Janusz Maylahn and Arnoud den Boer, 'Learning to collude in a pricing duopoly', (2020) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3741385> accessed 4 December 2020; Salil K. Mehra, 'Antitrust and the Robo-Seller: Competition in the Time of Algorithms', (2016) 100 Minnesota Law Review 1323; Alena Spiridonova and Edvardas Juchnevicius, 'Price algorithms as a threat to competition under the conditions of digital economy: Approaches to antimonopoly legislation of BRICS countries', (2020) 7 BRICS Law Journal 94; Guan Zheng and Hong Wu, 'Collusive Algorithms as Mere Tools, Super-Tools or Legal Persons', (2019) 15 Journal of Competition Law & Economics 123.

[11] Gal (n 10) 116.

[12] Ezrachi and Stucke (n 10).

hence very difficult to achieve.[13] From this perspective, the expanding use of algorithms raises issues familiar to antitrust enforcers that are well within the existing canon. As argued by Maureen Ohlhausen, former US FTC Commissioner, "there is nothing inherently suspect about using computer algorithms to look carefully at the world around you before participating in markets. So, from my perspective, if conduct was unlawful before, using an algorithm to effectuate it will not magically transform it into lawful behavior. Likewise, using algorithms in ways that do not offend traditional antitrust norms is unlikely to create novel liability scenarios."[14]

Somehow, between these two approaches, policy makers and competition authorities have so far endorsed a wait-and-see approach. According to the UK Competition and Markets Authority (CMA), the mechanisms by which algorithms could have an additional impact beyond traditional risk factors are quite speculative and algorithmic pricing is more likely to exacerbate 'traditional' risk factors (such as transparency and the speed of price setting), thereby facilitating collusion in markets which are already susceptible to human coordination.[15] In a similar vein, the French and German antitrust authorities, as well as the UK Digital Competition Expert Panel, have concluded that, in the situations

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[13] See, e.g., Axel Gautier, Ashwin Ittoo, and Pieter Van Cleynenbreugel, 'AI algorithms, price discrimination and collusion: a technological, economic and legal perspective', European Journal of Law and Economics (forthcoming); Ashwin Ittoo and Nicolas Petit, 'Algorithmic Pricing Agents and Tacit Collusion: A Technological Perspective', in *L'intelligence artificielle et le droit* (H. Jacquemin and A. De Streel, eds.), Bruxelles, Larcier (2017), 241; Justin Johnson and Daniel Sokol, 'Understanding AI Collusion and Compliance', forthcoming in *Cambridge Handbook of Compliance* (Daniel Sokol & Benjamin van Rooij, eds.); Nicolas Petit, 'Antitrust and Artificial Intelligence: A Research Agenda', (2017) 8 Journal of European Competition Law & Practice 361; Thibault Schrepel, 'Collusion by Blockchain and Smart Contracts', (2019) 33 Harvard Journal of Law & Technology 117; Ulrich Schwalbe, 'Algorithms, Machine Learning, and Collusion', (2019) 14 Journal of Competition Law & Economics 568.

[14] Maureen K. Ohlhausen, 'Should We Fear The Things That Go Beep in the Night? Some Initial Thoughts on the Intersection of Antitrust Law and Algorithmic Pricing', (2017) 11 <https://www.ftc.gov/public-statements/2017/05/should-we-fear-things-go-beep-night-some-initial-thoughts-intersection> accessed 1 September 2020. See also Lea Bernhardt and Ralf Dewenter, 'Collusion by code or algorithmic collusion? When pricing algorithms take over', (2020) 16 European Competition Journal 312; and Pieter Van Cleynenbreugel, 'Article 101 TFEU's Association of Undertakings Notion and Its Surprising Potential to Help Distinguish Acceptable from Unacceptable Algorithmic Collusion', (2020) 65 Antitrust Bulletin 423.

[15] UK Competition and Markets Authority (n 5) 48.

considered so far, the current legal framework is sufficient to tackle possible competitive concerns, without disregarding the possibility of revising the antitrust toolkit and regime should further evidence of algorithmic collusion emerge.[16] In brief, this approach is expressed well by Margrethe Vestager, the Executive Vice-President of the European Commission in charge of antitrust rules and digital policy: "It's true that the idea of automated systems getting together and reaching a meeting of minds is still science fiction. ... But we do need to keep a close eye on how algorithms are developing ... so that when science fiction becomes reality, we're ready to deal with it."[17]

Nonetheless, a few months ago the European Commission published an open public consultation on the need for a possible new competition tool that, among several policy options, would allow it to intervene when a structural lack of competition prevents the market from functioning properly, such as oligopolistic market structures with an increased risk for tacit collusion, including markets featuring increased transparency due to algorithm-based technological solutions.[18]

Against this backdrop, the paper aims to address this controversial issue, investigating whether current antitrust rules are suited to facing new challenges posed by AI, whether algorithmic interactions ('meeting of algorithms') could be treated similarly to a 'meeting of minds' or whether new regulatory tools are needed.

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[16] Autorité de la Concurrence and Bundeskartellamt (n 7); UK Digital Competition Expert Panel, 'Unlocking digital competition', (2019) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/785547/unlocking_digital_competition_furman_review_web.pdf> accessed 2 September 2020.

[17] Margrethe Vestager, 'Algorithms and Competition', (2017) remarks at the Bundeskartellamt 18th Conference on Competition <https://ec.europa.eu/competition/speeches/index_theme_17.html> accessed 1 September 2020.

[18] European Commission, 'New Competition Tool', Inception impact assessment, (2020) <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12416-New-competition-tool> accessed 1 September 2020.

The work is structured as follows. Section 2 illustrates the economic and legal framework for understanding collusion. Section 3 sets the scene, describing different collusive scenarios in which algorithms may play a role and potential challenges for competition policy. Section 4 analyzes approaches and solutions to address risks posed by algorithmic collusion. Section 5 concludes by arguing that existing antitrust rules are still fit for the task.

2. Collusion: economic theory and antitrust rules.

Collusion is commonly described as any form of agreement among rivals to maximize joint profits by coordinating prices and output. Indeed, while a monopolistic firm may unilaterally maximize its profits, in an oligopolistic market the profit maximization strategy requires a joint effort and certain conditions which facilitate coordination among competing firms.

As game theory has demonstrated, since firms' decisions are interdependent in an oligopolistic scenario, a collusive outcome may be achieved not only through explicit agreements, but also tacitly, with each participant deciding its own strategy independently of its rivals. However, despite firms being aware of their mutual interdependence in an oligopolistic market, the cooperative strategy is threatened by strategic behaviors because each player has an incentive to cheat and deviate from the common policy by undercutting rivals' prices. Therefore, the collusive equilibrium is the result of a reward-punishment scheme, meaning that, if oligopolistic players want to maximize their profits, they need not only to share a common policy, but also to safeguard the agreement by monitoring each participant's adherence to it and by punishing any deviations. Some factors and

market conditions can support the stability of collusive equilibrium over time, such as market concentration, the existence of barriers to entry, firms' cost structures and market shares, product differentiation, demand patterns and depressed market conditions, the interaction frequency, and the degree of market transparency.[19]

Against this backdrop, antitrust law challenges the means used by market players to reach a collusive outcome, rather than prohibiting collusion as such. Notably, the European Article 101 TFEU refers to agreements between undertakings, decisions by associations of undertakings and concerted practices, while Section 1 of the US Sherman Act applies to every contract, combination in the form of trust and conspiracy. Instead of providing a precise definition of agreement, the rationale is to include different forms of coordination in order to distinguish between joint conduct and independent behavior. Indeed, autonomous parallel behavior resulting from awareness of oligopolistic interdependence (so-called conscious parallelism) is not prohibited because antitrust rules do "not deprive economic operators of the right to adapt themselves intelligently to the existing and anticipated conduct of their competitors."[20]

Therefore, the case law has clarified that, irrespective of the form, the existence of an agreement requires "a concurrence of wills" on the implementation of a policy, "the pursuit of an objective, or the adoption of a given line of conduct on the market," the form in which it is manifested being unimportant so long as it constitutes the faithful expression

[19] However, see Luke Garrod and Matthew Olczak, 'Explicit vs tacit collusion: The effects of firm numbers and asymmetries', (2018) 56 International Journal of Industrial Organization 1, finding that cartels are less likely to arise in markets with a few symmetric firms.

[20] EU Court of Justice, 16 December 1975, Joined Cases 40-48, 50, 54-56, 111, 113 and 114/73, *Suiker Unie v. Commission,* para. 174. See also EU Court of Justice, Joined Cases C-89, 104, 114, 116-117, 125-129/85, *Ahlström Osakeyhtiö v. Commission* (*Wood Pulp*). On the US side, see *Bell Atl. Corp. v. Twombly*, 550 U.S. 544, 601-602 (2007).

of the parties' intention,[21] or a "meeting of minds", "a unity of purpose or a common design and understanding," as well as "a conscious commitment to a common scheme".[22] Furthermore, in the EU the concept of concerted practices has been introduced, defined as any direct or indirect contacts intended to influence the conduct of other firms, with the aim of filling potential gaps by precluding coordination between firms which, "without having reached the stage where an agreement, properly called, has been concluded, knowingly substitutes practical co-operation between them for the risks of competition."[23] As clarified by courts, the concepts of agreements and concerted practices are intended to catch forms of collusion having the same nature which are distinguishable from each other only by their intensity and the forms in which they manifest themselves.[24] Moreover, in order to tackle forms of coordination which are intermediate between agreements and conscious parallelism, courts have intervened in cases of plus factors and facilitating practices (such as price announcements and information exchanges), i.e. elements which may work as indirect indications of an agreement suggesting that firms have not acted independently because either the parallel conduct seems unnatural or it has been facilitated.

Nonetheless, given that under certain conditions oligopolists can coordinate their business behaviors without entering into an arrangement, antitrust authorities have traditionally struggled with tacit collusion. Therefore, in order to address the oligopoly problem, the very notion of agreement has been questioned because it is deemed to be too formalistic, is hard to make operational, and is unconnected with the modem theory of oligopoly.

[21] EU General Court, 26 October 2000, Case T-41/96, *Bayer AG v. Commission*, paras. 69 and 173. See also EU General Court, 3 December 2003, Case T-208/01, *Volkswagen AG v. Commission.*
[22] *Interstate Circuit Inc. v. U.S.*, 306 US 208, 810 (1939); *American Tobacco Co. v. U.S.*, 328 U.S. 781, 809–10 (1946); *Monsanto Co. v. Spray- Rite Service Corp.*, 465 U.S. 752, 768 (1984).
[23] EU Court of Justice, 14 July 1972, Cases C-48, 49, 51-57/69, *ICI v. Commission (Dyestuff).*
[24] EU Court of Justice, 4 June 2009, Case C-8/08, *T-Mobile Netherlands and others v. NMa*, para. 23.

Notably, it has been suggested that the agreement requirement be reformed by interpreting it as applicable to all interdependent behavior that is successful in producing oligopoly prices.[25] After all, as argued by Kaplow, "successful interdependent coordination that produces supra-competitive pricing leads to essentially the same economic consequences regardless of the particular manner of interactions that generate this outcome."[26]

Against this background, it comes as no surprise that the expanding use of algorithms in business decision-making has reinvigorated the debate about the need to revisit the notion of agreement. Indeed, according to one strand of literature, algorithms are expected not only to increase the likelihood of collusion by affecting some factors and market conditions and making collusive agreements more stable and easier to sustain, but also to learn autonomously over time to collude, rather than being mere tools in human hands. If this scenario were realistic, algorithmic collusion would amplify the oligopoly problem, widening the cases of tacit collusion or consciously parallel behavior that fall outside the reach of current antitrust provisions.

3. Algorithms in action: scenarios and challenges for competition policy.

As previously mentioned, the first and most common hypothesis attributes to algorithms the ability to influence the implementation of collusion, making collusive agreements more stable, regardless of whether they are explicit or tacit. Notably, the use of algorithms may affect those factors and market conditions identified in economic literature as

[25] Louis Kaplow, 'On the Meaning of Horizontal Agreements in Competition Law', (2011) 99 California Law Review 683.
[26] Kaplow (n 25) 686.

favorable parameters for supporting the collusive equilibrium reached by rival companies.[27]

Regarding market structure, algorithms can reduce coordination costs, facilitating collusion even in less concentrated markets, thereby making the number of firms in the market a less relevant factor. Further, by collecting and analyzing large amounts of data quickly and in real-time, algorithms are going to increase market transparency, thereby facilitating the detection of deviations. Moreover, the speed in processing market data will also increase the frequency of interactions enabling rapid and effective punishments of deviations through fast price adjustments. The effect on entry barriers is instead considered ambiguous because while the possibility of implementing dynamic and personalized pricing strategies due to algorithms may on the one hand decrease entry barriers, the need to feed algorithms with a huge amount of information may on the other hand increase these barriers.

However, there are also countervailing effects. Indeed, the innovative nature of algorithms may reduce the homogeneity of products and services offered and allow companies to develop new business models, thereby increasing asymmetries among market players and making their alignment of incentives harder to achieve and sustain. As a consequence, the collusive equilibrium and stability would be negatively affected.

Against this backdrop, several scenarios may emerge.

First, algorithms can be used as tools to implement and facilitate explicit collusion by either acting as messengers among companies, enabling the alignment of their market behaviors without recourse to conventional means[28] or monitoring their conduct to

[27] Autorité de la Concurrence and Bundeskartellamt (n 7) 17-19; OECD (n 4) 20-24.
[28] Ezrachi and Stucke (n 10).

enforce a collusive agreement, also enabling a rapid reaction in the case of deviations.[29] In this scenario, algorithms may further support the stability of an explicit collusive agreement by making it easier to detect and respond to deviations, and by reducing the chance of errors and agency slack, which occur when, despite an agreement having been reached among senior managers within a firm, salespeople and employees may have incentives to undermine the cartel.[30]

This possibility of collusion has been addressed with real-world cases. Indeed, antitrust authorities have detected implemented cartels thanks to the use of dynamic pricing algorithms, i.e., software designed to monitor market changes and automatically react, adjusting conspirators' prices in order to avoid eventual undercuts.

Notably, the US Department of Justice in *Topkin*[31] and the UK CMA in *Trod*[32] found evidence of anti-competitive arrangements concerning retail sales of posters and frames sold on Amazon marketplace, which were implemented by the use of automated repricing software configured to automatically adapt prices, making sure that each company was not undercutting the other. As noted by the CMA, while repricing software is normally used by online sellers to compete with other online sellers by automatically adjusting the prices of their products in response to the live prices of rivals' products, in the case in question the repricing software was configured by the conspirators to restrict price competition between them in order to give effect to the collusive agreement.[33] More

[29] Autorité de la Concurrence and Bundeskartellamt (n 7) 27-30; OECD (n 4) 26; UK Competition and Markets Authority (n 5) 22-23.
[30] UK Competition and Markets Authority (n 5) 23.
[31] U.S. Department of Justice, 6 April 2015, *U.S. v. David Topkin* <https://www.justice.gov/atr/case/us-v-david-topkins> accessed 3 September 2020.
[32] UK Competition and Markets Authority, 12 August 2016, Case 50223, *Online sales of posters and frames* <https://www.gov.uk/cma-cases/online-sales-of-discretionary-consumer-products> accessed 3 September 2020.
[33] UK Competition and Markets Authority (n 32) para. 5.47.

recently, the European Commission fined four consumer electronics manufacturers (Asus, Denon & Marantz, Philips, and Pioneer) for imposing fixed or minimum resale prices on their online retailers, taking advantage of the use of pricing algorithms to monitor and automatically adapt retail prices to those of competitors.[34] As a result, the pricing restrictions imposed on low pricing online retailers had a broader impact on overall online prices for the respective consumer electronics products and the use of sophisticated monitoring tools also allowed the manufacturers to effectively track resale price setting in the distribution network and to intervene swiftly in the case of price decreases.

Because in this scenario the algorithms play a secondary role, serving as a mere tool to facilitate and enforce an explicit coordination already established between humans, it is not problematic for antitrust authorities to evaluate this conduct within the standard definition of agreement and concerted practice.

However, pricing algorithms may also lead to tacit coordination and may extend tacit collusion beyond the boundary of oligopoly. In particular, the collusive outcome may be reached via third party algorithms, companies could unilaterally use algorithms to facilitate conscious parallelism, and finally, self-learning algorithms may even autonomously collude.[35]

[34] European Commission, 24 July 2018, Cases AT.40465 (*Asus*), AT.40469 (*Denon & Marantz*), AT.40181 (*Philips*), AT.40182 (*Pioneer*).

[35] Ezrachi and Stucke (n 10) have labeled these scenarios as "Hub and Spoke", "Tacit Collusion on Steroids – The Predictable Agent", and "Artificial Intelligence, God View, and the Digital Eye", respectively. See Joseph E. Harrington, 'Third Party Pricing Algorithms and the Intensity of Competition', (2020) <https://ase.uva.nl/binaries/content/assets/subsites/amsterdam-school-of-economics/2020/harrington-2020-third-party-pricing-algorithm-and-the-intensity-of-competition.pdf> accessed 4 December 2020, showing that third party development of a pricing algorithm has an anticompetitive effect even when only one firm in a market adopts it.

Under the first hypothesis, competitors adopt the same algorithmic pricing model and third-party providers of algorithm services act as a hub in a so-called hub-and-spoke scenario, allowing coordination without the need for direct communication or contact between the companies. Hub-and-spoke arrangements are triangular schemes combining vertical relationships with a hidden horizontal one, namely a cartel in which the facilitating firm (the hub) organizes a collusive outcome (the rim) among firms acting at one level of the supply chain (the spokes) through vertical restraints. In the algorithmic landscape, French and German antitrust authorities have distinguished between alignment at code level and alignment at data level.[36] The former could arise if companies delegate their strategic decisions to a common third party who acts using an algorithm. The latter could involve rivals using the algorithm as a means for an information exchange or a software supplier causing an alignment of input data by relying on a common data pool between competitors.

The UK CMA has considered the hub-and-spoke conspiracy scenario as the most immediate risk.[37] Nonetheless, it poses competition issues that could be addressed under existing antitrust rules. Notably, according to the case law, because it is the rim that connects the spokes, proof of a hub-and-spoke cartel requires evidence of a horizontal

[36] Autorité de la Concurrence and Bundeskartellamt (n 7) 31-42.
[37] UK Competition and Markets Authority (n 5) 31. Further, the Spanish Competition Authority is currently investigating a possible case of algorithmic collusion in the real estate brokerage market (Press Release, (2020) <https://www.cnmc.es/sites/default/files/editor_contenidos/2020219%20NP%20Intermediation%20Market%20EN_.pdf> accessed 30 September 2020): in this case, coordination would have been implemented through the use of software and computer platforms and would have been facilitated by companies specializing in computer solutions through the design of the property management software and its algorithms.

agreement among the spokes (the so-called rim requirement), the level of knowledge required by the spokes being under discussion, i.e., awareness or just foreseeability.[38]

Nonetheless, two additional hypotheses appear more troublesome from the perspective of the antitrust enforcement. Notably, companies may unilaterally design pricing algorithms to react to rivals' pricing or may rely on algorithms which, learning by themselves, may arrive at tacit coordination without the need for any human intervention and without communicating with one another. In the former case, because algorithms have been designed to respond intelligently to the conduct of competitors, the mere interaction of algorithms increases the likelihood of reaching a conscious parallelism, without requiring companies to engage in any communication.[39] Hence, the question for antitrust enforcers is whether this algorithmic interaction may constitute a form of coordination (algorithmic communication), facilitated for instance by signaling practices (i.e. announcing the intent to change a relevant parameter of competition, such as the price). In the latter case, because there is no human intervention and no communication between algorithms, the possibility of attributing their conduct to a firm may even be questioned.

However, algorithms may also bring pro-competitive benefits.[40] Notably, algorithms promote both static and dynamic efficiencies, enabling firms to reduce transaction costs and costs of production, and promoting the improvement of existing products and services and the development of new ones. Further, on the demand side, by providing more information and bringing new tools, algorithms empower consumers, fostering their

[38] See, e.g., EU Court of Justice, 21 January 2016, Case C-74/14, *Eturas UAB and others v. Lietuvos Respublikos konkurencijos taryba*; *United States v. Apple, Inc.* (*The eBook* Case), 791 F.3d 290 (2nd Cir. 2015).
[39] See Vestager (n 17) considering the challenges that automated systems create "very real."
[40] OECD (n 4) 14-15; UK Competition and Markets Authority (n 5) 20-21. UK Competition and Markets Authority, 'Algorithms: How they can reduce competition and harm consumers', (2021) <https://www.gov.uk/government/publications/algorithms-how-they-can-reduce-competition-and-harm-consumers> accessed 20 January 2021.

engagement, raising their awareness and making them conscious decision-makers in the markets. Finally, algorithmic systems can even be used to detect collusion between firms to ensure competitive prices.

On efficiency grounds, in the *Webtaxi* decision the Luxembourg Competition Authority has recently exempted an agreement under which taxi operators jointly determined the fares for their services via an algorithm provided by a booking platform which took into account certain parameters (e.g., distance, traffic conditions, price per kilometer).[41] The antitrust authority stated that efficiencies resulting from the use of the algorithmic pricing model outweighed anti-competitive restrictions. In particular, while the latter were considered limited since the combined market shares of the taxi operators involved were below a 30% threshold, the benefits resulting from a more efficient allocation of resources were significant because operators were able to adapt the supply in peak and off-peak hours, thereby reducing the number of empty rides and, consequently, also cutting pollution, and customers enjoyed a uniform and centralized offer of services available on 24/7 basis.

Finally, as highlighted by the European Commission in its recent White Paper on Artificial Intelligence, AI may also represent an additional useful tool for antitrust law enforcement.[42] Indeed, the potential of AI in the processing of large amounts of data and pattern recognition offers relevant opportunities for competition law enforcement, hence

[41] Conseil de la Concurrence Grand-Duché de Luxembourg, 7 June 2018, Decision n. 2018-FO-01, *Webtaxi,* <https://concurrence.public.lu/fr/decisions/ententes/2018/decision-2018-fo-01.html> accessed 4 September 2020.

[42] European Commission, 'White Paper on Artificial Intelligence: A European approach to excellence and trust', (2020) COM(2020) 65 final <https://ec.europa.eu/info/publications/white-paper-artificial-intelligence-european-approach-excellence-and-trust_en> accessed 10 November 2020.

antitrust authorities may increasingly rely upon the use of algorithms and AI-powered analytical tools.[43]

4. Is it time for algorithmic antitrust?

The analysis undertaken in the previous section on the different scenarios in which algorithmic-facilitated coordination may take place provides some insights. Antitrust authorities have been able to tackle the algorithmic challenge, uncovering anti-competitive coordination in scenarios where algorithms were used as tools to assist companies in implementing and facilitating explicit collusion and where third-party providers of algorithm services acted as a hub in a hub-and-spoke conspiracy. However, antitrust enforcement would struggle to deal with automated systems programmed to react to each other or self-learning algorithms autonomously able to reach tacit coordination.

Despite the fact that no real cases about the last two scenarios have been observed to date, several scholars are calling for the current antitrust rules to be modified to meet the increasing use of algorithms. After all, according to Ezrachi and Stucke, we are actually witnessing the end of competition as we know it.[44]

[43] See Martin Huber and David Imhof, 'Machine learning with screens for detecting bid-rigging cartels', (2019) 65 International Journal of Industrial Organization 277, suggesting that the combination of machine learning and screening is a powerful tool for detecting bid rigging. See also Andreas von Bonin and Sharon Malhi, 'The Use of Artificial Intelligence in the Future of Competition Law Enforcement', (2020) 11 Journal of European Competition Law & Practice 468, analyzing opportunities and risks of the use of AI, and referring to Albert Sanchez-Graells, 'Screening for Cartels' in Public Procurement: Cheating at Solitaire to Sell Fool's Gold?' (2019) 10 Journal of European Competition Law & Practice 199, in order to describe the criticisms of the UK CMA's 'Screening for Cartels' algorithmic tool aimed at helping procurers screen their tender data for signs of illegal bid rigging activity.

[44] Ezrachi and Stucke (n 10).

Notably, Heinemann and Gebicka invite antitrust enforcers to revisit the concepts of agreement and concerted practice,[45] and the OECD endorses a clearer definition of agreement, although admitting that at this point it is hard to draw conclusions on whether algorithmic interactions ("meeting of algorithms") should be treated in a way similar to a "meeting of minds."[46] Gal too finds treating the adoption of algorithms as facilitating practices or plus factors troublesome.[47] Because algorithms perform many functions and may bring benefits, it is necessary to verify whether they are justified by pro-competitive considerations balancing anti-competitive risks against efficiencies. Moreover, the very content of the prohibition would be difficult to define in a clear way so as to ensure legal certainty to market players.

By sharing concerns about the effectiveness of a form-based approach, it has also been proposed that the focus on the market effects of algorithms be shifted. Thomas suggests integrating the notion of concerted practices with an economic effects analysis;[48] and, with regard to price-matching algorithms, Siciliani argues that antitrust enforcers should rely on established price-cost tests in order to determine when the use of such algorithms is illegitimate.[49]

On a different note, other scholars support an *ex-ante* intervention instead of pursuing the standard antitrust analysis, which may consist in market investigations or sector inquiries, a review of merger control, or regulation. In particular, Ezrachi and Stucke propose to test algorithmic collusion in controlled or artificial environments such as a regulatory

[45] Heinemann and Gebicka (n 10).
[46] OECD (n 4) 36-39.
[47] Gal (n 10) 111-112.
[48] Stefan Thomas, 'Harmful Signals: Cartel Prohibition and Oligopoly Theory in the Age of Machine Learning', (2019) 15 Journal of Competition Law & Economics 159.
[49] Paolo Siciliani, 'Tackling Algorithmic-Facilitated Tacit Collusion in a Proportionate Way', (2019) 10 Journal of European Competition Law & Practice 31.

sandbox and to launch market investigations in order to better inform authorities of algorithms' dynamics.[50] Harrington suggests reading the mind (i.e. the code) of artificial agents to make collusion illegal, rather than the communication that facilities it.[51] Therefore, he proposes to define a blacklist of algorithms per se unlawful according to their specific design, resolving the problem of liability by restricting the class of allowable algorithms or by prohibiting algorithms with specific features that support prices above the competitive level. Moreover, Zheng and Wu propose a market-based regulatory approach, namely, to introduce a Pigouvian tax on the negative externality of competition caused by algorithmic pricing, by charging a certain amount of fees according to technical and economic criteria on all the firms that use algorithms in a non-oligopolistic market where sustainable supra-competitive prices are apparent.[52]

Lamontanaro suggests, instead, implementing a whistleblower bounty program that would improve the detection of algorithmic cartels and allow authorities to gain the expertise necessary to enforce antitrust laws without impeding innovation.[53]

Finally, some scholars point to algorithmic compliance requiring companies to ensure antitrust compliance by design and by default, rather than building pricing algorithms in a way that allows them to collude.[54]

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[50] Ezrachi and Stucke (n 10).
[51] Harrington (n 10).
[52] Zheng and Wu (n 10).
[53] Aleksandra Lamontanaro, 'Bounty Hunters for Algorithmic Cartels: An Old Solution for a New Problem', (2020) 30 Fordham Intellectual Property, Media and Entertainment Law Journal 1259.
[54] Bernhardt and Dewenter (n 14); Ai Deng, 'From the Dark Side to the Bright Side: Exploring Algorithmic Antitrust Compliance', (2020) <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3334164> accessed 4 September 2020; Peter G. Picht and Benedikt Freund, 'Competition (Law) in the Era of Algorithms', (2018) 39 ECLR 403; Peter G. Picht and Gaspare Tazio Loderer, 'Framing Algorithms: Competition Law and (Other) Regulatory Tools', (2019) 42 World Competition 391; Simonetta Vezzoso, 'Competition by design', in *Competition Law for the Digital Age* (B. Lundqvist and M. Gal, eds.) Edward Elgar (2019) 93. See also Vestager (n 17). Moreover, see John Moore, Etienne Pfister, and Henri Piffaut, 'Some Reflections on Algorithms, Tacit Collusion, and the Regulatory Framework', (2020) 1 Antitrust Chronicle 14, 19, considering antitrust enforcement and dedicated regulation as complements in ensuring the effectiveness of competition policy vis-à-vis algorithmic pricing, notably envisioning a framework where firms could be

In short, the challenges brought by AI and, more generally, by digital markets are casting doubt on the capacity of conventional remedies to ensure competition. By exploring alternative radical remedies, for instance Gal and Petit assess the mandatory sharing of algorithmic learning, i.e., a duty to share the knowledge produced by learning algorithms trained on data unlawfully collected or exploited.[55]

The European Commission is currently exploring a (quasi) regulatory approach. Opening a public consultation on the need for a possible new competition tool, the Commission envisages the possibility of intervention when a structural lack of competition prevents the market from functioning properly, such as oligopolistic market structures with an increased risk of tacit collusion, including markets featuring increased transparency due to algorithm-based technological solutions.[56] Notably, in its inception impact assessment, the Commission refers explicitly to the fact that "the growing availability of algorithm-based technological solutions, which facilitate the monitoring of competitors' conduct and create increased market transparency, may result in the same risk even in less concentrated markets."[57]

At this point it is unclear whether the new competition tool's scope of application will cover all the scenarios previously analyzed or only some of them. There also remains a lack of clarity on what remedies could be imposed. However, in the proposal presented

required (or incentivized) first to test their algorithms prior to deployment in real market conditions (risk assessment), then to monitor the consequences of deployment (harm identification).

[55] Michal S. Gal and Nicolas Petit, 'Radical Restorative Remedies for Digital Markets, (2021) 37 Berkeley Technology Law Journal, arguing that such remedy has four main virtues, that is it creates better conditions for restoring competition for the market, it can be applied almost immediately, it can limit the enjoyment of illegally obtained comparative advantages without harming consumers by prohibiting the use of algorithms which increase consumer welfare, and it does not require continual supervision.

[56] European Commission (n 18). See also Francisco Beneke and Mark-Oliver Mackenrodt, 'Remedies for algorithmic tacit collusion', Journal of Antitrust Enforcement (forthcoming), exploring how fines and structural and behavioral remedies can serve to discourage collusive results achieved by autonomous algorithmic agents.

[57] European Commission (n 18) 1.

by the European Commission in December 2020, the planned new competition tool has been folded into the Digital Markets Act, and apparently watered down into market investigations that will allow the Commission to qualify companies as gatekeepers, dynamically update the obligations on gatekeepers when necessary, and design remedies to tackle systematic infringements of the Digital Markets Act rules.[58]

Nonetheless, the Commission will enjoy investigative powers, such as the ability to request information, interview participants, and conduct on-site inspections, which explicitly include access to databases and algorithms.[59]

The initiative undertaken by the European Commission would represent a change of paradigm that would significantly alter the antitrust toolkit. This change would occur despite a lack of evidence of algorithmic collusion having yet emerged. Conversely, it is worth noting that competition authorities have endorsed a wait-and-see approach so far. Notably, the UK CMA considers speculative the mechanisms by which algorithms could have an additional impact beyond traditional risk factors, noting that it is unclear how likely the predictable agent and autonomous machine models of coordination are to materialize at this point .[60] In a similar vein, the UK Digital Competition Expert Panel finds it hard to predict whether greater use of algorithms will lead to algorithmic collusion.[61] Further, according to the French and German antitrust authorities, it is as of yet unknown whether algorithmic communication is a realistic scenario, hence, in the

[58] European Commission, 'Proposal for a Regulation on contestable and fair markets in the digital sector (Digital Markets Act)', COM(2020) 842 final.
[59] European Commission (n 58) Articles 19-21.
[60] UK Competition and Markets Authority (n 5), 31 and 48.
[61] UK Digital Competition Expert Panel (n 16) 15 and 110.

situations considered so far, the current legal framework is sufficient to tackle possible competitive concerns.[62]

In the meantime, the French Competition Authority has announced the creation of a new specialized department (the Digital Economy Unit) aimed at strengthening the human resources dedicated to detecting and analyzing the behavior adopted by players in the digital sector.[63] By the same token, the Netherlands Authority for Consumers and Markets has launched a trial in which it seeks to find out how it can monitor in practice the functioning of algorithms that businesses use.[64] And the UK CMA has launched the 'Analysing Algorithms Programme' seeking views and evidence from academics and industry experts on the potential harms to competition and consumers caused by the deliberate or unintended misuse of algorithms.[65]

The lack of empirical evidence leads some scholars to downplay algorithmic collusion as merely speculative and unlikely. Notably, Petit argues that the AI literature generates predictions on the basis of strict assumptions and the findings are not complemented by a symmetrical investigation of the destabilizing effect of algorithms on harm to competition.[66] For instance, Miklós-Thal and Tucker suggest that better demand forecasting resulting from algorithms, machine learning, and artificial intelligence can

[62] Autorité de la Concurrence and Bundeskartellamt (n 7).
[63] Autorité de la Concurrence, 'The Autorité de la concurrence announces its priorities for 2020', (2020) <https://www.autoritedelaconcurrence.fr/en/press-release/autorite-de-la-concurrence-announces-its-priorities-2020> accessed 25 September 2020. See also UK Competition and Markets Authority, 'A new pro-competition regime for digital markets', (2020) <https://www.gov.uk/government/news/cma-advises-government-on-new-regulatory-regime-for-tech-giants> accessed 10 December 2020, considering essential that the new Digital Markets Unit builds up a great deal of expertise and knowledge, including the capability to understand the role of algorithms and artificial intelligence.
[64] Authority for Consumers and Markets, 'ACM launches a study into the functioning of algorithms in practice', (2020) <https://www.acm.nl/en/publications/acm-launches-study-functioning-algorithms-practice> accessed 18 December 2020.
[65] See also UK Competition and Markets Authority (n 40), accompanying the launch of the CMA's Analysing Algorithms Programme.
[66] Petit (n 13). See also Itoo and Petit (n 13) considering algorithms not determinatively, and perhaps not even significantly causal of tacit collusion.

lead to lower prices and higher consumer surplus, thereby negatively affecting the sustainability of collusion in an industry.[67] At the same time, Gautier et al. note that the collusive behavior of most algorithms discussed in the literature were assessed in strict, laboratory and experimental settings and that the majority of models proposed tend to overlook some important characteristics and uncertainties of real businesses.[68] In a similar vein, Schwable identifies challenges to learning collusion, which makes it less easy and inevitable than is often suggested.[69] Since algorithmic collusion is virtually non-existent, Schrepel considers the focus of much academic research on this scenario as the result of a publication bias.[70] And, in any case, even if algorithmic collusion were to become a common practice, it would remain old wine in new bottles. Indeed, as also maintained by Ohlhausen, the expanding use of algorithms is not prone to creating enforcement blind spots, but rather raises familiar issues that are well within the existing canon.[71] Following this line of reasoning, Van Cleynenbreugel advances the claim that platforms relying on algorithms may be considered as "associations of undertakings" within the meaning of Article 101 TFEU.[72] In this way, decisions to rely on self-learning algorithms would fall within the scope of antitrust provisions, even in the absence of a concurrence of wills or proof of contact between two or more undertakings, hence without indulging in a discussion on the existence of an agreement or concerted practice. In short,

[67] Jeanine Miklós-Thal and Catherine Tucker, 'Collusion by Algorithm: Does Better Demand Prediction Facilitate Coordination Between Sellers?', (2019) 65 Management Science 1455.
[68] Gautier, Ittoo, and Van Cleynenbreugel (n 13). Notably, the authors point to limitations related to the assumption that the products of the competing firms are homogenous, that the demand is linear or deterministic, that firms can only set a restricted range of prices and that they compete solely on the basis of prices.
[69] Schwable (n 13).
[70] Schrepel (n 13).
[71] Ohlhausen (n 14). See also Bernhardt and Dewenter (n 14) considering collusion by code covered mainly by existing provisions.
[72] Van Cleynenbreugel (n 14).

according to this strand of literature, concerns about algorithmic collusion are not justified.

However, it is worth mentioning a recent study by Assad et al. analyzing the German retail gasoline market, which is an early adopter of algorithmic-pricing software, and suggesting that AI adoption has a significant effect on competition by increasing prices and margins.[73] Further, because margins start increasing about a year after market-wide adoption of algorithmic pricing software, according to the authors this also suggests that algorithms in that market have learned tacitly-collusive strategies.

Against this backdrop, it seems appropriate to call for a cautionary approach. It is undisputed that existing antitrust rules are fully suited to addressing algorithmic-facilitated coordination in scenarios of explicit collusion and hub-and-spoke conspiracy. Further, the impact of algorithms on those factors and market conditions traditionally identified as favorable parameters for supporting the collusive outcome is ambiguous.[74] While algorithms can reduce coordination costs and facilitate both the detection of deviations and the rapid implementation of effective punishments, there are also countervailing effects which may destabilize the collusive equilibrium. The ongoing debate revolves around the hypotheses of algorithmic collusion and essentially around the possibility to consider them as realistic scenarios.

Lacking empirical evidence and real-world cases of algorithmic collusion, the wait-and-see approach embraced by some competition authorities is wise and reasonable. Although

[73] Assad, Clark, Ershov, and Xu (n 10). See also Spanish National Commission on Markets and Competition and Catalan Competition Authority (n 7) 6 arguing that the possibility of algorithmic collusion is "a reality, theoretically and empirically demonstrated."

[74] See also Ariel Ezrachi and Maurice Stucke, 'Sustainable and Unchallenged Algorithmic Tacit Collusion', (2020) 17 Northwestern Journal of Technology and Intellectual Property 217, 226-228, acknowledging that algorithmic tacit collusion "will not affect every (or even most) markets" and that it is most likely in markets already susceptible to collusion.

the prospect of an algorithmic antitrust may be fascinating, it is indeed premature to advocate for a reform of antitrust rules and concepts or for legislative actions aimed at introducing regulatory measures while it remains unclear whether the predictable agent and autonomous machine models of coordination will materialize.

5. Concluding remarks.

Three years ago, Margrethe Vestager concluded a speech arguing that antitrust authorities should not panic about the way algorithms are affecting markets, but nonetheless recognize the need to keep a close eye on how algorithms are developing in order to be ready when science fiction becomes reality.[75] Though this scenario still seems a long way off, the European Commission is apparently convinced that the time has come to intervene. Indeed, the public consultation on a new competition tool that it launched aimed, among several policy options, at allowing the Commission to intervene in oligopolistic market structures with an increased risk of tacit collusion, including markets featuring increased transparency due to algorithm-based technological solutions.[76] Rather than following a wait-and-see approach, the Commission seemed ready to take the stand supporting the narrative according to which existing antitrust law is unfit to handle algorithmic-facilitated coordination.

However, in the proposal for a Regulation on contestable and fair markets in the digital sector (Digital Markets Act) presented by the European Commission in December 2020 the new competition tool has been watered down into market investigations that will allow the Commission to qualify companies as gatekeepers, dynamically update the

[75] Vestager (n 17).
[76] European Commission (n 18).

obligations on gatekeepers when necessary, and design remedies to tackle systematic infringements of the Digital Markets Act rules. Further, the proposal contains no mention of algorithmic-facilitated coordination.

After all, there is no evidence of algorithmic collusion so far and, as acknowledged by British, French, and German competition authorities, the mechanisms by which algorithms could have an additional impact beyond traditional risk factors are quite speculative.[77] Hence, algorithmic pricing is more likely to exacerbate traditional risk factors, facilitating collusion in markets which are already susceptible to human coordination. In such a scenario, existing antitrust rules are fit for the task.

Finally, it is worth noting that some scholars urge focus on the potential anticompetitive use of blockchain technology. Indeed, as noted by Catalini and Tucker, in the same way that the decentralized nature of blockchain technology allows for network effects to emerge without assigning market power to a platform operator, the absence of a central entity could facilitate collusion and make antitrust enforcement more difficult.[78] Blockchain solutions might facilitate both the sharing of competitively sensitive information and the implementation of anticompetitive agreements, especially when they involve the use of smart contracts. Notably, as argued by Schrepel, by allowing the implementation of agreements whose constraint stems from cryptographic rules, blockchain and smart contracts transform collusion into a cooperative game.[79]

[77] Autorité de la Concurrence and Bundeskartellamt (n 6); UK Competition and Markets Authority (n 5).
[78] Christian Catalini and Catherine Tucker, 'Antitrust and Costless Verification: An Optimistic and a Pessimistic View of Blockchain Technology', (2019) 82 Antitrust Law Journal 861. See also Lin William Cong and Zhiguo He, 'Blockchain Disruption and Smart Contacts', (2018) NBER Working Paper No. 24399 < http://www.nber.org/papers/w24399> accessed 10 November 2020.
[79] Schrepel (n 13).

These perspectives have caught the attention of the US antitrust enforcers. In a recent speech Makan Delrahim, former Chief of the Antitrust Division at the US Department of Justice, acknowledged both the opportunities and challenges the blockchain implicates from an antitrust perspective stating that, even though this technology offers tremendous potential value, there is also potential for misuse of well-crafted blockchain solutions.[80] Therefore, blockchain represents a natural follow-up of this work and it is left for further research.

[80] Makam Delrahim, 'Never Break the Chain: Pursuing Antifragility in Antitrust Enforcement', (2020) Remarks at the Thirteenth Annual Conference on Innovation Economics <https://www.justice.gov/opa/speech/assistant-attorney-general-makan-delrahim-delivers-remarks-thirteenth-annual-conference> accessed 5 September 2020.