Pricing algorithms: thoughts on a framework for competition law analysis

Anne-Claire Hoyng

Ingrid Vandenborre

Caroline Janssens[*]

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Introduction

Pricing algorithms are increasingly common across different sectors and markets. They generally take the form of either dynamic pricing models or personalised pricing tools. Whereas dynamic pricing refers to algorithm-based adjustments of prices to changes in demand and supply, often in real time, and without any kind of discrimination between customers, personalised pricing refers to the application of different prices to customers based on their personal characteristics through the application of an algorithm. These algorithms can range from simple models used mainly to compare and match prices to more sophisticated tools based on machine learning and real time data.

In recent reports a growing number of competition authorities have identified potential competition concerns around the use of pricing algorithms. The potential concerns raised are price co-ordination, information exchange, tacit collusion and price discrimination. However, these reports have largely focused on "issue spotting". While some reports state or imply that the existing legal framework is insufficient, in the absence of clear empirical evidence for the potential harms identified, and of clear criteria to assess anti-competitive effects, these reports do not yet offer a solid basis to assess the potential issues from a competition law perspective.

In this article, we will discuss how the current legal framework already provides a robust basis to assess pricing algorithms and their effects on competition and consumers. We will in this context also discuss the recent decisions and judgments that confirm the conditions under which algorithmic pricing may result in an antitrust violation. Based on this framework, we will also offer a set of guidelines for companies to mitigate potential antitrust risks that may stem from the use of pricing algorithms. First however, we will take stock of the current growing debate in competition law around pricing algorithms, in relation to potential collusion and personalised pricing, and discuss what is understood by pricing algorithms, including the pro- and anti-competitive effects it may have on the competitive process in a specific market.

From this discussion, it will be clear that it is important that the benefits of price algorithms are taken into account and are balanced against the potential harms identified when considering any intervention into pricing algorithms. In this respect, the focus should be on the competitive and consumer impact of the algorithm based on its use and context. By contrast, a detailed description of an algorithm formula (i.e. algorithmic transparency requirements), as suggested in several recent proposals, will in most cases not be very helpful for that assessment, particularly given that the essence of an algorithmic formula is that it will self-learn to improve over time.

Finally, this article does not explore in detail the occurrence of tacit collusion whereby pricing algorithms not explicitly programmed to collude self-learn over time to do so without human intention nor any other information sharing, or existing co-ordination. To date, pure forms of tacit collusion remain highly theoretical and generally fall outside of the EU competition rules which require a meeting of minds between companies to restrict competition. Further inter-disciplinary research (competition law, consumer protection, data protection, regulation, economics, computer science, etc.) is required to inform the ongoing debate as to whether or not there is an enforcement gap.

The growing antitrust focus on pricing algorithms

The number of national and international reports and studies on the challenges of algorithms for competition policy and enforcement has been overwhelming, including reports by the Organisation for Economic Co-operation

[*] Anne-Claire Hoyng is Global Head for Competition Policy at Prosus, previously Director for Global Competition and Consumer Law at Booking. com. Ingrid Vandenborre is a partner and Caroline Janssens is a senior professional support lawyer/non practicing solicitor with Skadden, Arps, Slate, Meagher and Flom LLP. The authors wish to thank Michael Frese, associate with Skadden, Arps, Slate, Meagher and Flom LLP for his invaluable contribution.

and Development (OECD),[1] the European Union (EU),[2] the International Competition Network (ICN),[3] the UK,[4] Germany,[5] France,[6] the Netherlands,[7] Portugal,[8] Norway,[9] Finland,[10] and Japan.[11] Other studies are ongoing, including in the Netherlands,[12] and Greece.[13] Some national competition authorities have created specialised digital economy units within their structure or join forces with other sector regulators, to develop in-depth expertise into algorithms as part of their remit, as is the case for example in France[14] and the UK.[15]

These reports elaborate on why algorithms matter for the digital economy, the importance of understanding the context of the digital economy and the underlying technology of algorithms, and how algorithms can provide substantial benefits to consumers by enhancing the quality of product and services and increasing efficiency and effectiveness across many areas.

However, these reports express concern that algorithmic systems may also, potentially, cause wide ranging harms to competition and to consumers. The reports discuss the potential use of pricing algorithms to facilitate collusion, and focus in particular on information exchanges through algorithms. In terms of direct consumer detriment, the reports examine the use of algorithmic systems to personalise prices. Many other concerns are raised in these reports,[16] which are beyond the scope of this article.

Overall, these reports ask for vigilance and call for increasing the monitoring of collusion risks. Some allude to possible remedies. According to the CMA report, there is a "strong case for intervention" due to "the opacity of algorithmic systems and the lack of operational transparency that make it hard for consumers and customers to effectively discipline firms" and due to the "important strategic positions" of some of the firms concerned both in the UK and internationally.[17] The CMA gives example of remedies they might impose, which include conducting audits of algorithms and requiring companies to disclose information about their algorithmic systems.[18] According to the recent Finnish report, problems caused by algorithms can only partially be addressed by law.

While helpful in identifying potential issues, these reports do not offer any empirical evidence of actual risk, or insights as to what might guide the agencies' assessment of algorithmic pricing, thereby creating legal uncertainty around the enforcement risk related to the use

[1] OECD, "Algorithms and Collusion: Competition Policy in the Digital Age" (2017) *https://www.oecd.org/competition/algorithms-collusion-competition-policy-in-the-digital-age.htm* [Accessed 1 November 2021].
[2] OECD, "Algorithms and Collusion—Note from the European Union" (2017) *https://one.oecd.org/document/DAF/COMP/WD(2017)12/en/pdf* [Accessed 1 November 2021]. The EC's proposal for a Digital Markets Act Impact Assessment does refer to algorithms, although only very briefly and primarily in reference to self-preferencing and lack of transparency and not with regard to pricing algorithms.
[3] ICN, "The impact of digitalization in cartel enforcement" (2020) *https://www.internationalcompetitionnetwork.org/wp-content/uploads/2020/06/CWG-Big-Data-scoping-paper.pdf* [Accessed 1 November 2021].
[4] UK Competition and Markets Authority (CMA), "Pricing algorithms: Economic working paper on the use of algorithms to facilitate collusion and personalised pricing" (hereafter "CMA's economic working paper on the use of algorithms"), 8 October 2018, *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021]; "Unlocking digital competition" (the Furman report), a report of the Digital Competition Expert Panel appointed by the UK Chancellor of the Exchequer and chaired by Professor Jason Furman, former chief economist to former US President Obama, 13 March 2019, *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/785547/unlocking_digital_competition_furman_review_web.pdf*; Ofcom, "Personalised Pricing for Communications", 4 August 2020; CMA, "Algorithms: How they can reduce competition and harm consumers", 19 January 2021, *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954331/Algorithms_++.pdf* [Accessed 1 November 2021] (hereafter "CMA's consultation paper on algorithms"). See also, CMA, "Algorithms: How they can reduce competition and harm consumers. Summary of responses to the consultation", May 2021, *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/991676/Summary_of_responses_to_algorithms_paper_publish.pdf* [Accessed 1 November 2021]; UK Department for Business, Energy and Industrial Strategy (BEIS) research paper on Personalised Pricing and Disclosure, 2021/008, 20 July 2021, *https://www.gov.uk/government/publications/personalised-pricing-and-disclosure* [Accessed 1 November 2021].
[5] German Commission of Experts on Competition Law, "A New Competition Framework for the Digital Economy: Report by the Commission 'Competition Law 4.0'", 9 September 2019, *https://www.bmwi.de/Redaktion/EN/Publikationen/Wirtschaft/a-new-competition-framework-for-the-digital-economy.pdf?__blob=publicationFile&v=3* [Accessed 1 November 2021], the Commission concluded that "[i]f algorithms are trained with too little data or with data that is too uniform, this will have a negative impact on the algorithms' abilities to deal with the problems they were supposed to solve"; Joint study by the French Autorité de la Concurrence and the German Bundeskartellamt "Algorithms and Competition" (hereafter "Joint French-German study on algorithms", November 2019, *https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Berichte/Algorithms_and_Competition_Working-Paper.html* [Accessed 1 November 2021]; German Monopolkommission, XXIII Biennial Report, 2020 *https://www.monopolkommission.de/en/press-releases/343-biennial-report-xxiii-competition-2020.html* [Accessed 1 November 2021].
[6] "Joint French-German study on algorithms", *https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Berichte/Algorithms_and_Competition_Working-Paper.html* [Accessed 1 November 2021].
[7] Dutch Authority for Consumers & Markets (ACM), "Guidelines on the protection of the online consumer. Boundaries of online persuasion", 11 February 2020, *https://www.acm.nl/en/publications/guidelines-protection-online-consumer* [Accessed 1 November 2021]; ACM, "Position Paper on Supervision of Algorithms", 10 December 2020.
[8] Portuguese Autoridade da Concorrencia, "Digital ecosystems, Big Data and Algorithms", July 2019.
[9] Norway Competition Authority, "Survey on the use of monitoring algorithms", 3 February 2021.
[10] Finland Competition Authority, "Collusion situations caused by algorithms" and "Personalised pricing in light of consumer and competition policy", 9 February 2021.
[11] Japan Fair Trade Commission, "Report on algorithms and artificial intelligence", 31 March 2021.
[12] On 10 December 2020, the ACM launched a study into the functioning of algorithms in practice, i.e., a pilot investigation in which the ACM will map out the type of information it needs in order to study the use of algorithmic applications by companies in future investigations and supervision activities.
[13] On 11 March 2020, the Hellenic Competition Commission launched an e-commerce sector inquiry to assess if artificial intelligence and algorithms are harming consumers. The final report is expected to be released in October 2021.
[14] The French Competition Authority's digital economy unit was launched on 9 January 2020. The French government also established a panel of leading practitioners in digital regulation to offer expertise about algorithms to the French competition authority and other government departments.
[15] The CMA inaugurated its Digital Markets Unit (DMU) on 8 April 2021. In addition, the CMA has indicated that it intends to work closely with the Information Commissioner's Office, the Communications regulator, and the Financial Conduct Authority through the newly set up Digital Regulation Cooperation Forum to share intelligence and take co-ordinated action regarding algorithms.
[16] Other concerns raised in these reports include tacit collusion, manipulating customer choice, facilitate preferencing of other for commercial advantage, self-preferencing, manipulating ranking and overall lack of transparency in the decision making processes of algorithms.
[17] "CMA's consultation paper on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954331/Algorithms_++.pdf* [Accessed 1 November 2021], para.4.2.
[18] "CMA's consultation paper on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954331/Algorithms_++.pdf* [Accessed 1 November 2021], para.4.21.

of algorithms. As they also do not take into account sector/market specific considerations, they raise more questions than they address.

At the same time, a panoply of new legislative initiatives introduce different, and often overlapping requirements that similarly lack clear foundational principles. For example, the EU Platform-to-Business Regulation[19] provides light touch rules on algorithmic ranking transparency; the European Commission's (Commission) proposed Digital Services Act[20] and Digital Markets Act[21] both introduce wide-ranging transparency measures on algorithms; the Commission's proposed Artificial Intelligence (AI) Regulation[22] introduces a similar strict framework of transparency and monitoring of results on high-risk AI[23] systems and their algorithms and data before they can be put on the market—requirements include risk management systems, data governance, technical documentation, record-keeping, transparency and provision of information to users, human oversight, accuracy, robustness and cybersecurity. The Commission also introduced the Omnibus Directive[24] as part of its "New Deal for Consumers" initiative which is aimed to strengthen consumer protection law in light of an increasingly globalised consumer marketplace and the rise of e-commerce. The directive introduced new obligations for companies engaging in personalised pricing, including requirements to inform consumers in a clear and comprehensible manner every time the price presented to them online is automated, based on an algorithm taking into account their personal consumer behaviour.[25] In Germany, new competition measures to tackle companies of "paramount significance for competition across markets"[26] can prohibit ex ante certain types of conduct connected to the use of algorithms, including self-preferencing and certain types of cross-market data processing. In China, regulators are set to tighten their oversight of the use of algorithms by online platforms within the next three years.[27]

Several agency reports commented on the need for companies to render transparent the algorithmic models they employ to determine pricing and other decisions as a mean to correct or prevent algorithmic collusion. However, as some studies and articles have pointed out, that suggestion may betray a deep misunderstanding about artificial intelligence. Establishing a causal link between algorithms and a harm would be challenging. Pricing algorithms based on artificial intelligence act independently from any human intervention by relying on their refined use of artificial neural network. Because a model can include countless variables combined in random ways, it might not be straightforward to determine whether prices are set in a tacitly co-ordinated way. In these circumstances, the explanation of the algorithm may always be limited and its scope not restrictively pre-defined. Also, it is key to bear in mind that transparency of the algorithm makes it more vulnerable and exposed to rivals which could make algorithmic collusion more likely. In its recent research on personalised pricing and disclosure, the UK Department for Business, Energy and Industrial Strategy (BEIS) acknowledged the challenges of mandatory disclosure remedies, anticipating that these may raise prices and lead to uniform pricing. The research also suggested transparency may in fact support cartel and co-ordinated pricing.[28] Moreover, transparency requirements would not affect potential anti-competitive effects absent monitoring of the actual impact of algorithms in practice. The discussion around algorithm transparency thus risks distracting from, rather than focusing the competitive analysis.

[19] Regulation (EU) 2019/1150 of the European Parliament and of the Council of 20 June 2019 on promoting fairness and transparency for business users of online intermediation services [2019] OJ L186/57; European Commission's guidelines to online platforms on algorithmic ranking transparency complementing the EU Platform-to-Business Regulation, 7 December 2020.

[20] Proposal for a Regulation of the European Parliament and of the Council on a Single Market for Digital Services (Digital Services Act) and amending e-Commerce Directive, COM/2020/825 final, 15 December 2020.

[21] Proposal for a Regulation of the European Parliament and of the Council on contestable and fair markets in the digital sector (Digital Markets Act), COM/2020/842 final, 15 December 2020.

[22] Proposal for a Regulation of the European Parliament and of the Council laying down harmonized rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain union legislative acts, COM/2021/206 final, 21 April 2021.

[23] AI systems identified as high-risk include AI technology used in critical infrastructures (e.g., transport), educational or vocational training that may determine the access to education and professional course of someone's life (e.g., scoring of exams); safety components of products (e.g., AI application in robot-assisted surgery); employment, workers management and access to self-employment (e.g., CV-sorting software for recruitment procedures); essential private and public services (e.g., credit scoring, denying citizens opportunity to obtain a loan); law enforcement that may interfere with people's fundamental rights (e.g., evaluation of the reliability of evidence); migration, asylum and border control management (e.g., verification of authenticity of travel documents); administration of justice and democratic processes (e.g., applying the law to a concrete set of facts).

[24] Directive (EU) 2019/2161 of the European Parliament and the Council of 27 November 2019 amending Council Directive 93/13/EEC and Directives 98/6/EC, 2005/29/EC and 2011/83/EU of the European Parliament and of the Council as regards the better enforcement and modernisation of Union consumer protection rules (Omnibus Directive) [2019] OJ L328/7. It is part of the European Union's "New Deal for Consumers" initiative aimed at improving and modernising consumer protection legislation and strengthening their enforceability. The EU Member States must transpose the Omnibus Directive into national law by 28 November 2021 and must apply said national law as of 28 May 2022.

[25] Omnibus Directive, recital 45: "Traders may personalise the price of their offers *for specific consumers or specific categories of consumer based on automated decision-making* and profiling of consumer behaviour allowing traders to assess the consumer's purchasing power. Consumers should therefore be clearly informed when the price presented to them is personalised on the basis of automated decision-making, so that they can take into account the potential risks in their purchasing decision. Consequently, a specific information requirement should be added to Directive 2011/83/EU to inform the consumer when the price is personalised, on the basis of automated decision-making so that they can take into account the potential risks in their purchasing decision. Consequently, a specific information requirement should be added to Directive 2011/83/EU to inform the consumer when the price is personalised, on the basis of automated decision-making. This information requirement should not apply to techniques such as 'dynamic' or 'real-time' pricing that involve changing the price in a highly flexible and quick manner in response to market demands when those techniques do not involve personalisation based on automated decision-making. This information requirement is without prejudice to Regulation (EU) 2016/679 [GDPR], which provides, inter alia, for the right of the individual not to be subjected to automated individual decision-making, including profiling" [emphasis added].

[26] The 10th amendment to the German Act against Restraints of Competition (Gesetz Gegen Wettbewerbsbeschränkungen) took effect on 19 January 2021.

[27] "Algorithms up to tighter grip in China; governance regime expected in three years", MLex, 30 September 2021.

[28] "BEIS research on Personalised Pricing", *https://www.gov.uk/government/publications/personalised-pricing-and-disclosure* [Accessed 1 November 2021], p.21.

The concept of algorithm pricing and potential competition concerns

Almost every company will determine prices for its products and services based on observed market conditions, and many rely on a variety of tools to guide their decisions (e.g., market reports, customer surveys, price tracking data). A pricing algorithm is one such tool. It determines the price a seller has to charge to achieve a predefined objective.

Algorithmic pricing/dynamic pricing is a software tool that sellers can use to price their products. It can perform complex calculations and data-processing functions that could be costly to execute for a human being. It helps suppliers to dynamically adjust prices based on various conditions. This may include a company's own confidential information (e.g., inventory, cost base) as well as other observable information (e.g., screen scraping of competitors' prices, demand fluctuations, market conditions prevalent at the time, etc.). Suppliers can use dynamic pricing to target different purposes at different times, including volume or margins.

The literature recognises that numerous types of dynamic pricing exist that are designed to address a variety of problems or tasks, ranging from simple ones that only take historical data into account, to very sophisticated ones relying on real-time data. Some pricing algorithms have been designed to follow simple rules, such as matching the lowest competitor's price, or remaining within the lowest quartile of prices. Alternatively, more advanced algorithms may rely on a predefined prediction model, e.g., regression analysis. Further, algorithms may be able to use real-time big data to continuously learn how to set prices using the machine learning or deep-learning processes. Algorithmic pricing may be used in almost every sector, both offline (setting prices for goods sold in brick-and-mortar stores) and online.

Potential competition concerns centre on algorithmic pricing collusion and personalised pricing which could also enable forms of direct or indirect price discrimination. We will discuss each in turn.

Algorithmic pricing collusion

The concern related to the use of a pricing algorithm is that it might lead to collusive/co-ordinated outcomes between competitors. In particular, concerns around algorithms collusion include:

(a) Explicit co-ordination, whereby the increased availability of pricing data and use of automated pricing systems make it easier to detect and respond to deviations and reduce the chance of errors or accidental deviations[29]; use of pricing algorithms by sellers could result in supra-competitive prices, whether by facilitating explicit co-ordination, i.e. reinforcing a cartel agreement or—at least theoretically—by influencing pricing decisions between companies that take ostensibly unilateral pricing decisions.[30] These price algorithms may make it easier to detect and respond to deviations from an agreed price.

(b) "Hub-and-spoke" structures facilitating information exchanges, e.g., companies using the same algorithmic system to set prices, for example by using the same software or services supplied by a third-party, or by delegating their pricing decisions to a common intermediary.

(c) Autonomous tacit collusion, whereby pricing algorithm software learns to collude without requiring other information sharing or existing co-ordination, or human intervention.[31]

We will discuss in more detail below some approaches to assess co-ordinated effects that may stem from the use of pricing algorithms. We already note here though that the likelihood of co-ordinated effects on the basis of pricing algorithms is generally dependent on a number of conditions:

(a) The proportion of the relevant market that has delegated its pricing to a common intermediary's pricing algorithms: if a sufficiently large proportion of an industry uses a single algorithm to set prices, this could result in a hub-and-spoke structure that may have the ability and incentive to increase prices.

(b) Whether the common intermediary's pricing algorithms makes use of strategic/commercially sensitive, information or data from multiple clients when determining prices for each client.

(c) Whether the markets are concentrated and homogeneous: algorithmic pricing may be more likely to facilitate collusion in markets

[29] See, e.g., "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], paras 5.7–5.9.

[30] "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], para.5.2.

[31] See, e.g., "CMA's consultation paper on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954331/Algorithms_++.pdf* [Accessed 1 November 2021], para.2.80. See also Ariel Ezrachi and Maurice Stucke, "Artificial Intelligence & Collusion: When Computers Inhibit Competition" (2017) *University of Illinois Law Review* 1775, and the discussion of this article in the "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], paras 5.15–5.24; "CMA's consultation paper on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954331/Algorithms_++.pdf* [Accessed 1 November 2021], para.2.80(c). As indicated above, we will not address tacit collusion issues in this article.

which are already susceptible to co-ordination, such as where firms' offerings are homogeneous. Hansen and others have pointed to markets susceptible to collusion.[32] Literature further suggests that market transparency, dispersed demand, frequent repeated interactions, stable demand and cost structure, and product homogeneity make any form of collusion more likely.[33]

(d) Wider constraints on market power (strength of network effects, multi-homing, barriers to entry and dynamic competition).

(e) Presence of a credible deterrent mechanism to deviation.

Personalised pricing

Algorithm pricing has also been identified as potentially creating consumer harm through facilitating personalised pricing, which includes advertising different prices to different people and practices which achieve the same effect (such as providing discounts to selected customers). While price discrimination can be pro-competitive, agencies have expressed concern around personalisation because it can be difficult to detect and may target vulnerable consumers or have unfair distributive effects. In its report, the BEIS noted that price discrimination can make price comparisons more difficult, raise search costs, and reduce competition. The report also noted price discrimination can damage consumer trust and create data privacy concerns due to the extent of data collection it relies on.[34]

Although the term "personalised pricing" is employed in a wide variety of circumstances, it can essentially be seen as a form of price discrimination in which individual consumers are charged different prices based on their personal characteristics and conduct. Personalised pricing thus results in consumers each paying a different price, generally as a function of their willingness to pay. Price discrimination can generally fall under three categories[35]:

(a) First-degree of price discrimination (individual pricing or perfect discrimination), theoretical form of price discrimination where each consumer is charged his or her full willingness to pay—which is unlikely to occur in practice.

(b) Second-degree of price discrimination (indirect discrimination), where the seller offers a number of versions of the same product at different prices, leaving to the consumers the decision to choose a version according to their own preferences.

(c) Third-degree of price discrimination (group pricing), where different prices are set to different groups of consumers partitioned according to their observed characteristics.

Personalised pricing is in the sliding scale between first and third-degree of price discrimination. Usually, consumers are segmented into smaller consumer groups than those considered in third-degree price discrimination, but not necessarily composed by a single individual. Accordingly, price personalisation is not limited to an individual but may also relate to groups of individuals.

A case for identifying competition benefits of a common algorithm and personalised pricing

Although many of the agency reports recognise the benefits of algorithm pricing, the focus of the discussion is typically on the potential harm. This is unfortunate as it creates a perception that algorithms should be treated with scepticism and hostility. While algorithms may come with more potential benefits in some sectors than in others, there is no basis to assume per se anti-competitive effects or consumer harm.

Benefits of a common algorithm

A common pricing algorithm may intensify pricing competition, allowing for faster (often in real time) and more accurate price adjustments, taking into account extensive market information. This improves the matching of fluctuating demand and supply, which leads to a better outcome for consumers, and a level playing field between suppliers. As noted by the OECD, "[d]ynamic pricing algorithms have been recognised to improve market efficiency, by allowing companies to react instantaneously to changes in supply conditions—such as stock availability, capacity constraints or competitors' prices—as well as to fluctuations in market demand".[36] These benefits may be more pronounced in particular sectors, but they are not limited to specific sectors.

Competition authorities have also recognised that co-ordination on the use of a pricing algorithm may come with consumer benefits, for example, when part of a common platform. The *Luxembourg Webtaxi* case serves as an example of such efficiencies being acknowledged by authorities. On 7 June 2018, following a complaint, the Luxembourg Competition Authority (LCA) adopted

[32] K.T. Hansen, K. Misra, M.M. Pai, "Collusive Outcomes via Pricing Algorithms" (2021) 12(4) *Journal of European Competition Law & Practice* 334, 337. They identify two key market structures: First, stable markets where demand is a relatively predictable function of the prices offered—the stability of the underlying environment facilitates algorithmic learning. Second, markets where the demand is a predictable function of additional high-frequency information firms may not have access to, but a data-rich third party can.

[33] F. Beneke and M.-O. Mackenrodt, "Remedies for algorithmic tacit collusion" (2021) 9(1) *Journal of Antitrust Enforcement* 152, 159.

[34] "BEIS research on Personalised Pricing", *https://www.gov.uk/government/publications/personalised-pricing-and-disclosure* [Accessed 1 November 2021], p.6, table 1.

[35] OECD, "Personalised Pricing in the Digital Era", 28 November 2018, *https://one.oecd.org/document/DAF/COMP(2018)13/en/pdf* [Accessed 1 November 2021], p.9.

[36] OECD, "Algorithms and Collusion", *https://www.oecd.org/competition/algorithms-collusion-competition-policy-in-the-digital-age.htm* [Accessed 1 November 2021], p.16. See also the "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], paras 4.2–4.4.

a decision[37] exempting the algorithmic price-fixing arrangement of Webtaxi, a booking platform for taxi services in Luxembourg, from the prohibition of the national equivalent of art.101 TFEU. Taxis belonging to several companies made use of the booking platform, which fixed the fares for the participating taxis in a non-negotiable manner with the help of price algorithms, factoring in several parameters such as price per kilometre, distance and travelling time of taxi rides and traffic condition. The LCA concluded that this arrangement qualified as a by-object restriction but went on to assess the claimed justifications. The LCA found that the fixed fares came with various benefits for the participating taxis, consumers and the environment. With respect to consumer benefits, the LCA assessed the algorithm and concluded that algorithm-based fares would always be equal to or lower than the meter price as the algorithm used a digressive price per kilometre. In addition, the LCA found that Webtaxi's per-kilometre price was lower than that of its direct competitors. Given that Webtaxi's estimated market share was only 26%, the algorithm did not remove price competition in the market. Together with the benefits for the taxis and the environment, the LCA concluded that the restriction was justified.

Supply-side efficiencies

On the supply-side, algorithms have a positive impact on productivity, permitting companies to use human capital more efficiently. The collection and processing of big data can facilitate decision-making, predict risk, locate inefficiencies and assist managers to allocate resources, lowering the costs of making optimal price predictions. Additionally, as acknowledged in the OECD study, algorithms have a positive impact on supply costs by allowing sellers to reduce waste and optimise inventory management. In markets where there is no value in retaining stock for the merchant but there would be some value in buying these products for customers, pricing algorithms play a crucial role in helping merchants to meet demand. Offerings including perishable goods such as delivery of meals, flowers, groceries, hotel rooms or airplane tickets, are only some examples of products and services that would fall under this category.

For example, in the travel/hospitality industry, if a hotel room is not sold and the date for the stay has passed, the potential revenue is lost forever. The commercial challenge for an accommodation is that it must sell its availability/fixed capacity before a set date. Fluctuations in demand make this challenging. If prices are set too high no one buys the overnight stay; if prices are set too low the accommodation might be sold out but have to forego potential revenues. To tackle this issue accommodations use revenue management systems to adapt their prices up to that date in order to maximise revenue. Algorithmic pricing can therefore help accommodations allocate their capacity in the right way. This is especially relevant against the background of the COVID-19 pandemic as travel restrictions and lockdowns across the globe have resulted in a scarce demand in the travel industry.

The use of an algorithm can create a level playing field between suppliers and substantially reduce the costs of setting and changing prices, and facilitate entry by new suppliers, as they can quickly learn how a market works.[38] For example, entry into the short-term rental accommodation sector has been made easier with pricing algorithms. Due to lack of expertise and experience in the accommodation segment, suppliers often miss out on bookings because they are not capable of setting the right price to attract customers, and customers miss out on a property because of the "wrong" pricing, i.e. pricing that is too high compared to the competitive set to be able to attract customers. Pricing algorithms also enable suppliers to compete better with traditional hotels, which have often significantly more experience with pricing and revenue management.

Algorithms have become useful tools for implementing firmwide business rules and policies, including policies on pricing and discounts.[39] These may range from simple rules, such as matching the lowest competitor's price, or remaining within the lowest quartile of prices, to more sophisticated multi-factor models.

Finally, algorithms in themselves can also become a competitive parameter, with companies aiming to develop algorithms that are better at forecasting and matching.

Benefits of personalised pricing

Personalised pricing can be beneficial, increasing total output and consumer welfare, including lowering search costs for consumers and bringing about a more precise match between consumers and products and services; allowing firms to set a lower price and profitably sell to consumers who would not be willing to pay the uniform price that firms would otherwise set; the ability to offer targeted discounts might help new entrants to compete, particularly in markets with switching costs. Well-informed and confident consumers are essential in driving competition between suppliers offering these services. Some respondents to the CMA report noted that quantity discounts (e.g., "12 for the price of 10") could enhance consumer welfare by resulting in fewer numbers of larger sales (thereby increasing efficiency) and encouraging more consumption and production and

[37] Luxembourg Competition Authority Decision 2018-FO-01 of 7 June 2018.
[38] See on that point, the "Joint French-German study on algorithms", *https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Berichte/Algorithms_and_Competition_Working-Paper.html* [Accessed 1 November 2021], p.22.
[39] "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], p.10.

increasing economies of scale, bringing down the price of each item for all consumers of that product.[40] In addition, some respondents noted that using proxies such as "student" or "over 65" to identify different groups' willingness to pay could increase consumer welfare, also by encouraging the production of additional units of a product, reaping economies of scale, and leading to potential reductions in price.[41] Similarly, the BEIS noted that price discrimination can open up markets, notably to poorer and lower valuation consumers, and that price discrimination that takes the form of discount codes/coupons may drive higher demand and higher consumer utility.[42]

As the OECD outlines: "Personalised pricing, like any price discrimination, is typically pro-competitive and often enhances consumer welfare. As compared to more traditional forms of price discrimination, personalised pricing generally has more accentuated effects, having the potential to optimise static efficiency and incentives for innovation".[43] Overall personalised pricing can have a positive effect for consumers where the benefit to consumers who pay less outweighs the harm to those charged more. For example, businesses may decide to offer products below the average price to consumers who have less money to spend.[44]

Finally, some studies suggest that differential pricing can intensify competition relative to uniform pricing, by allowing high-margin sellers to compete more aggressively for price-sensitive customers, who might otherwise buy from a lower-priced rival.[45]

Thoughts towards a framework for the assessment of pricing algorithms

In this section, we assess whether the current competition law framework is equipped to deal with any negative side effects of price algorithms, while acknowledging the potential benefits. We separately discuss possible factors that may help set a framework for the assessment of unilateral pricing.

(a) Co-ordinated effects: scope to capture forms of explicit co-ordination

(i) Price algorithms that implement hard core restrictions

There have been several cases involving algorithms that resulted in fines. All these cases have one thing in common: the algorithm was selected as the tool to implement an anti-competitive agreement. For example, in *Trod*,[46] the CMA imposed a fine on Trod Limited (Trod) and GB eye Limited (GBE) for agreeing not to undercut each other's posters and frames sold on Amazon UK. After a short period of monitoring and changing their co-ordinated prices manually, GBE and Trod decided to use repricing software to implement the arrangement. The collusive arrangement originated from complaints made by Trod that GBE was undercutting Trod on the retail market. In order to settle the dispute, the companies agreed that they would not undercut each other's prices for products sold on Amazon UK. After a short period of monitoring and changing their prices manually, GBE decided to use repricing software to implement the arrangement. The companies adopted distinct software for the implementation of the anti-competitive agreement and engaged in numerous discussions on the appropriate configuration. GBE's software was configured to undercut competing products on Amazon UK, except for the products on which it competed with Trod, in which case Trod's price would be matched unless there was a cheaper third-party seller on Amazon UK. Trod, on the other hand, adopted repricing software that was configured not to undercut GBE on Amazon UK. The CMA concluded that this formed hardcore cartel activity.

In *Consumer Electronics*,[47] the Commission fined four consumer electronics manufacturers for restricting the ability of online retailers to determine their resale prices independently. Pricing software played a prominent role at least in some of these cases. In *Asus*, price-comparison websites and price-monitoring software were used by Asus to identify retailers pricing below the recommended resale price. In case of failure to observe the minimum prices, Asus would contact the retailer by email or phone and threaten or even penalise it with penalties such as supply cuts, bonus cuts, exclusion from certain partner programmes and prohibition to use the Asus logo online. In *Pioneer* and *Philips*, dealers used software programs to track the prices online and automatically adjust to match the lowest price available online. Pioneer used this to take steps against the retailer that first set the lower price.

[40] "CMA' summary of responses to the consultation on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/991676/Summary_of_responses_to_algorithms_paper_publish.pdf* [Accessed 1 November 2021], para.3.21.
[41] "CMA' summary of responses to the consultation on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/991676/Summary_of_responses_to_algorithms_paper_publish.pdf* [Accessed 1 November 2021], para.3.21.
[42] "BEIS research on Personalised Pricing", *https://www.gov.uk/government/publications/personalised-pricing-and-disclosure* [Accessed 1 November 2021], p.6, table 1.
[43] OECD, "Personalised Pricing in the Digital Era" *https://one.oecd.org/document/DAF/COMP(2018)13/en/pdf* [Accessed 1 November 2021], p.7.
[44] "ACM's guidelines on the protection of the online consumer", *https://www.acm.nl/en/publications/guidelines-protection-online-consumer* [Accessed 1 November 2021].
[45] White House Report, "Big Data and Differential Pricing", February 2015 *https://obamawhitehouse.archives.gov/sites/default/files/whitehouse_files/docs/Big_Data_Report_Nonembargo_v2.pdf* [Accessed 1 November 2021], p.6.
[46] Case 50223 Online sales of posters and frames, CMA Decision of 12 August 2016. The CMA investigation followed similar investigations by the US DoJ in *US v Daniel William Aston and Trod Limited* (2016) and *US v David Topkins* (2015).
[47] Cases AT.40181—*Philips*; AT.40182—*Pioneer*; AT.40465—*Asus*; AT.40469—*Denon & Marantz*, European Commission Decisions of 24 July 2018.

In *Casio*,[48] the CMA fined Casio £3.7 million for entering into a resale price maintenance (RPM) agreement with at least one of its main resellers to prevent the advertising or selling of digital pianos and keyboards below the prices specified by Casio. The CMA found that the agreement was monitored including by means of internet searching and software that provided reports based on automated searching. Automated price-monitoring software played a similar role in the parallel CMA investigations against other musical instrument manufacturers.[49]

In *Ageras*,[50] the Danish Competition Authority (DCCA) fined Ageras A/S DKK1.275.000 (c. €171,408.45) for setting minimum prices on the digital platform ageras.dk—which connects professional service providers with accountants, bookkeepers and lawyers. The DDCA found that by creating an algorithm and pop-up prompt informing individual partners on the platform of an "estimated market price" and disseminating "minimum quotes", Ageras invited the partners on the platform to enter into an illegal agreement with the intent of raising prices on the platform which amounted to a "by object" restriction of Danish and EU competition law. The DCCA found that the partners acquiesced to the arrangement by failing to publicly distance themselves from the practice or by explicitly consenting directly to Ageras. Further, the DCCA found that Ageras's "estimated market price" pop-up also acted as a price signal that reduced the uncertainty of the partners when bidding on the platform. The authority addressed its decision only to Ageras because Ageras initiated the practices, and implemented the algorithm and pop-up prompts.

There are also ongoing investigations. For example, the Spanish competition authority (CNMC) has opened an investigation into anti-competitive agreements in the real estate intermediation market.[51] The CNMC is investigating whether this co-ordination was implemented by means of software and digital platforms and is exploring whether the conduct has been facilitated by IT firms offering real estate brokerage software and algorithms.

In these examples, there was a very clear anti-competitive agreement underlying the use of the algorithms. Put differently, the algorithms were used to reinforce traditional anti-competitive agreements and limit price competition (i.e., lower prices). The misuse of price algorithms fits squarely within the existing legal framework, notably art.101 TFEU, which prohibits "all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the internal market, and in particular those which: (a) directly or indirectly fix purchase or selling prices …". The fact that these practices are implemented with price algorithms does not exonerate these companies.

Outside of these instances of explicit co-ordination, the empirical basis for anti-competitive collusion on the ground of pricing algorithms is limited. For example, in its latest report on algorithms, the CMA noted "[i]n general, the risks of collusion in real-world markets is unclear due to a relative paucity of empirical evidence. (…) there have been few enforcement cases by competition authorities against firms that used pricing algorithms to enforce explicit collusive agreements", the report added "[w]hilst there has been a lot of attention and discussion of algorithmic harms in general, there is relatively little empirical work on some of the specific areas of consumer and competition harms, and almost none that we are aware of in the UK".[52]

In any event, existing Commission Guidance would seem apt to deal with many of the potential concerns associated with pricing algorithms.

(ii) Other co-ordinated effects: price algorithms that implement co-operation agreements

Also outside the area of deliberate misuse, the existing legal framework would seem fit for purpose to assess potential co-ordinated effects arising from the use of pricing algorithms.

For example, some pricing algorithms may be best assessed as joint commercialisation agreements. Commercialisation agreements involve co-operation between competitors in the selling, distribution or promotion of their substitute products.[53] An example could be a joint internet platform.[54] According to the Guidelines on horizontal co-operation agreements, a joint sales platform that sets uniform prices for all participating

[48] Case 50565-2, Online resale price maintenance in the digital piano and digital keyboard sector, CMA Decision of 1 August 2019.
[49] Case 50565-4, Online resale price maintenance in the synthesizer and hi-tech sector, CMA Decision of 29 June 2020; Case 50565-5, Online resale price maintenance in the electronic drum sector, CMA Decision of 22 July 2020; Case 50565-6, Online resale price maintenance in the digital pianos, digital keyboards and guitars sectors, CMA Decision of 17 July 2020.
[50] "Danish Competition Council: Ageras has infringed competition law", DCCA press release, 30 June 2020 *https://www.en.kfst.dk/nyheder/kfst/english/decisions/20200630-danish-competition-council-ageras-has-infringed-competition-law/* [Accessed 1 November 2021]; "Digital platform pays a fine of DKK 1.275.000 for violating the Danish Competition Act", DCCA press release, 12 July 2021 *https://www.en.kfst.dk/nyheder/kfst/english/judgements/20210712-digital-platform-pays-a-fine-of-dkk-1-275-000-for-violating-the-danish-competition-act/* [Accessed 1 November 2021].
[51] "The CNMC opens antitrust proceedings against seven firms for suspected price coordination in the real estate intermediation market", CNMC press release, 19 February 2020 *https://www.cnmc.es/sites/default/files/editor_contenidos/Notas%20de%20prensa/2020/2020219%20NP%20Intermediation%20Market%20EN.pdf* [Accessed 17 November 2021].
[52] "CMA's consultation paper on algorithms", *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/954331/Algorithms_++.pdf* [Accessed 1 November 2021], para.2.87.
[53] See Commission Guidelines on the applicability of art.101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements [2011] OJ C11/1 (Guidelines on horizontal co-operation agreements"), para.225.
[54] Guidelines on horizontal co-operation agreements, para.254.

merchants would normally amount to a restriction under art.101(1) but may well be justified under art.101(3) TFEU.[55]

The Guidelines on horizontal co-operation agreements provide a useful framework against which to assess pricing algorithms in this respect. First, some pricing algorithms are likely to qualify as "by object" restrictions. This is the case when the algorithm amounts to price fixing or has the object of co-ordinating the pricing policy of competing merchants.[56] If the arrangement results in an "overall co-ordination of the prices charged by the parties", the fact that merchants also sell into channels not covered by the arrangement does not change the analysis.[57] In these situations, a pricing algorithm would have to be justified under art.101(3) TFEU, which will require that price fixing is indispensable for the integration of other marketing functions, and this integration will generate substantial efficiencies.[58]

Importantly, the Guidelines on horizontal co-operation agreements indicate that restrictive effects are unlikely if the parties' market shares do not exceed 15%. A safe harbour applies to any commercialisation agreement that does not amount to a "by object" restriction and that fall below this threshold. Outside this safe harbour, no presumptions apply and restrictive effects need to be proven. Relevant factors to establish restrictive effects for purposes of commercialisation agreements are market power and commonality of costs. If a collusive effect has been established, the commercialisation agreement may still be justified if it comes with efficiency gains. According to the Guidelines on horizontal co-operation agreements, this can happen in the form of lower prices or better product quality or variety.[59]

The Guidelines on horizontal co-operation agreements contain an instructive example concerning joint internet platforms.[60] If a number of smaller merchants join an electronic platform for the promotion, sale and delivery of their products or services and this platform sets uniform prices, then this will likely be considered a by object restriction. However, if it can prove, for example, that the arrangement results in greater choice, higher quality service or the reduction of search costs, that the participating merchants are still able to operate individually and compete in other sale channels, and that there are other platforms, then it may likely be eligible for justification under art.101(3) TFEU.

A similar framework would seem appropriate for companies using a common algorithmic system to determine prices and react to changes in the market, including by using the same software or services supplied by a third-party, or by delegating their pricing decisions to a common intermediary.

The *Eturas* case[61] sets out clear limits. This case concerned a commercial online booking platform for licensed travel agents. The platform administrator had sent a message to the travel agents, via the platform's personal electronic mailbox, informing them that the discounts on products sold through the system would be capped. Following the dissemination of that message, the system underwent the technical modification necessary to implement that measure. In that context, the CJEU had to determine under what conditions the travel agents could be held liable. The CJEU ruled that the concept of a concerted practice implies concertation among the companies at hand and consequently their conduct on the market. The CJEU held that

> "[I]f it cannot be established that a travel agency was aware of that message, its participation in a concertation cannot be inferred from the mere existence of a technical restriction implemented in the system at issue in the main proceedings, unless it is established on the basis of other objective and consistent indicia that it tacitly assented to an anticompetitive action."

(iii) Other co-ordinated effects: Price algorithms that facilitate information exchange

Price algorithms can in some cases be more appropriately assessed as information exchanges.[62] This may apply for example in the case of companies using common or similar algorithms based on market data, which they use to inform, but not automate, their pricing decisions.

The Commission Guidance recognises that information exchange "may solve problems of information asymmetries", "may improve [companies'] internal efficiency through benchmarking against each other's best practices", "may also help companies to save costs by reducing their inventories, enabling quicker delivery of perishable products to consumers, or dealing with unstable demand" and "may directly benefit consumers by reducing their search costs and improving choice".[63] The same arguments also apply to pricing algorithms.

The Commission Guidance also cautions that the exchange of information may lead to restrictions of competition in particular situations. This can be the case "where the exchange is liable to enable undertakings to be aware of market strategies of their competitors" and

[55] Guidelines on horizontal co-operation agreements, para.254.
[56] Guidelines on horizontal co-operation agreements, para.234.
[57] Guidelines on horizontal co-operation agreements, para.235.
[58] Guidelines on horizontal co-operation agreements, para.246.
[59] Guidelines on horizontal co-operation agreements, para.250.
[60] Guidelines on horizontal co-operation agreements, para.254.
[61] *Eturas UAB v Lietuvos Respublikos Konkutencijos Taryba* (C-74/14) EU:C:2016:42; [2016] 4 C.M.L.R. 19 at [44].
[62] Guidelines on horizontal co-operation agreements, para.55: "Information exchange can take various forms. Firstly, data can be directly shared between competitors. Secondly, data can be shared indirectly through a common agency (for example, a trade association) or a third party such as a market research organisation or through the companies' suppliers or retailers".
[63] Guidelines on horizontal co-operation agreements, paras 57 and 96.

ultimately depends on "the characteristics of the market in which it takes place (such as concentration, transparency, stability, symmetry, complexity etc.) as well as on the type of information that is exchanged, which may modify the relevant market environment towards one liable to coordination".[64] Such case by case assessment would seem appropriate in relation to pricing algorithms.

Information exchanges are assessed under two frameworks: "by object" restrictions and "by effect" restrictions. The "by object" treatment of information exchange should normally be limited to "individualised data regarding intended future prices or quantities".[65] With respect to "by effect" restrictions, the Guidelines provide that "effects of an information exchange on competition must be analysed on a case-by-case basis", that this requires a comparison between "the likely effects of the information exchange with the competitive situation that would prevail in the absence of that specific information exchange" and that this requires an "appreciable adverse impact on one (or several) of the parameters of competition such as price, output, product quality, product variety or innovation".[66]

The following section from the Guidelines is particularly relevant:

> "it is important to assess the restrictive effects of the information exchange in the context of both the initial market conditions, and how the information exchange changes those conditions. This will include an assessment of the specific characteristics of the system concerned, including its purpose, conditions of access to the system and conditions of participation in the system. It will also be necessary to examine the frequency of the information exchanges, the type of information exchanged (for example, whether it is public or confidential, aggregated or detailed, and historical or current), and the importance of the information for the fixing of prices, volumes or conditions of service".[67]

These same principles would seem applicable to the use of algorithms in the circumstances outlined above.

With respect to the type of information, the Guidelines indicate that

> "an information exchange that contributes little to the transparency in a market is less likely to have restrictive effects on competition than an information exchange that significantly increases transparency. Therefore it is the combination of both the pre-existing level of transparency and how the information exchange changes that level that will determine how likely it is that the information exchange will have restrictive effects on competition. The pre-existing degree of transparency, inter alia, depends on the number of market participants and the nature of transactions, which can range from public transactions to confidential bilateral negotiations between buyers and sellers. When evaluating the change in the level of transparency in the market, the key element is to identify to what extent the available information can be used by companies to determine the actions of their competitors".[68]

In terms of the granularity of the data, the Commission takes the view that

> "collection and publication of aggregated market data (such as sales data, data on capacities or data on costs of inputs and components) by a trade organisation or market intelligence firm may benefit suppliers and customers alike by allowing them to get a clearer picture of the economic situation of a sector. Such data collection and publication may allow market participants to make better-informed individual choices in order to adapt efficiently their strategy to the market conditions".

This is important as an algorithm may serve the same purpose as a market intelligence firm.

The Commission takes the view that "[i]n general, exchanges of genuinely public information are unlikely to constitute an infringement of Article 101",[69] noting that "[f]or information to be genuinely public, obtaining it should not be more costly for customers and companies unaffiliated to the exchange system than for the companies exchanging the information".[70] Also market coverage matters: "For an information exchange to be likely to have restrictive effects on competition, the companies involved in the exchange have to cover a sufficiently large part of the relevant market".[71] The Commission takes the view that the minimum market coverage cannot be determined in the abstract but may be as high as 25%.[72]

These distinctions are equally relevant for pricing algorithms. To establish anti-competitive effects it would have to be established, at the very least, that the algorithm makes use of price sensitive information (e.g., real-time competitor prices or other price sensitive data points, like future inventory or demand data) that is not generally available, including through other market monitoring tools.

[64] Guidelines on horizontal co-operation agreements, para.58.
[65] Guidelines on horizontal co-operation agreements, paras 73–74.
[66] Guidelines on horizontal co-operation agreements, para.75.
[67] Guidelines on horizontal co-operation agreements, para.76.
[68] Guidelines on horizontal co-operation agreements, para.78.
[69] Guidelines on horizontal co-operation agreements, para.92. See however *Del Monte Produce v Commission* (T-587/08) EU:T:2013:129 at [369], where the General Court held that the fact certain information could be obtained from other sources is not relevant as "the exchange system established enabled the undertakings concerned to become aware of that information more simply, rapidly and directly".
[70] Guidelines on horizontal co-operation agreements, para.92.
[71] Guidelines on horizontal co-operation agreements, para.87.
[72] Guidelines on horizontal co-operation agreements, para.88.

(b) Unilateral effects: the scope for enforcement in case of dynamic or personalised pricing

Pricing algorithms are meant to implement price changes, whether over time (dynamic pricing) or across customers (personalised pricing). Personalised pricing is a form of price differentiation (or price discrimination). A perfect mechanism of personalised pricing results in selling products at the exact price each customer is willing to pay. This is also known as first degree price discrimination, which may be very costly to operate in real life. More realistic than perfect price discrimination is a mechanism which sets different prices based on customer characteristics, i.e., independent from supply-side/cost-based differentiation. This is known as third-degree price discrimination. It should be emphasised that price discrimination is not limited to pricing algorithms, as there is price discrimination in any market that is subject to bargaining. However, it can be used to make price discrimination more effective (depending on the quality of the data used), more accurate, or more practical in markets that are not characterised by individual negotiations.

As discussed above, price discrimination can have beneficial and detrimental effects. Any form of price differentiation requires some degree of market power to avoid "high willingness to pay" customers switching over to competitors that offer standardised prices.[73] If this market power reaches a level of dominance, it may also lead to a competition law violation under art.102 TFEU. According to subpara.(c) of the second paragraph of art.102 TFEU, undertakings with a dominant position in the internal market, or in a substantial part of that market, are precluded from applying dissimilar conditions to equivalent transactions with other trading parties, thereby placing them at a competitive disadvantage, as trade between Member States may be affected.

The Uber model is often cited as an illustrative example. The Uber pricing methods ensure that the prices for a ride are increased by a multiplier if the demand for taxis is higher than the number of available drivers and vice versa. This is beneficial as it ensures that customers who urgently need a ride and thus are willing to pay more will find a vehicle while others postpone their demand. In this respect, Uber's algorithms are clearly beneficial for taxi drivers as well as customers. The only material concern then arises in relation to collusion between the taxi drivers, which can be assessed under the Horizontal Cooperation Guidelines, as explained above.

The conditions for illegal price discrimination by dominant companies have been developed in CJEU case law. It was most recently discussed in the *MEO* case.[74] The case concerned a dispute between television broadcaster MEO and royalty collection organisation GDA. MEO had lodged a complaint with the Portuguese competition authority alleging inter alia that GDA had applied less favourable terms to MEO than to another television broadcast company. This dispute reached the CJEU, which was asked whether competitive detriment for MEO was a condition for illegality. The CJEU concluded that a finding of discrimination is not enough; there must also be findings that it hinders the competitive position of some of its business partners. Moreover, the court found that a disadvantage for some of the business partners is not sufficient: what is required is a distortion of competition between the business partners (but this distortion does not need to be quantified).[75] Relevant considerations are: the degree of market power, the degree of negotiating power, the conditions and arrangements for the charges, the duration of the price differences, the level of the price differences (notably the percentage of total costs), and the possible existence of a strategy aimed at hamstringing a particular business partner (or the absence of any interest to exclude a business partner).[76]

This suggests that the antitrust assessment of personalised or dynamic pricing should—at least from an antitrust perspective which tends to focus on exclusionary abuses—focus on the extent to which the personalised or dynamic pricing distorts the competitiveness of the suppliers' customers, even if the company concerned may hold a dominant position. Moreover, it provides a helpful framework for the assessment of personalised pricing to end-customers, by suggesting the relevance of available alternative sources of supply.

Increasingly, competition law enforcement has extended to what have traditionally been identified as exploitative abuses. While arguably, even for exploitative abuses, a plausible market effect is required, consumer protection laws supplement competition laws in this area and apply outside a market dominance framework. Consumer protection laws may for example prohibit firms from implementing personalised pricing in a non-transparent way, requiring them to disclose information about their pricing strategies; or investigate and sanction ancillary unfair practices that may reinforce the negative effects of personalised pricing, such as misleading practices that limit transparency and consumer choice.[77]

[73] "Joint French-German study on algorithms", *https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Berichte/Algorithms_and_Competition_Working-Paper.html* [Accessed 1 November 2021], p.6.
[74] *MEO–Serviços de Comunicações e Multimédia v Autoridade da Concorrência (MEO)* (C-525/16) EU:C:2018:270.
[75] *MEO* EU:C:2018:270 at [26].
[76] *MEO* EU:C:2018:270 at [31] and [34].
[77] Directive (EU) 2019/2161 of the European Parliament and of the Council of 27 November 2019 amending Council Directive 93/13/EEC and Directives 98/6/EC, 2005/29/EC and 2011/83/EU of the European Parliament and of the Council as regards the better enforcement and modernisation of Union consumer protection rules recital 45: "[…] Consumers should therefore be clearly informed when the price presented to them is personalised on the basis of automated decision-making, so that they can take into account the potential risks in their purchasing decision. Consequently, a specific information requirement should be added to Directive 2011/83/EU to inform the consumer when the price is personalised, on the basis of automated decision-making". See also art.6 Directive 2011/83 (consumer rights directive): "Before the consumer is bound by a distance or off-premises contract, or any corresponding offer, the trader shall provide the consumer with the following information in a clear and comprehensible manner: where applicable, that the price was personalised on the basis of automated decision-making".

Conclusion

In this article we have outlined recent reports, discussed potential competition law frameworks, and suggested that the focus should be on the competitive impact of the algorithm based on its use (with or without co-ordination, informative or indicative, and distorting or otherwise affecting downstream competition) rather than seeking to describe its formulas, which will self-learn to improve over time.

It is clear that where an algorithm is used to reinforce traditional anti-competitive agreements, they involve an outright violation of competition law. Similarly, algorithms should not be designed with the goal to enable or facilitate collusion, should not be intentionally exposed to competitors, and should not be programmed to switch between collusive and non-collusive pricing decisions conditional upon a competitor's reactions to signals, for example.[78] However, outside these instances involving clear anti-competitive intent, it is important to balance the potential pro- and anti-competitive effects of a pricing algorithm.

Having identified a potential framework for the assessment of pricing algorithms under the existing competition laws, we want to conclude by offering a few suggestions to reduce enforcement risk.

(a) First, the use of algorithms should be transparent, continually risk-assessed and allow for full accountability.

(b) Secondly, it is advisable for companies to clearly document the intent and purpose of their dynamic pricing initiatives both in business and technical context and changes in use over time[79] (e.g., ensuring new entrants, lower prices, enabling a better match between supply and demand). It can be relevant to document the competitors whose prices are factored in and the timeline for price optimisation.[80]

(c) Thirdly, it is important to be mindful of the data used in a common algorithm (e.g., applied by a platform), to refrain from disclosing specific information about a common pricing algorithm (i.e., structure, workings, data content) and not to inform partners who use the common algorithm if their competitors participate in the same dynamic pricing program.

(d) Fourthly, certain safeguards may be included in the contractual arrangements between the user and a software provider or a platform (e.g., the user could restrict the vendor from using the company's data for other than the contractual purposes and not to disclose or use it for other engagements, or to exclude the identification of industry participants using the algorithm).[81]

(e) Fifthly, users of algorithms may want to implement a practice to regularly assess price developments to monitor their effects as consistent with the stated purpose, and identify patterns that are not consistent with the structure of the market.[82]

(f) Sixthly, it may be prudent to allow for users of an algorithm tool to override or opt out of the tool and default back to manual pricing in certain instances or circumstances.

(g) Finally, good compliance practice could require experimental testing to see if pricing algorithms would lead to tacit collusion.[83]

Having these safeguards in place should be helpful in avoiding potential exposure, especially in markets where the use of pricing algorithms is common.

[78] OECD, "Competition Compliance Programmes", 2021, *https://www.oecd.org/daf/competition/competition-compliance-programmes-2021.pdf* [Accessed 1 November 2021], pp.39–40; Ai Deng, "From the Dark Side to the Bright Side: Exploring Algorithmic Antitrust Compliance", 13 December 2019, *https://www.nera.com/content/dam/nera/publications/2019/PUB_AT_Algorithmic-Compliance.pdf*.

[79] "Joint French-German study on algorithms", *https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Berichte/Algorithms_and_Competition_Working-Paper.html* [Accessed 1 November 2021], p.62; Furman report, *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], para.3.171; Autoridade da Concorrencia, "Digital ecosystems, Big Data and Algorithms", July 2019, para.275.

[80] "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], para.8.7; The Furman report (March 2019), *https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/785547/unlocking_digital_competition_furman_review_web.pdf* [Accessed 1 November 2021], para.3.171.

[81] "Joint French-German study on algorithms", *https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Berichte/Algorithms_and_Competition_Working-Paper.html* [Accessed 1 November 2021], p.37.

[82] "CMA's economic working paper on the use of algorithms", *https://www.gov.uk/government/publications/pricing-algorithms-research-collusion-and-personalised-pricing* [Accessed 1 November 2021], para.9.1.

[83] OECD, "Competition Compliance Programmes", *https://www.oecd.org/daf/competition/competition-compliance-programmes-2021.pdf* [Accessed 1 November 2021], pp.39–40.