Autorité de la concurrence

Bundeskartellamt

Algorithms and Competition

Executive Summary

I. Introduction

There is little doubt that digitalisation is revolutionising many sectors of our economies. Algorithms are among the most important technological drivers of this process and enable firms to be more innovative and efficient. Nevertheless, debate has arisen on whether and to what extent algorithms might have detrimental effects on the competitive functioning of markets, especially by facilitating collusive practices.

This joint study by the *Autorité de la concurrence* and the *Bundeskartellamt* addresses the potential competitive risks associated with the use of algorithms. It elaborates on the concept of algorithm as well as on different types and fields of application (II.) and subsequently focusses on algorithms and collusion (III.). After that, the study discusses practical challenges when investigating algorithms (IV.) and concludes with a tentative outlook for the tasks of competition authorities deriving from the paper (V.).

II. Algorithms – notion, types and fields of application

In principle, any kind of software consists of one or more algorithm(s). However, in the context of the study, the focus is on algorithms which entail potential economic consequences and, more specifically, potential impacts on competition. Such cases can relate to algorithms performing a wide variety of tasks. Thus, it can be helpful to categorise algorithms in several ways, by the task they perform, by the input parameters that they use or by the involved learning method.

In particular, the paper discusses algorithms used for dynamic price setting. These algorithms may adapt prices to the company's own cost, capacity, or demand situation but also to competitors' prices, which can be monitored using yet another algorithm. Furthermore, the paper takes into account peculiarities of self-learning algorithms, which might derive their parameters with a high degree of automation from a potentially dynamic set of training data.

Issues concerning the interpretability of algorithms are also addressed. In this regard, one can broadly distinguish algorithms which are basically interpretable for humans, in particular allowing to identify the strategy and actions that result from using the algorithm via the code or a description of the algorithm, from algorithms whose behaviour is hardly interpretable for humans. The study refers to the former as "descriptive" algorithms and to the latter as "black-box" algorithms.

III. Algorithms and collusion

With a particular focus on pricing algorithms, the study explores potential detrimental effects of such algorithms on competition and the different ways in which they may affect strategic interactions between companies, potentially leading to horizontal collusion.

First, the economic principles behind horizontal collusion are analysed, including considerations on algorithms' potential impact on both the stability and the emergence of collusion (A.). Second, the use of pricing algorithms is discussed considering three scenarios, elaborating on the situations that they cover as well as their potential competition law implications (B.).

The paper also discusses interdependencies between algorithms and the market power of the companies using them. In particular, these interdependencies can lead to additional market entry barriers.

A. Economic principles of horizontal collusion

Although economic research has addressed horizontal collusion from various perspectives, with partly varying definitions, collusion can be described as a situation in which firms employ reward-punishment schemes for rewarding competitors as they abide by a supra-competitive outcome and punishing them when they depart from it.

Both economic research and case practice have identified several factors that can influence the stability of collusion, such as the number of companies on a market, the existence of entry barriers, the interaction frequency, and the degree of market transparency for different market participants. Algorithms could affect some of these factors and thus potentially have an impact on the stability of collusion. Considering the potential effects, the study finds that the actual impact of the use of algorithms on the stability of collusion in markets is *a priori* uncertain and depends on the respective market characteristics.

The paper also discusses the emergence of collusion, in particular by considering how companies might coordinate on a specific equilibrium without human communication. The study in particular reaches the preliminary conclusion that theoretical findings on the emergence of collusion can provide only limited practical insights into which kinds of algorithms are more prone to facilitate the emergence of tacit collusion.

B. Use of algorithms in different scenarios

The paper considers three scenarios. The legal assessment of the scenarios notably takes into account the fact that Art. 101 TFEU and the corresponding domestic provisions only prohibit agreements and concerted practices. In other words, a violation of competition law necessitates some kind of communication between the companies concerned. Conversely, companies have the right to adapt their behaviour intelligently to the existing or anticipated conduct of their competitors.

1. Algorithms as supporters or facilitators of "traditional" anticompetitive practices

The first scenario covers situations in which a "traditional" anticompetitive practice resulting from prior contact between humans already exists. The algorithm thus only comes into play in a

second step to support or facilitate the implementation, monitoring, enforcement or concealment of the respective anticompetitive practice.

Besides supporting or facilitating horizontal collusion, algorithms could also be used in the context of vertical agreements or concerted practices. For example, algorithms could be used to detect deviations from a fixed or minimum resale price or to allow a retaliation by manufacturers against retailers not complying with a given price recommendation.

The study points out that the involvement of an algorithm in such a scenario does not raise specific competition law issues, as a prior agreement or concerted practice can be established, which in general may be assessed under Art. 101 TFEU. Nevertheless, although the existence of an infringement might be found without further consideration of the algorithm, developing a case-specific understanding of the algorithm might still be advisable, for example as it could allow an assessment of potential counteracting efficiencies as well as reinforced negative effects of the anticompetitive practice.

2. Algorithm-driven collusion between competitors involving a third party

In the second scenario, a third party, e.g. an external consultant or software developer, provides the same algorithm or somehow coordinated algorithms to competitors. The particularity of these situations is that there is no direct communication or contact between the competitors, but a certain degree of alignment could nevertheless arise from the actions of the third party.

Generally, one could distinguish between alignment at the level of the algorithm (code level) and alignment at the level of the input factors (data level). Alignment at code level could arise when a third party not only provides algorithms with a shared purpose, for example the calculation of prices, but also using a similar (or related) implemented methodology. A specific form of alignment at code level would be the complete delegation of strategic decisions to a common third party who takes these decisions using an algorithm. Alignment at data level could involve the competitors using the algorithm as a means for an information exchange or a software supplier causing an alignment of input data by relying on a common data pool between competitors.

So far, there is only very limited algorithm-specific case law. Due to the variety of potential situations covered within this scenario, an assessment will always depend on the specificities of each case. Given the ECJ jurisprudence (VM Remonts[1], Eturas[2]), one of the central questions in this scenario is whether the competitors are aware of the third party's anticompetitive acts, or could at least reasonably have foreseen them.

Potential competition concerns in such situations could, *inter alia*, depend on the content of the algorithmic alignment. For example, an alignment of prices or price parameters at code level will likely constitute a restriction of competition by object. As for an alignment at data level, the established principles for information exchange apply.

In all of these cases, market coverage might be relevant both for the assessment of competitive concerns as well as for authorities exercising their discretion on whether to initiate an investigation.

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1 *ECJ*, VM Remonts v Konkurences padome, Judgment of 21.07.16, Case C-542/14.

2 *ECJ*, Eturas et al. v Lietuvos Respublikos konkurencijos taryba, Judgment of 21.01.16, Case C-74/14.

3. Collusion induced by the parallel use of individual algorithms

The algorithms covered by this third scenario are unilaterally designed and implemented, i.e. each company uses a distinct pricing algorithm. There is no prior or ongoing communication or contact between the respective companies' human representatives. Still, the fact that several or even all competitors rely on pricing algorithms might facilitate an alignment of their market behaviour, resulting from a mere interaction of computers.

Beyond algorithms reaching tacit collusion, the question arises of whether algorithms could engage in behaviour that resembles explicit forms of collusion. However, so far, there has been significant uncertainty on the nature of potential "algorithmic communication", which is most often discussed in the context of self-learning "black-box" algorithms. A specific form of "algorithmic communication" could be signalling practices, i.e. situations in which algorithms indicate to competitors that they are about to change a relevant parameter of competition, such as the price, in a certain way.

In addition to the theoretical considerations on the emergence and stability of collusion discussed in the previous section, there is a growing body of research considering the plausibility of algorithmic collusion by analysing concrete technical implementations of algorithms in specific, mostly experimental, settings. In other words, two or more pricing algorithms are tested in research laboratories of universities by making them interact in an experimental setting that mimics a competitive environment. In many of the experiments, the results show that some degree of collusion can be achieved. Against this background, the paper discusses the assumptions taken in experimental settings as well as their relation to real-world markets. The paper concludes that it currently remains an open question whether an alignment of pricing algorithms could likely arise "by chance" in settings that correspond to real market conditions.

Assessing this scenario from a legal point of view, the study first turns to the distinction between coordination and mere parallel behaviour. In light of the uncertainties concerning potential shapes of "algorithmic communication", the paper points out that it seems to be too early to clearly delineate which potential types of interaction constitute illegal behaviour. Moreover, the paper recalls that under the current case law, Art. 101 TFEU does not prohibit conscious parallel behaviour. Thus, situations in which an algorithm merely unilaterally observes, analyses, and reacts to the publicly observable behaviour of the competitors' algorithms might have to be categorised as intelligent adaptations to the market rather than coordination.

Another legal issue in this scenario concerns the question of the extent to which the behaviour of a self-learning algorithm can be attributed to a company. Some authors have suggested treating algorithmic behaviour as one would consider a company's employees' actions. Consequently, companies could be held liable simply for introducing and using an algorithm that engages in anti-competitive behaviour. Others suggest accountability of a company for the behaviour of its algorithm(s) if a reasonable standard of care and foreseeability is breached.

The paper concludes that the standards for assessing a company's responsibility for collusive algorithmic behaviour may vary to some extent between these two approaches. It seems clear, however, that companies need to think about how they could ensure antitrust compliance when using pricing algorithms.

IV. Practical challenges when investigating algorithms

The study also addresses practical challenges when investigating algorithms by first describing potential types of evidence that might be used to establish a competition law infringement and subsequently outlining ways to obtain and analyse relevant information.

Among potential types of evidence, a distinction can be made between relevant information associated with the role of the algorithm and its context on the one hand, and the functioning of the algorithm on the other hand. For example, as regards the role of the algorithm and its context, information on the objective of the algorithm, its implementation and changes over time could be relevant. Furthermore, authorities might consider information on the input data used by the algorithm. Finally, it could be helpful to gather information on the output and the decision-making process connected with the algorithm.

Once an authority has initiated an investigation, it can build on its established investigative powers, such as information requests, inspections and interviews, to obtain the necessary information. Depending on the case at hand, information could also be acquired by requesting internal documentation.

A more in-depth analysis of the algorithm may yield additional evidence, in particular revealing additional facts associated with the functioning of the algorithm. For such an analysis, different investigative approaches could be envisioned, *inter alia* an analysis of (relevant parts of) the source code in connection with information on the respective environment and interfaces, a comparison of real (past) input/output couples, a simulation of the algorithmic behaviour on generated inputs or a comparison of the algorithm to other (more easily interpretable) algorithms and methods.

V. Concluding remarks

The study concludes that in the situations considered so far, the contemporary legal framework, in particular Art. 101 TFEU and its accompanying jurisprudence, allows competition authorities to address possible competitive concerns. In fact, competition authorities already have dealt with a certain spectrum of cases involving algorithms, which have not raised specific legal difficulties.

As regards the scholarly debate whether Art. 101 TFEU needs to be understood more broadly, and inasmuch as some authors call for a broader interpretation of Art. 101 TFEU, the paper recalls that it is yet unclear which types of cases competition authorities will face in the future; consequently it is not possible yet to predict whether there is a need to reconsider the current legal regime and the methodological toolkit and, if so, in which way.

As digital markets keep evolving, authorities should continue expanding their expertise on algorithms, in an exchange with each other as well as by interacting with businesses, academics and other regulatory bodies. Such an effort is in line with the more general tendency of authorities to devote more resources to the challenges posed by the ongoing digitalisation.