

# PRICING ALGORITHMS AND COLLUSION: IS THERE CLARITY ON WHAT CORPORATIONS MAY BE ON THE HOOK FOR?



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## I. MOTIVATION

What are pricing algorithms? Put simply, pricing algorithms are computer models that suggest the optimal (generally “profit-maximizing”) price given various inputs. These inputs may include factors controlling for prevailing market demand and supply conditions as well as prices actually charged (or expected to be charged) by competitors for similar (substitutable) or complementary goods.<sup>2</sup>

Historically, some academics and policymakers have suggested that pricing algorithms could be used as signaling mechanisms to invite and potentially facilitate tacit or even express coordination among competitors. Yet, as algorithmic behavior becomes more prevalent in many markets, especially when open and notorious, the conduct begins to look more like some form of information exchange or “benchmarking exercise” among competitors, rather than simple unilateral behavior. From that perspective – and setting aside explicit collusion – one could treat the pervasive use of algorithms as a form of industry or market collaboration.

Much like information exchanges, it may be pro- or anti-competitive under the rule of reason outlined in the 2000 US Department of Justice (DOJ) and Federal Trade Commission (FTC) “Antitrust Guidelines for Collaborations Among Competitors” (DOJ/FTC Guidelines).<sup>3</sup> For the European Union, this guidance is provided by the 2011 European Commission (EC) “Guidelines on the Applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements,”<sup>4</sup> also extending to more general exchanges of information among competitors. Similarly, for several Central and South American countries, guidelines on this topic are from 2013 and authored by Abrantes-Metz.<sup>5</sup>

A significant focus has been placed on whether pricing algorithms facilitate collusion and whether this should be the central focus of competition authorities. Opinions range from “making all tacit collusion illegal since pricing algorithms facilitate collusion” all the way to “there is nothing

2 In November 2018, Abrantes-Metz had the privilege of participating in the Federal Trade Commission’s (FTC) Hearings on Consumer Protection and Competition. The panelists were Ai Deng, Joe Harrington, Kai-Uwe Kühn, Sonia Kuester Pfaffenroth, Maurice E. Stucke, and Rosa Abrantes-Metz, with Ellen Connelly and James Rhilinger as moderators. The video for this panel (available at <https://www.ftc.gov/news-events/audio-video/video/ftc-hearing-7-nov-14-welcome-remarks-session-1-algorithmic-collusion>) illustrates the divergence of opinions on how to address pricing algorithms from an antitrust perspective.

3 US Department of Justice and Federal Trade Commission, 2000. “Antitrust Guidelines for Collaborations Among Competitors,” available at <http://www.ftc.gov/os/2000/04/ftcdo-jguidelines.pdf>. We note that we are not commenting on whether such conduct meets the agreement standard for Section 1.

4 European Commission, 2011. “Guidelines on the applicability of article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements,” Official Journal of the European Union, available at <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2011:011:0001:0072:EN:PDF>.

5 Rosa M. Abrantes-Metz, 2013. “Regional Competition Center for Latin America: Antitrust Guidelines for Exchanges of Information Among Competitors,” available at [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3291659](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3291659).

new here, nor anything that needs to be addressed.” Our view is that a necessary, but currently missing, first step is to clearly define what collusion or actual coordination looks like in the context of pricing algorithms. What is a “collusive algorithm?” Would we know one if we saw it? Only with a working definition can we really begin a discussion of what, if anything, needs to be updated or addressed in the various legal frameworks, and only then can policymakers provide corporations with any sort of guidance for the development, implementation, and monitoring of non-collusive pricing algorithms.

## II. PRICING ALGORITHMS, COMPETITION, AND COLLUSION

### A. Pricing Algorithms and Benefits to Competition

In principle, any business can develop and use a pricing algorithm. Usually, however, there is a connotation that pricing algorithms can *quickly* change prices, given *quickly* changing information. Due to this, it is not practical for a brick-and-mortar retailer to retag all their products during the day, even if a pricing algorithm were to suggest that the market would support a higher price during the lunch hour rush. It is also not practical to send an employee to other brick-and-mortar stores to survey what their prices are throughout the day. While these traditional retailers could use programs and econometric models to aid in setting their prices over time, and while such models could fairly be called “pricing algorithms,” these models are not the sort of application most people have in mind when using the term.

Instead, when we talk about “pricing algorithms,” we usually think of an internet application of some sort. An internet retailer, for example, could alter prices moment-to-moment as their algorithms consider (i) how many customers have recently browsed those items and (ii) how many browsing customers decided to make a purchase at the old prices. The retailer could deploy “bots” – artificial intelligence (AI) programs that continuously scour competitors’ websites to see what prices they are charging.

Pricing algorithms provide many potentially procompetitive effects, enhancing both static and dynamic efficiencies. For example, they improve price transparency, facilitate the collection and organization of information, and generally enhance efficiency. By facilitating price discovery, these algorithms can help markets reach equilibrium more efficiently, which redounds to the benefit of both producers and consumers.

But, as with most of antitrust, the nuances matter. A very simple pricing algorithm could be set to “determine what my competitors are charging, and set my price to be \$1 lower than the lowest.” But it could also be, “determine what my competitors are charging, and set my price to the average.” By making prices more formulaic, they become more predictable to the competition, which may allow competitors to reach a supra-competitive equilibrium more easily, whether through tacit or explicit collusion. How concerned should we be about this, and how, if at all, should policymakers respond to this concern? It is fair to say that a consensus has not yet emerged.

One reason people fear an increase in collusive outcomes from algorithmic pricing, and why people fear the current law may not be adequate to address it, is that pricing algorithms might *learn* to “collude” without any human explicitly programming them to do so. Some time ago, AI researchers developed a poker-playing AI. They did not teach it to bluff, but it learned to bluff by itself (pretty frightening!). Suppose, in all good faith, I develop a pricing algorithm. This algorithm learns that wherever I set my price, my competitor moves to it. It then comes to learn that it can keep raising prices without fear of competitive reprisal up until the elasticity of demand becomes large enough. The market thus reaches an equilibrium with supra-competitive prices and decreased output. How reasonable is this scenario? And how would current law address it?

It is well established in classical economics that we have “perfect competition” when a market has (infinitely) many competitors, the product is homogeneous, production functions are identical, there are no barriers to entry, and *there is perfect information*. The equilibrium price is the optimal price, and it is equal to the marginal cost of production. This is the socially desirable benchmark against which economists compare competitive effects from real market outcomes.

By allowing quicker dissemination of information in the market between relative supply and demand, and more rapid response to market conditions, pricing algorithms seem to be “an agent” of the “perfect competition” model – after all, perfect competition requires perfect information. As a general statement, therefore, it cannot be true that “more information” leads to non-competitive outcomes in the presence of the other features of perfect competition when the perfectly competitive outcome assumes complete information.

In our view, pricing algorithms should not, as a general rule, be feared as instruments that can somehow convert an otherwise competitive market into a non-competitive one. Quite the opposite: We should expect them to enhance competition. But what if the market structure is fundamentally “non-competitive,” to begin with?

## ***B. Pricing Algorithms and Possible Collusion***

If pricing algorithms increase the likelihood of collusive outcomes in markets prone to collusion (which has yet to be shown), then there is a social welfare concern. Further, if such outcomes are considered legally tacit, since they are reached absent the sort of explicit human interaction we have historically associated with illegality, then there may be a legal issue to address and, arguably, the law may need to change to address this new reality. But, in the context of Section 1 jurisprudence, that is a big ask. It would have to take on the subject of non-coordinated interdependent behavior as well as the remedial challenges in that context.

Some market features are traditionally seen as facilitating collusion, such as having a small number of competitors, high barriers to entry, and product homogeneity, among others. It is at least possible that pricing algorithms – by providing greater transparency, more frequent information sharing (or interactions), and high trading frequency – may facilitate the signaling and implementation of common pricing policies. They would certainly seem able to facilitate the monitoring and punishment of deviations from collusion. If so, pricing algorithms may well increase the likelihood of tacit collusion, not only in oligopolistic markets with high barriers to entry and high degrees of transparency, but potentially also in other markets where, to date, collusion may have been harder to achieve and sustain over time.

This is a concern many experts raise, and it cannot be easily dismissed. However, there are mitigating considerations. For example, *all else equal*, demand elasticity is higher for internet-based shopping for fairly homogeneous products, which *decreases* the profitability of charging higher prices. This follows from the consumers’ very low internet search costs.

With a traditional brick-and-mortar retailer, a consumer might be willing to pay more for the convenience of *not* getting back into their car and searching (perhaps unsuccessfully) for a better deal somewhere else. In that instance, “better” needs to consider the net of their time and transportation costs. As another example, grocery stores can offer loss-leaders that get people into the store, and can then charge higher prices for other items once customers are relatively captive. Yet there is no perfect analog to “loss-leaders” on the internet, where searching for competitive prices and availability is virtually costless. That decreases market power and enhances competition among internet retailers relative to brick-and-mortar retailers.

On the supply side, *all else equal*, are barriers to entry weakened by the availability of big data and pricing algorithms? It is not clear. On the one hand, pricing algorithms enhance incumbents’ ability to identify potential market threats more quickly and easily, allowing them to preemptively acquire possible entrants or to react more aggressively to potential entry. On the other hand, the availability of more pricing data may prove useful to potential entrants looking to improve their predictions and lower entry costs, thereby enhancing the likelihood of successful entry.

As a result, it is theoretically ambiguous whether pricing algorithms will lead to higher prices. What is the empirical record? How large are the net profit margins for the retail sector, for which so many companies provide web-based trade? And how have retail net profit margins evolved in the last few decades in comparison to other sectors that are less directly affected by web-trading?

Each year, the S&P 500 releases industry-specific returns on equity and net margins, and, each year, the retail industry is among the least profitable, with decreasing margins over time. This is particularly true for web-only retailers, which often see margins as low as 0.5–3.5 percent. The internet has made it easier than ever before for consumers to compare prices around the world. It has also made it easier for suppliers to observe each other’s prices and react promptly to competitors’ pricing. Pricing convergence does seem to be occurring, but to a *lower* price level with *decreased* market power.

The market evolution in commodities trading also provides important data. Over the last few decades, trading has been moving from over-the-counter (OTC) to exchanges. Detailed market-wide trading information, such as volumes and prices, is not as easily available to all market players when products trade OTC, which is usually done through financial intermediaries who do not disclose such information. In contrast, when products trade on an exchange, detailed market-wide data are readily and publicly available to all market participants. Market players can see the whole market at every moment in time, reflecting high market transparency. They can use the larger amount of data to develop their pricing algorithms to a larger extent than in OTC trading with more limited data availability. What is the empirical evidence on this higher market transparency and higher incidence of pricing algorithms?

Despite exchange trading adding additional fees (for example, to operate the exchange) that do not exist in OTC trading, bid-ask spreads are generally narrower in exchange trading than in OTC. This provides evidence of higher market efficiency and lower profit margins in exchanges. While collusion may still happen in exchange trading (as evidencing of spoofing cases in metals futures, for example), it has been in OTC trading that many instances of widespread systematic collusive conduct, either alleged or actually uncovered in the last several years, has occurred. Of course, this does not mean that collusion will not occur through pricing algorithms, only that it seems less likely, *all else equal*.

But are these more likely to be the exception or the rule? That is what needs to be studied.

### III. WHAT WOULD “COLLUSIVE ALGORITHMS” LOOK LIKE?

Let us set aside the possibility that the algorithm will “learn to collude by itself” in this section.

As Justice Stewart famously said in an altogether different context, “I know it when I see it.” Is that true for collusive pricing algorithms as well? Is there an algorithm we could look at and agree was “collusive” in nature? What does that really mean? Should not corporations know what authorities regard as a “collusive algorithm?”

In general, competitors could collude<sup>6</sup> on numerous parameters. For example, they could agree not to purchase from a supplier, or not invest in developing a new product feature. They could agree to divide up the market or customers. And, of course, they could agree on price. Broadly speaking, price collusion can take two forms. There is price fixing: Agreeing to charge \$10 for widgets, not \$9. Moving away from that extreme, competitors can also agree not to undercut each other on price. This is evidenced by equal prices, but also by non-decreasing prices over time.

To fix a price, algorithms need to be able to exchange information with one another. The algorithm from Company *A* (Algorithm *A*) would need to be able to send a proposed price to Algorithm *B* at Company *B*, which would need to be able to send a response back to Algorithm *A*. To us (as non-computer scientists), it would be fairly straightforward to know if algorithms had the necessary transfer protocols to exchange information. As economists, we would ask if there would ever be a legitimate need for any such protocol.

What about the non-compete form of collusion, though? That might be difficult to discern. If Algorithm *A* amounts to, “Replicate Price *B*” and vice versa for Algorithm *B*, is that problematic? After all, the economic model of perfect competition is that each firm takes the price as given. Implementing that as an algorithm would essentially be precisely that: Checking what the price is and replicating it. Declaring such algorithms to be anti-competitive might seem almost paradoxical. And yet, a non-compete algorithm may look very much the same.

This is where things get tricky. “Collusion” seems to imply that a firm is foregoing some kind of profitable opportunity at least some of the time. If my competitor is selling its widgets for \$10, why am I not selling mine at \$9 and making a great deal of profit by luring away my competitors’ customers? Because I promised I would not. But that promise is only binding or constraining on my behavior if I would, in fact, profit from a \$9 price. This suggests that one testable characteristic of a collusive algorithm – as distinct from a non-collusive algorithm in this context – is that it foregoes a lower price *when that lower price would increase profit*.

But wait, not so fast. I presumably made that promise to maintain the \$10 price in order to maximize my profits. After all, why else collude except to raise profits? This is not a contradiction; it is balancing short- and long-term profits. In that case, a very smart pricing algorithm could reach the same conclusion: Even though this quarter’s profits might be maximized by setting a price of \$9, discounted lifetime profits would not be. No real collusion is necessary to achieve an identical outcome.

But then, perhaps a collusive price agreement also involves a punishment mechanism: We agree not to undercut each other’s price with an understanding that if one of us does, the other may retaliate. Perhaps this is a testable characteristic. The algorithm responds to a lower price from a competitor by setting its price below the profit-maximizing price in another form of foregone profits.

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<sup>6</sup> By “collude” we simply mean to coordinate expressly in an anticompetitive way, leaving aside the question of legality.

Yes, perhaps, but again, not so fast. Suppose I program my algorithm as follows: Match Price *B*, but if Price *B* ever decreases, then set my price to 50 percent below *B*. I do this, trusting that Algorithm *B* will eventually learn that lowering its price is not profit-maximizing. In this scenario, Algorithm *B* is completely innocent in every way. Is there anything illegal, or should there be anything illegal, about Algorithm *A*? Maybe, but this is not an example of collusion.

In yet other cases, collusion could be characterized as a different objective function: Competitors *A* and *B* work together to maximize their aggregate profit, not their individual profit functions. For instance, this could mean that Competitor *A* foregoes \$1 in profit so that Competitor *B* can earn an extra \$2 in profit. It agrees to this arrangement only because Competitor *B* manages to make a \$1 side payment back to Competitor *A*. Looking at both Algorithms *A* and *B* might reveal that, by working together, they maximize joint profit while foregoing some of their own profit.

The lesson may – and we stress the word “may” – be that collusive algorithms can only be identified in sets. Perhaps no one algorithm, in isolation, could be categorized as “collusive” in nature.

Competitive firms seek to maximize profit; collusive firms also seek to maximize profit. The difference is that collusive firms ultimately maximize profit by reducing output and raising price. Collusive firms – if successful – achieve greater profit. But an innocent pricing algorithm – if successful – should lead to greater profit as well. Identifying what is *algorithmically different* about a “collusive” algorithm from a “non-collusive” algorithm remains an open question.

## IV. THE NEED FOR PRACTICAL GUIDANCE FOR CORPORATIONS

As discussed above, what a collusive pricing algorithm may look like falls into a somewhat gray and undefined area. Pricing algorithms could be seen as coordination among competitors, which could be potentially collusive. But do the current FTC/DOJ 2000 Guidelines offer enough guidance in this regard? As explained by the FTC when addressing “Dealings with Competitors:”

“In today’s marketplace, competitors interact in many ways, through trade associations, professional groups, joint ventures, standard-setting organizations, and other industry groups. Such dealings often are not only competitively benign but procompetitive. But there are antitrust risks when competitors interact to such a degree that they are no longer acting independently, or when collaborating gives competitors the ability to wield market power together.

For the most blatant agreements not to compete, such as price fixing, bid rigging, and market division, the rules are clear. The courts decided many years ago that these practices are so inherently harmful to consumers that they are always illegal, so-called *per se* violations. For other dealings among competitors, the rules are not as clear-cut and often require fact-intensive inquiry into the purpose and effect of the collaboration, including any business justifications. Enforcers must ask: what is the purpose and effect of dealings among competitors? Do they restrict competition or promote efficiency?”<sup>7</sup>

When broadly seen, the Guidelines provide a general framework of analysis for all forms of coordination among competitors. But if we are not sure what a collusive pricing algorithm really looks like (short of literal information transfers), how are we going to be able to apply the framework provided?

Let us also not forget the question of whether pricing algorithms could learn to collude by themselves, without “direct/explicit” human influence. Is there liability, and, if so, where does it lie? What is the “proof” of explicit collusion, and who will be going to jail?

Corporations need guidance on all of these questions and others. Official “Best Practices” for pricing algorithms would be welcome so that corporations are not suddenly caught off-guard for conduct for which a clear standard has not been established. Given the rapid adoption of pricing algorithms across a multitude of industries, this is better provided sooner rather than later.

<sup>7</sup> See <https://www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/dealings-competitors>.

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