1. Introduction

Humans have been creating and using algorithms for thousands of years [1], but never before have the effects of algorithms been so pervasive in our everyday lives and the functioning of the economy as a whole. Recent developments in technologies relating to computer processing power, data storage, and artificial intelligence have enabled the adoption of increasingly sophisticated algorithms that are reshaping competitive landscapes across industries, raising many new questions about competition and antitrust in the process. This article focuses on three areas of antitrust where the use of algorithms has drawn scrutiny from both enforcers and practitioners around the globe: collusion, mergers, and algorithm self-preferencing.

2. Collusion

While antitrust enforcers, researchers, and practitioners generally agree that algorithms can facilitate price discovery and promote competition, there have been concerns that the increasing use and sophistication of algorithms may make it easier for competitors to engage in explicit or tacit collusion [2]. Moreover, antitrust enforcers, researchers, and practitioners have identified two enforcement challenges associated with algorithmic collusion. First, because algorithms can be complex and obscure, collusion facilitated by algorithms may be harder to detect [3]. Second, tacit collusion by learning algorithms, which is theorized to be possible without human intervention, would not be considered illegal under the current competition laws [4].
As such, competition authorities and scholars have spent considerable effort studying algorithmic collusion. In this section, we summarize recent developments in case laws, regulations, and academic research on algorithmic collusion.

Because algorithms vary by use and sophistication, the discussions regarding algorithmic collusion are often divided into three general scenarios: 1) algorithms that facilitate explicit collusive agreements, 2) algorithms in hub-and-spoke settings, and 3) autonomous algorithmic collusion. Below, we discuss each scenario separately.

2.1. Algorithms that Facilitate Explicit Collusive Agreements

In this scenario, just like in any “traditional” price-fixing schemes, there is an explicit agreement to fix prices among competitors. Algorithms are merely vehicles through which the agreements are carried out. Competition authorities have noted that even though the involvement of an algorithm in this scenario does not change the applicable legal framework, it is necessary to understand the algorithms at issue to evaluate the competitive effects of the alleged conspiracy [5].

Competition authorities have investigated a few cases in which firms used algorithms to facilitate explicit agreements to collude. For example, as early as 2015, the Antitrust Division of the US Department of Justice ("DOJ") and the Competition and Markets Authority in the UK ("CMA") investigated a price-fixing scheme among online poster sellers, in which the sellers allegedly adopted specific pricing algorithms to coordinate prices [6]. In 2020, the Spanish Competition Authority ("CNMC") opened proceedings against several property websites, alleging that those companies coordinated prices and other terms of sales by real estate agents "through the design of real estate brokerage software and the algorithms embedded in them" [7].

2.2. Algorithms in Hub-and-Spoke Settings

In the context of algorithmic collusion, hub-and-spoke arrangements typically arise where a platform, which connects suppliers with consumers, sets prices (or offers tools to set prices) through pricing algorithms. For example, Amazon provides automated pricing tools to its third-party sellers. As another example, ride-hailing platforms set prices for their drivers. Concerns have been raised that the algorithms in hub-and-spoke settings compromise suppliers’ abilities to set prices independently and reduce competition [8]. For example, the Romanian Competition Authority noted that algorithms used by ride-hailing platforms may facilitate collusion even though they are not explicitly designed to do so [9]. In 2018, the Competition Commission of India (the “CCI”) investigated and dismissed an allegation that Uber and Ola (a local ride-hailing service similar to Uber) used their respective algorithms to facilitate price-fixing among drivers. [10] The CCI found that there was no prima facie case because no agreement to fix prices existed between Uber and Ola and because no agreement to fix prices existed among the drivers themselves. [11] The CCI’s decision was upheld by the Indian Company Law Appellate Tribunal in 2020. [12]

Unlike the CCI that concluded that "a hub-and-spoke cartel would require an agreement between [spokes] to set prices through the platform or an agreement for the platform to coordinate prices between them," the Danish Competition and Consumer Authority (DCCA) did not view the existence of an agreement as a requirement for finding anticompetitive conduct. In its recent investigation of Ageras, a platform that connects professional service providers such as tax preparers to their clients, the DCCA found that Ageras violated the Danish Competition Act by informing individual providers of “estimated market prices” for specific opportunities and disseminating “minimum quotes” for certain leads [13].
2.3. Autonomous Algorithmic Collusion

There have been concerns that learning algorithms may increase the likelihood of tacit collusion, perhaps without direction from or even knowledge of humans \[^{14}\]. That is, even in cases when companies adopt separate, unilaterally designed pricing algorithms, there is concern that the algorithms themselves may converge to collusive strategies that result in supracompetitive prices.

There is a growing body of literature on the relationship between autonomous pricing algorithms and competition. Those studies focus on learning algorithms that are set to maximize profits and compete in a repeated fashion with no end in sight \[^{15}\]. Some of those studies find that learning algorithms can converge to supracompetitive prices in laboratory settings, demonstrating that autonomous algorithmic collusion is theoretically possible \[^{16}\]. Others note that a change in the environment may lead to opposite results, suggesting that the effect of autonomous pricing algorithms on competition may depend on the circumstances under which those algorithms are used \[^{17}\]. Moreover, the complexity and nuance of the economics behind collusion also means that whether and how autonomous algorithms will affect competition will likely be a case-specific inquiry \[^{18}\]. Indeed, competition authorities and researchers have highlighted the need for a better understanding of how autonomous pricing algorithms affect competition in the real world.

3. Merger Analysis

To this day, the majority of algorithmic antitrust-related cases brought by competition authorities, both in Europe and other regions of the world, have involved algorithmic collusion or unilateral conduct as opposed to mergers. Nevertheless, antitrust experts have raised concerns about how pricing algorithms could potentially challenge traditional economic tools used in merger analyses.

Pricing discrimination consists of charging different prices to different customers for the same product, based on their willingness to pay for that product \[^{19}\]. Pricing discrimination has been in use since long before the adoption on digital platforms, for instance through special discounts offered to certain types of customers (e.g., students), and the European Commission ("EC") had already acknowledged back in 1997 that pricing discrimination could create narrower relevant product markets \[^{20}\]. Competition authorities are also not strangers to analyzing price discrimination cases that involve the use of algorithms. As an example, airline companies have been offering different prices to different customers using algorithms for years. In its decisional practice for assessing relevant markets in airlines merger cases, the EC has considered distinguishing customer groups, such as time-sensitive and non-time-sensitive passengers or premium and non-premium customers \[^{21}\].

Antitrust experts and international organizations have raised concerns about the implications that algorithmic price discrimination could have on the merger review process. In 2017, the OECD mentioned in its paper on algorithms and collusion that pricing algorithms could raise specific challenges to competition tools that are used to measure market power, such as the SSNIP (Small but Significant and Non-Transitory Increase in Price) test. These tools usually involve price comparisons, and pricing algorithms "are capable of changing prices based on supply and demand at such a speed and with so many interactions between them that a standard price comparison will be quite a difficult exercise" \[^{22}\].

In a 2017 article by Terrell McSweeney, then Commissioner at the U.S. Federal Trade Commission ("FTC"), and Brian O’Dea, also of the FTC, the authors considered how the fracturing of relevant markets enabled by algorithmic price discrimination in digital commerce may require antitrust authorities to assess an increasing number of potential relevant markets, arguing that pricing algorithms could "increase the chances that a given merger will harm
consumers in some relevant market even if the remaining post-merger competition is sufficient to protect the majority of consumers” [23]. The authors warned that structural remedies to mergers such as divestiture could be more difficult to design by enforcers because companies might not have discrete assets associated with targeted price discrimination markets. McSweeny and O’Dea recommended enforcers to consider behavioral remedies, such as “tethering” the prices for customers in the price discrimination markets of concern to certain prices in other markets [24].

The EC, in its 2019 report on competition policy for the digital era, also argues that the digitization of the economy requires a deep re-thinking of the concepts of market power and market definition: “[i]n the digital world, it is less clear that we can identify well-defined markets. Furthermore, in the case of platforms, the interdependence of the markets becomes a crucial part of the analysis whereas the role of market definition traditionally has been to isolate problems” [25]. Overall, the application of traditional competition tools for merger review from the brick-and-mortar framework to the digital world is an area of active debate among antitrust experts and careful economic analysis will be needed in the coming years.

4. Algorithm Self-Preferencing

With the rise of new technology platforms in areas such as e-commerce, social media, and news feeds, search and recommendation algorithms have also risen to prominence as mechanisms that influence much of consumers’ decisions. Another active area of development and debate regarding new antitrust issues in digital markets is the competitive implications of search or recommendation algorithms that provide preferential treatment for the firm’s own products or services.

4.1. Recent Enforcement Actions

In the early 2010s, unilateral conduct involving algorithm bias drew the attention of competition enforcers when both the FTC and the EC opened antitrust investigations into Google in response to allegations that it unfairly promoted its own content on the Google search results page and selectively demoted competitors’ content [26]. The FTC closed its investigation in 2013 and found that the evidence did not support the allegation that Google’s changes to its search algorithms were made without a legitimate business justification and Google’s changes could plausibly be viewed as an improvement in the overall quality of its search results [27]. The EC, on the other hand, fined Google €2.42 billion in 2017 for abusing “its market dominance as a search engine by giving an illegal advantage to another Google product, its comparison shopping service” [28]. Despite these decisions, the question of whether Google’s search result placement practices are anticompetitive remains unresolved. In Europe, the EC’s decision is under appeal at the EU General Court [29]. Across the Atlantic, a 2020 report issued by the U.S. House Committee on the Judiciary calls for antitrust investigation into whether Google’s “self-preferencing” practices have “had the effect of privileging Google’s own inferior services while demoting competitors’ offerings” [30]. How the U.S. and EC antitrust investigations into Google’s search result placement unfold in the next few years could be an important bellwether for competition enforcement in this area.

In the years following the FTC’s and EC’s Google decisions, other competition authorities from around the world have also increasingly focused on potential antitrust implications from algorithm bias. In June 2021, the French Competition Authority fined Google €220 million for having abused its dominant position in the advertising server market for website and mobile application publishers by implementing practices that favored its own advertising technologies. The Authority stated that this “is the first decision in the world to look into complex algorithmic auctions processes through which online display advertising works” [31]. Earlier in 2021, the Chinese competition authority, the State Administration for Market Regulation (“SAMR”), issued a CNY 18 billion fine to the e-commerce
platform Alibaba for abusing its dominant position on the e-commerce platform market to induce retailers to market their products exclusively on Alibaba’s platforms. The SAMR found that Alibaba enforced its exclusivity requirement, in part, by reducing the search visibility of retailers’ products on Alibaba’s platforms if that retailer sold on other platforms [32]. In addition to these investigations, competition authorities from China, Japan, and the UK have all recently issued reports or guidelines that flag self-preferencing algorithms as an area of antitrust concern [33].

4.2. Balancing of Competitive Effects

Although the effect of self-preferencing algorithms is a relatively new topic in the world of antitrust, its economic implications can be explained using well-known economic principles. The core antitrust concerns that arise from algorithm self-preferencing are similar to concerns that arise from the tying of products, because in both situations, the antitrust concern is with the potential misuse of market power in one market to suppress competition in a separate market. It is recognized that tying could have both pro-competitive and anticompetitive implications, and that analysis of the specifics of each case is required to assess the net effect on competition. Courts have often adopted a “rule of reason” approach to antitrust tying, under which the benefits to consumers and potential restrictions to competition are assessed and balanced on a case-by-case basis. Although there are still relatively few antitrust cases involving algorithm self-preferencing, a similar case-by-case balancing approach would likely be appropriate given the complexities of these situations.

As with instances of tying, potential procompetitive benefits of self-preferencing algorithms include increased convenience for consumers and improved product functionality (similar to the FTC’s findings regarding Google’s algorithm and design changes in 2013). Similarly, potential anticompetitive effects of self-preferencing algorithms may be akin to those from anticompetitive tying, such as restricting rivals’ entry or ability to compete. As with tying cases, determining the net competitive effect of self-preferencing algorithms requires careful analysis of the facts of each case.

When assessing the competitive effects of self-preferencing algorithms, attention should also be given to the incentives for product development and innovation, especially under “freemium” business models such as those employed by popular services (e.g., LinkedIn, Dropbox, Spotify, and Adobe PDF) [34]. Under the “freemium” model, companies often give away the core product for free and then monetize for-fee products or services through ads or cross-selling paid services. For example, Dropbox gives away free online storage accounts and monetizes part of that userbase by cross-selling its paid premium accounts with added functions and storage capacities [35]. Such “freemium” strategies involving zero pricing can be helpful for enticing consumers to try unfamiliar technologies and for acquiring a critical mass of users. This type of customer growth strategy may be especially important for products in multi-sided markets that require buy-in from both consumers and producers (such as a job search platform that would require buy-in from both employers and job seekers). Referral algorithms used in such cross-promotions would be necessarily self-preferencing the company’s products. However, if companies’ abilities to monetize using self-preferencing algorithms are restricted, then many innovative and beneficial products that depend on the “freemium” business model may become economically unsustainable. When weighing the pro- and anticompetitive effects of self-preferencing algorithms, it is important to account for the role that such algorithms play in supporting the many free products and services that consumers currently enjoy.

5. Conclusion
As the discussions show, there have been many recent developments in antitrust involving concerns arising from the increasing use and sophistication of algorithms, but the development of the frameworks and tools for assessing those issues is at its early stage. Recent enforcement actions taken by competition authorities around the world suggest that the demand for such frameworks and tools is high. As those investigations unfold, we expect to see more developments in those areas.

Note from the Editors: although the e-Competitions editors are doing their best to build a comprehensive set of the leading EU and national antitrust cases, the completeness of the database cannot be guaranteed. The present foreword seeks to provide readers with a view of the existing trends based primarily on cases reported in e-Competitions. Readers are welcome to bring any other relevant cases to the attention of the editors.


[7] CNMC. The CNMC opens antitrust proceedings against seven firms for suspected price coordination in the real estate intermediation market. 19 Mar. 2020 ; See Spanish Competition Authority, The Spanish Competition Authority suspends most procedures in line with the Government’s Royal Decree declaring a state of alert but keeps open the e-services portal for procedures whose parties can prove that delay is against public interest, 19 mars 2020, e-Competitions March 2020, Art. N° 93812.


[10] Indian Competition Authority. Samir Agrawal / ANI Technologies / Uber India, Case No. 37/2018. 6 Nov. 2018 ; See Man Mohan Sharma, The Indian Competition Authority dismisses cartel allegations against taxi app drivers on the basis that they were following the algorithm pricing and not actively colluding to fix prices (Samir Agrawal / ANI Technologies / Uber India), 6 November 2018, e-Competitions November 2018, Art. N° 89446.


Within the economics literature, this is known as a repeated game with infinite horizon. [15]


For example, Johnson, Rhodes, and Wildenbeest (2020) find that collusion can be thwarted if platforms provide longer prominence to sellers whose behavior is consistent with a deviation from a collusive agreement. See, Johnson, Justin, et al. “Platform Design When Sellers Use Pricing Algorithms.” Working Paper, SSRN 3691621, 2020. [17]


EC. “Commission Notice on the definition of relevant market for the purposes of Community competition law.” Official Journal of the European Communities, 372, Sep. 1997, p. 5-13, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31997Y1209(01)&from=EN, ¶ 43 (“A distinct group of customers for the relevant product may constitute a narrower, distinct market when such a group could be subject to price discrimination. This will usually be the case when two conditions are met: (a) it is possible to identify clearly which group an individual customer belongs to at the moment of selling the relevant products to him, and (b) trade among customers or arbitrage by third parties should not be feasible.”) The U.S. Horizontal Merger Guidelines also discuss the feasibility of price discrimination when two conditions are met: “differential pricing and limited arbitrage.” See, U.S. DOJ and the FTC. Horizontal Merger Guidelines, Aug. 2010, p. 6, https://www.justice.gov/sites/default/files/atr/legacy/2010/08/19/hmg-2010.pdf. [20]


Antitrust, vol. 32, no. 1, 2017, pp. 76-79,  


[28] EC. "Antitrust: Commission fines Google €2.42 billion for abusing dominance as search engine by giving illegal advantage to own comparison shopping service." 27 June 2017,  


[31] Autorité de la concurrence. "The Autorité de la concurrence hands out a €220 millions fine to Google for favouring its own services in the online advertising sector." 7 June 2021,  

[32] SAMR. Press release of SAMR’s 2021 decision regarding Alibaba's. Apr. 2021,  

https://www.gov.uk/government/publications/algorithms-how-they-can-reduce-competition-and-harm-consumers (discussion of “unfair ranking and design”); See UK Competition Authority, The UK Competition Authority publishes new research on algorithms showing how they can reduce competition in digital markets, 19 janvier 2021, e-Competitions January 2021, Art. N° 98866; Ariane Le Strat, Peter Willis, The UK Competition Authority
