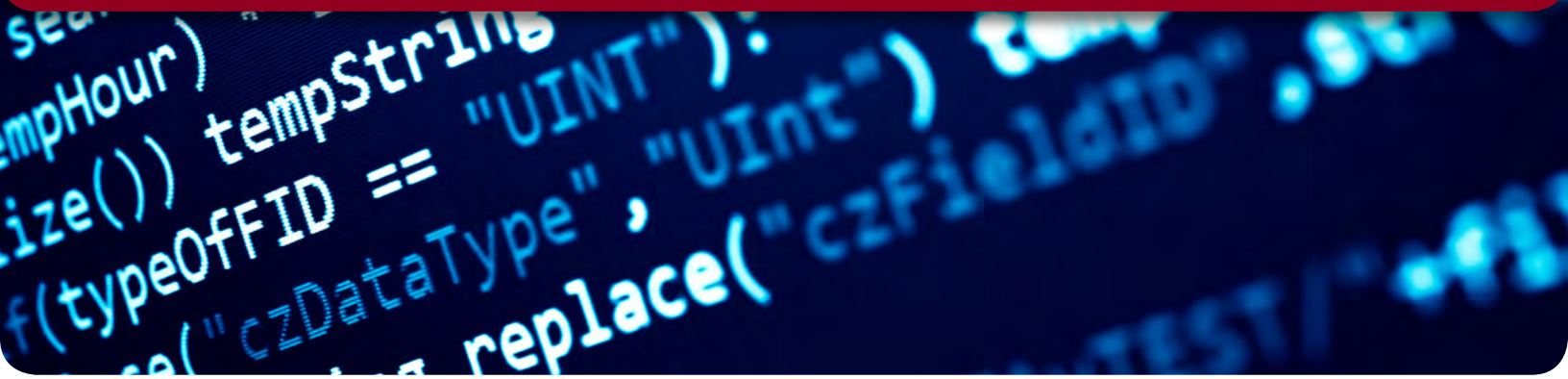
ALGORITHMS AND COMPETITION: FRIENDS OR FOES?



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I. INTRODUCTION

There has been a recent wave of distress in some corners of the antitrust community about the hypothesis that, with the fast development of machine learning and the growing popularity of pricing algorithms, firms are developing new sophisticated strategies to collude under the radar of antitrust watchdogs. Among several possible theories of harm, there is the concern that artificially intelligent machines may be causing competitive harm by coordinating prices in a much more efficient way than what a human being could ever aspire to do. We will focus this paper on this particular risk and leave aside other possible theories of harm.

The lively debate that is growing around this topic, while initially kept more at an academic level, is now reaching antitrust practitioners, competition authorities, governments and international fora such as the OECD, which hosted in June 2017 a Roundtable on Algorithms and Collusion. What's the verdict? Well, the jury is still out and while some commentators remain skeptical about the risks of algorithms, possibly concerned with the burden that a stronger antitrust enforcement could pose on businesses, others claim that this is a sensational discussion not to be taken more seriously than stories about machines taking control over humans.

So which of these visions is true? Are competition policy debates turning into arenas to discuss science fiction stories that serve only to stimulate our intellect? Or do we increasingly live in a world where some market players, using complex computer codes, can exploit and harm those who do not dominate technology?

While it is probably exaggerated to say that computer algorithms will dramatically change everything we know about competition, it would also be unwise to ignore the clear signals that markets are changing, as well as the resulting implications for competition policy. Apart from the evidence of cartels in multiple jurisdictions that have been facilitated by advanced technology, the fact that the risks of algorithms are being taken very seriously by heads of agency and even heads of State suggests, at the very least, that this problem deserves deeper scrutiny before one chooses to disregard it.

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In the analysis of this problem, it is equally important to avoid over simplistic approaches, such as assuming *a priori* that algorithms always facilitate anti-competitive agreements prohibited by competition law. Although in some cases this might be true, in other cases algorithms may raise new questions that require a more articulated analysis. In particular, it is important to evaluate whether algorithms might allow companies not only to collude in a wider spectrum of market structures, but also to do so without necessarily triggering a violation of competition laws, challenging thus existing antitrust approaches.

II. CAN ALGORITHMS ALTER STRUCTURAL CONDITIONS THAT FACILITATE COLLUSION?

The likelihood of collusion in a given industry depends on different market characteristics, which are commonly known as relevant factors for collusion. At first sight, it is hard to establish the impact of algorithms on the likelihood of collusion, as automated tools might affect relevant factors in different directions. Consider the following examples.

Relevant factors for collusion		How do algorithms affect collusion?
Structural characteristics	Structural characteristics	±
	Barriers to entry	±
	Market transparency	**+**
	Frequency of interaction	**+**
Demand variables	Demand growth	0
	Demand fluctuations	0
Supply variables	Innovation	-
	Cost asymmetry	-

Legend: + positive impact; - negative impact; 0 neutral impact; ± ambiguous impact.
Source: OECD (2017), "Algorithms and Collusion, Background note by the Secretariat, DAF/COMP(2017)4.

In the first place it is unclear how algorithms may affect the number of firms and barriers to entry, which are traditionally identified as two of the most important structural characteristics that affect the risk of collusion. While it is true that typical high-technology industries have a small number of large players (as is the case of search engines, online marketplaces and social networks), this is not necessarily a direct consequence of their proprietary algorithms and associated competitive advantage. After all, small companies can also develop better technologies to displace market incumbents, as has happened multiple times in the past.

In addition, the impact of algorithms on some supply factors could actually reduce the risk of collusion. For instance, algorithms are naturally an important source of innovation, allowing companies to develop non-traditional business models and extract more information from data, in order to improve product quality and customization. Similarly, if algorithms allow companies to differentiate their services or the production process in such a way that leads to cost asymmetry, collusion might be again harder to sustain, due to the inherent difficulties of finding a focal point to coordinate and as a result of the low incentives for the low-cost firms to collude.

Although the overall effect on collusion appears to be generally ambiguous, algorithms may likely affect some relevant factors for collusion more significantly than others. In particular, there is currently a concern that, as a result of recent technological developments, markets are becoming highly transparent and firms are increasingly able to use automated tools to interact quickly. This appears to be the case of financial markets, where the combination of transparency and high-frequency trading has already been responsible for some market distortions.

In order to evaluate the potential impact of these two market characteristics on collusion, a simple theoretical exercise can show that, when markets are sufficiently transparent and the retaliation lag is sufficiently small, collusion can always be sustained as an equilibrium strategy, no matter the market structure. The intuition for this result is straightforward: if markets are so transparent and reactive that firms can immediately detect and punish a deviation, no company has any incentive to deviate from an agreement.

It should be noted, however, that this result does not necessarily imply that collusion will be systematically observed in all digital markets. For instance, in less concentrated industries every player has an incentive to wait for other companies to form a cartel while remaining as an outsider, in order to benefit from the high price level charged by the cartel – the so-called "cartel umbrella." Therefore, in industries with many players, firms may still fail to coordinate despite the use of algorithms. Nonetheless economic theory suggests that algorithms could make collusion sustainable in a wider range of circumstances than before, possibly even in markets that were in the past characterized by fierce competition.

III. DO ALL FORMS OF ALGORITHMIC COLLUSION VIOLATE COMPETITION LAW?

It is important to make a distinction between instances where algorithms amplify conduct that is already covered under the current legal framework and instances where algorithms enable, to some extent, behaviors not covered by the current antitrust rules. Under the first scenario the discussion is rather straightforward, as algorithms ought to be assessed together with the main infringement that they enable. While detecting and proving the existence of such an infringement might be complex, agencies can nevertheless rely on existing rules on anti-competitive agreements, concerted practices and facilitating practices, which offer a framework to assess algorithms as practices ancillary to a main infringement.

Different considerations apply if algorithms replace formal cartels with tacit agreements which, not being forbidden by competition rules, would allow companies to extract an economic rent without the risk of triggering an antitrust violation. For that, firms can independently program algorithms to signal and coordinate a common policy as well as to monitor and punish deviators, all this without any explicit communication.

For instance, while in the past firms had to exchange detailed information in formal meetings in order to coordinate their pricing strategies, now they can unilaterally program algorithms to collect market data, monitor price variations and automatically retaliate if any company discounts. This is already facilitated, for example, by price aggregator websites, some of which use *scraping algorithms* that automatically extract updated price information from multiple companies' websites.

Algorithms may also serve as a much more effective tool to coordinate a tacit agreement by eliminating the cost of signaling. In the past, in order to propose a price rise without breaking the law, firms would have to increase prices for a significant amount of time in order to allow rivals to receive the signal and respond accordingly, risking in the meantime the loss of customers. Nowadays, firms can instantaneously execute countless price variations that are immediately detected by rivals, allowing them to coordinate strategies without giving enough time for consumers to react upon the price changes.

Although some competition authorities may investigate signaling practices under their competition law, more simple strategies can be implemented by firms in order to avoid fines and other sentences. In fact, in markets where products are sufficiently homogeneous, firms can simply program pricing algorithms to follow a market leader, by imitating in real time any price variations. Then, if the leader realizes what is happening without communicating with the remaining companies, this will very likely result in a collusive outcome that would hardly amount to an antitrust violation in any jurisdiction in the world.

In addition, some commentators have raised the hypothesis that firms can use machine learning techniques to make algorithms replicate a collusive outcome without being explicitly programed to do so. While machines that self-learn to collude may sound a lot like science fiction, some experiments in simulated environments have actually shown that neural networks are particularly good at reaching cooperative outcomes when playing the iterated prisoner's dilemma. Even though this hypothesis still remains to be empirically tested in real markets, the current antitrust toolkit of most jurisdictions might be unsuitable to detect, much less prosecute, this much nuanced form of (tacit) collusion.

IV. WHAT CAN COMPETITION AUTHORITIES DO?

In light of the many challenges brought by the rapid development of digital markets, some antitrust experts are advocating for the use of competition tools to reduce, as much as possible, the risk of collusion. This could involve, for instance, conducting market studies to identify industries where algorithms are more likely to harm competition; stronger merger control enforcement, by taking into consideration how algorithms might affect potential coordinated effects; and a variety of remedies, such as introducing auditing mechanisms for algorithms and applying "notice-and-take-down" processes if a considerable risk of collusion is detected.

The implementation of these and other traditional antitrust tools can certainly be helpful to address some of our most immediate concerns, but they might still be of little value to tackle more subtle forms of collusion that are not currently covered by competition law, particularly if these practices are increasingly widespread in a range of markets. In fact, while recognizing that the extent of algorithmic collusion is still unknown, policy makers might eventually be forced to reconsider some traditional competition law concepts, such as the legal approach to tacit collusion, the concept of agreement or the notion of liability.

Let's consider first the problem of tacit collusion, which is well known as one of the biggest antitrust legal challenges (the so-called "oligopoly problem"). So far, competition policy has provided limited solutions to the oligopoly problem, as it is commonly understood that the particular conditions required to sustain tacit collusion are rarely observed, with the exception of a few markets with a very small number of competitors, a high degree of transparency and high barriers to entry. However, algorithms might affect some characteristics of digital markets to such an extent that tacit collusion could become sustainable in a wider range of circumstances, possibly expanding the oligopoly problem to non-oligopolistic market structures. This raises the policy question of whether jurisdictions should reconsider the scope of their cartel rules to include tacit collusion.

A possible adjustment of antitrust tools could involve considering algorithms as "plus factors" for collusion. In other words, if competition authorities detect coordinated price movements in an industry, should they be allowed to consider the use of certain type of algorithms by businesses as a plus factor to prove an antitrust violation? If such a solution were applied, any companies with their prices aligned and who use at the same time dynamic pricing, third party data centers or machine learning algorithms, would have the burden to prove that their pricing strategy is not a result of collusion.

Another concept that deserves deeper analysis is the antitrust notion of agreement, which despite being broadly defined in most jurisdictions, has not been applied to new forms of interaction in digital markets. Indeed, if algorithms allow companies to implement very fast price changes that eventually converge to a common value, how does this differ from an actual explicit price negotiation?

Therefore, a possible solution to tackle algorithmic collusion would be to provide a more clear definition of agreement for antitrust purposes, which could eventually account for certain forms of "meeting of algorithms." For example, if firms program prices to replicate the price of a market leader, this could be seen as an offer to collude, which would be accepted when the leader raised the price. Likewise, an anti-competitive agreement could also involve a company publicly releasing a pricing algorithm that is downloaded and implemented by rivals.

Examples of tacit agreements between firms

Offer	Acceptance
Firm intermittently sets a higher price for a few seconds (costless signal)	Competitor increases price to the value signaled
Firm programs algorithm to mimic the price of a leader	The leader, recognizing this behavior, increases the price
Firm publicly releases a pricing algorithm	Competitor downloads and executes the same pricing algorithm
Firm programs an anti-competitive price to be triggered whenever the competitor's price is below a threshold	Recognizing the algorithm, the competitor always keeps the price above the threshold
Firm uses machine learning algorithm to maximize joint profits (for instance, by accounting for the spill-overs on competitors' profits)	Competitor reacts with the same strategy

Finally, even if the antitrust concepts of tacit collusion and agreement are reconsidered by policy makers, a last question that remains is how to establish liability. In particular, due to the subtlety of the potential anti-competitive behaviors enabled by algorithms, it is important to determine who should be fined or punished: the creator of the algorithm, the user or those that benefit from enhanced coordination?

Some commentators have suggested that when dealing with a robot engaging in anti-competitive conducts there are three possible ways of attributing responsibility: to the robot itself, to the humans who deploy it, or to no one. While the third option cannot be considered a realistic one, as it would *de facto* provide impunity for anti-competitive conduct put in place through the intermediary of an algorithm, the debate has highlighted the challenges of attributing antitrust liability to individuals when commercial strategies are delegated to an algorithm and humans have no ability to influence the way in which such decisions are taken.

Of course, most algorithms today still operate based on instructions designed by human beings and there is no doubt that humans will be in most cases responsible for the decisions taken. However, as artificial intelligence ("AI") develops further, the links between the agent (the algorithm) and its principal (the human being) become weaker and the ability of algorithms to act and price autonomously puts in question the liability of the individuals who benefit from the algorithm's autonomous decisions. In such cases, determining liability will mainly depend on the facts at hand.

All these questions do not have a clear and definite answer, but they will surely have to be addressed as the digital economy evolves at a rapid speed and machines become increasingly intelligent.

V. SHOULD AI SYSTEMS BE REGULATED?

It might seem too early at this stage to talk about regulating algorithms, since there is still a lack of evidence that firms systematically and successfully rely upon these tools to collude. However, there have already been some proposals to regulate AI systems in many other areas. For instance, in the transport sector, wide-reaching regulations are already being designed in anticipation to the appearance of self-driving cars.

Likewise, AI has been associated with many other risks outside the scope of antitrust, such as violations of privacy rights, information bias or even discrimination against particular groups of individuals, to enumerate just a few. In light of the many risks involved, it may be a question of time before AI systems are heavily regulated across multiple areas.

Nonetheless, it should not be forgotten that governments have adopted so far a market-oriented approach (with minimum regulatory intervention) to digital environments, which has resulted in the rapid growth of the digital economy and extraordinary gains for consumers. As a result, it is crucial to guarantee from these early stages that any new regulation is designed in such a way that does not overly restrict competition, stifle innovation or, of course, facilitate collusion even further.

As an example, some prominent authors have recently discussed new measures to force companies to be more transparent about the algorithms they use and to comply by design with competition rules. Apart from the obvious risks of restricting innovation and the enforcement costs involved, it should be noted that requiring firms to publicly disclose their algorithms could further enhance collusion, as that would allow them to easily access and copy each other's pricing strategies. This illustrates how well-intended regulations can very easily end up being counterproductive to their original goals.

In addition, it is also hard to say whether any viable regulations can actually be created with the purpose of tackling collusion. Such regulations could involve regulating prices, artificially designing markets (for example by restricting transparency or the frequency of price changes) or creating rules of algorithmic design that force algorithms to ignore certain market information. Unfortunately, all regulatory measures of this kind would pose substantial barriers to competition and, if not carefully considered, risk replacing collusion with an even worse distortion of the competitive process.

It seems that business strategies based on algorithms and automated decision-making can no longer be ignored. However, policy makers seem to be trapped in a delicate situation where both inaction and excessive enforcement pose their own risks. Whatever path they choose to take, a balanced approach should be used in order to protect as much as possible the competitive process in digital markets.