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Tacit Collusion on Steriods - The Tale on Online Price Transparency, Advanced Monitoring and Collusion

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The development of self-learning computers raises many challenging legal and ethical questions about the relationship between humans and computers, humans' control -- or lack of it -- over computers, and accountability for the computers' activities. While these issues have long captivated our interest, few would envision the day when these developments (and the legal and ethical challenges raised by them) would become an antitrust issue. With the accelerating development of Artificial Intelligence (AI) and sophisticated pricing algorithms, they are set to change the competitive landscape and the nature of competitive restraints. (Just consider Wal-Mart's acquisition of Jet.com.[1])

No doubt the technological developments in e-commerce, computers, Big Data, and pricing algorithms have lessened our reliance on local offerings and in doing so, contributed to our welfare – with lower prices, better products and greater choice. And yet, as our recently published book, *Virtual Competition: The Promise and Perils of the Algorithm-Driven Economy*,[2] explores, new anticompetitive strategies, including behavioural discrimination, algorithm driven collusion and the super-platforms' abuse of their gate keeper power, may emerge.

In what follows we focus on the strategic use of algorithms to stabilise and foster tacit collusion. The concerns these strategies raise have been acknowledged by competition enforcers. Commissioner Vestager warned recently of the antitrust impact of pricing algorithms. In a speech at the Bundeskartellamt she referred to virtual competition and the risk that online technologies may aid illegal pricing.[3] The European Commission has also acknowledged these risks in its Preliminary Report on the E-commerce Sector Inquiry and the possibility that price monitoring software may be used to facilitate explicit or tacit collusion.[4]

As pricing mechanisms shift to pricing algorithms, so too will the types of collusion. We are shifting from the world where executives expressly collude in smoke-filled hotel rooms to a world where pricing algorithms continually monitor and adjust to each other's prices and market data. The press[5] and competition officials in the EU[6] and US[7] are

1 http://www.cnbc.com/2016/08/09/wal-mart-ceo-doug-mcmillon-on-what-he-saw-in-jetcom.html
2 HUP, 2016. See: http://www.hup.harvard.edu/catalog.php?isbn=9780674545472&content=reviews
3 Lewis Crofts and Matthew Newman 'Vestager warns of pricing algorithms' antitrust impact' MLex, 16 March 2017; full speech available on the European Commission website: http://ec.europa.eu/competition/index_en.html
4 Commission staff working document - Preliminary Report on the E-commerce Sector Inquiry, Brussels, 15.9.2016 SWD(2016) 312 final
5 See, e.g., https://www.ft.com/content/9de9fb80-cd23-11e6-864f-20dcb35cede2
6 http://www.autoritedelaconcurrence.fr/doc/reportcompetition-lawanddatafinal.pdf; http://www.publications.parliament.uk/pa/ld201516/ldselect/ldeucom/129/12908.htm; Nicholas Hirst, Vestager eyes new frontiers for antitrust, Politico, 2/13/17, 2:12 PM CET
7 https://www.ftc.gov/news-events/events-calendar/2015/06/sharing-economy-issues-facing-platforms-participants-regulators;

already taking note. One concern is over how algorithms may operate in stealth mode – behind the scene – to sustain and support collusion, leaving us - the customers - with the illusion of competition. "Finding ways to prevent collusion between self-learning algorithms might be one of the biggest challenges that competition law enforcers have ever faced," the OECD recently observed.[8]

Before we explore algorithmic collusion, it is important to stress that Big Data and technological innovations are neither good, bad, nor neutral: their nature depends on how firms employ them, whether their incentives are aligned with our interests, and certain market characteristics.[9] We are not Luddites. We do not challenge technological advancement. But we are not techno-utopians either. We accept the possibility of new forms of collusion and the current laws' limitations in deterring them.

1. Tacit Collusion on Steroids

Industries are shifting from a pricing environment where store clerks stamped prices on products, to dynamic, differential pricing where sophisticated computer algorithms rapidly calculate and update prices. Today, the majority of EU retailers track online prices – predominantly via automated software programmes developed for that purpose; nearly 80% of those using such software consequently adjust their own prices to those of their competitors (sometimes on an automatic basis).[10] Manufacturers can more easily monitor deviations from "recommended" retail prices, using software that reports (sometimes with immediate alerts) on how much, and for how long, prices diverge from the recommended retail price (or another reference price).

As companies increasingly use algorithms and Big Data to price goods, what are the implications on collusion? One simple scenario is that algorithms help the colluders collude. The U.K. and U.S. have already prosecuted such cases. Indeed, before 'Black Friday', one of the busier times of the year for online sales, the U.K.'s Competition and Markets Authority reminded online sellers 'that discussing and agreeing price levels with competitors is illegal, and can result in serious penalties."[11] The CMA also warned that '[r]e-pricing software can be used to encourage healthy competition amongst online sellers, but it's illegal to use it as part of a price-fixing agreement."[12] Likewise, William Baer, the then assistant attorney general at the U.S. Department of Justice stated, "We will not tolerate anticompetitive conduct, whether it occurs in a smoke-filled room or over the Internet using complex pricing algorithms."[13]

But once we deviate from the simple scenario of express collusion, the illegality becomes murkier. As our commercial environment increasingly moves online, competitors might achieve the same anticompetitive outcome without agreeing to tamper with prices. The industry-wide use of algorithms, under certain market conditions, may lead to tacit collusion. Importantly, the conditions for tacit collusion, as several economists have noted, 'need not involve any "collusion" in the legal sense, and in particular need involve no communication between the parties. It is referred to as tacit collusion only because the outcome (in terms of prices set or quantities produced, for example) may well resemble that of explicit collusion or even of an official cartel."[14] Consequently, the rational, unilateral adoption by each firm to rely on pricing algorithms, and the concomitant increase in market transparency, may escape antitrust scrutiny. This is because tacit collusion, as the United States Supreme Court observed in *Brooke Group Ltd. v. Brown & Williamson Tobacco Corp.*, is legal:

https://www.ftc.gov/system/files/documents/public_statements/945343/mcsweeny_-_loyola_antitrust_colloquium_keynote_4-15-16.pdf

8 https://one.oecd.org/document/DAF/COMP(2016)14/en/pdf; http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DAF/COMP(2015)2&docLanguage=En

9 https://hbr.org/2016/10/how-pricing-bots-could-form-cartels-and-make-things-more-expensive

10 European Commission Staff Working Document Preliminary Report on the E-commerce Sector Inquiry, SWD(2016) 312 final (2016), page 9

11 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/565424/60ss-price-fixing-guidance-for-online-sellers.pdf

12 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/565424/60ss-price-fixing-guidance-for-online-sellers.pdf

13 http://www.reuters.com/article/us-usa-antitrust-ecommerce-plea-idUSKBN0MX1GZ20150406

14 Marc Ivaldi, Bruno Jullien, Patrick Rey, Paul Seabright, and Jean Tirole, "The Economics of Tacit Collusion," Final Report for DG Competition (Toulouse: European Commission, March 2003), page 4, http://ec.europa.eu/competition/mergers/studies_reports/the_economics_of_tacit_collusion_en.pdf

"[T]acit collusion, sometimes called oligopolistic price coordination or conscious parallelism, describes the process, not in itself unlawful, by which firms in a concentrated market might in effect share monopoly power, setting their prices at a profit-maximizing, supracompetitive level by recognizing their shared economic interests and their interdependence with respect to price and output decisions and subsequently unilaterally set their prices above the competitive level.[15]"

For tacit coordination to be sustainable over time, several conditions are needed: "First, the coordinating firms must be able to monitor to a sufficient degree whether the terms of coordination are being adhered to. Second, discipline requires that there is some form of credible deterrent mechanism that can be activated if deviation is detected. Third, the reactions of outsiders, such as current and future competitors not participating in the coordination, as well as customers, should not be able to jeopardise the results expected from the coordination."[16] As one European case notes, "there must be an incentive not to depart from the common policy on the market."[17] Among the characteristics of markets susceptible to tacit collusion, companies must be able to effectively retaliate when a competitor seeks a relative advantage by discounting. The retaliation must be "sufficiently likely and costly to outweigh the short-term benefits from 'cheating' on the collusive path."[18] In addition, to sustain tacit collusion, potential competitors or customers should not be in a position to jeopardize the results expected from the common policy. One would therefore expect tacit collusion in highly concentrated markets involving homogenous products where buyers cannot exert buyer power, and the market in general is characterized by high entry barriers,[19] although that is questionable.[20]

Of course, not all markets will be ripe for tacit collusion. But the industry-wide use of pricing algorithms may increase the number of instances in which tacit collusion may be sustained. As we explore in *Virtual Competition* the endemic use of similar (or identical) algorithms can transform a previously competitive market to new market conditions, which owing to the similarity of the algorithms, greater transparency, and the speed of competitive responses, enable durable tacit collusion and higher prices.

"As companies increasingly use algorithms and Big Data to price goods, what are the implications on collusion?"

As each seller shifts to pricing algorithms, the demand for digitized market information and transparency will increase. More market data will be digitalized and accessible, and market transparency will likely increase. Consumers and rival algorithms will immediately see each firm's current price and terms online. As the algorithms process the increasing flow of market data, each company's algorithm can better assess its and its rivals' sales, and whether its lost sales are due to an overall lower level of demand or due to a competitor's initiatives, such as offering "secret discounts" not reflected in the posted online price.

Speed is critical to sustain the online tacit collusion. When pricing is transparent, computers can rapidly police deviations, and calculate the profit implications of myriad moves and counter-moves to punish deviations.[21] The speed of calculated responses effectively deprives discounting rivals of any significant sales. The greater the improbability that the first-mover

15 Brooke Group Ltd. v. Brown & Williamson Tobacco Corp., 509 U.S. 209 (1993); R. S. Khemani and D. M. Shapiro, Glossary of Industrial Organisation Economics and Competition Law (Paris: Organisation for Economic Co-operation and Development, 1993), http://www.oecd.org/dataoecd/8/61/2376087.pdf

16 The Commission's Guidelines on the assessment of horizontal mergers under the Council Regulation on the control of concentrations between undertakings (2004/C 31/03), para. 41

17 Case T-342/99, Airtours plc v Commission of the European Communities [2002] ECR II-2585

18 Ivaldi et al., "The Economics of Tacit Collusion," *supra* n.12, page 5

19 Federal Trade Commission and U.S. Department of Justice, Horizontal Merger Guidelines, para. 7

20 Amanda P. Reeves & Maurice E. Stucke, Behavioral Antitrust, 86 Indiana Law Journal 1527 (2011) (identifying collusion in markets with low entry barriers)

21 http://www.newyorker.com/business/currency/when-bots-collude

will benefit from its discounting, the greater the likelihood of tacit collusion. As competitors' prices shift online, their algorithms can assess and adjust prices—even for particular individuals at particular times and for thousands of products—within milliseconds.[22] Thus if each algorithm can swiftly match a rival's discount and eliminate its incentive to discount in the first place, the "threat of future retaliation keeps the coordination sustainable."[23] Each algorithm can learn that any price reductions will be quickly detected and punished. On the other hand, the speed also means that collusion can be signalled in a matter of seconds. The algorithms can learn that price increases (when sustainable) will yield greater profits if they follow. In an environment dominated by similar pricing algorithms that are aware of opportunities to foster interdependence, one risk is higher prices.[24]

The stability needed for tacit collusion is further enhanced by the fact that computer algorithms are unlikely to exhibit human biases. As the European Commission observed, "Coordination is more likely to emerge if competitors can easily arrive at a common perception as to how the coordination should work. Coordinating firms should have similar views regarding which actions would be considered to be in accordance with the aligned behaviour and which actions would not."[25] Human biases, of course, may be reflected in the programming code. But biases will not necessarily affect decisions on a case-by-case basis: a computer does not fear detection and possible financial penalties or incarceration; nor does it respond in anger.[26] "We're talking about a velocity of decision-making that isn't really human," says Terrell McSweeny, a commissioner with the US Federal Trade Commission (FTC). "All of the economic models are based on human incentives and what we think humans rationally will do. It's entirely possible that not all of that learning is necessarily applicable in some of these markets."[27] Consider the effect then when each competitor in an industry adopts a pricing algorithm which is set to conform with tacit collusion (follow price increase, punish deviations). Even if the computer is not specifically programmed to tacitly collude, the algorithms, through trial-and-error, can arrive at that outcome when they have a similar goal (profit maximization) and access to each other's prices and other key market data. The algorithms will likely engage in "predictive analytics"—that is, the study of patterns in pricing and commercial decisions. Such an analysis will enable firms to combine "real-time, historical and third-party data to build forecasts of what will happen in their business months, weeks or even just hours in advance."[28] That technology would enable "moving away from 'systems of record' to 'systems of engagement' that use predictive analytics to cut through the noise in big data and uncover insights that can be acted on."[29]

One would expect a market norm to emerge. When dynamic pricing yields a competitive advantage, no firm can afford the time gap to assess whether the algorithm's suggested price should be implemented. The firm relies on the pricing algorithm precisely because it is ineffective for humans to independently analyze all the underlying market data to calculate prices (or discounts) on many products. If the whole purpose of dynamic pricing is to update prices quickly so as to reflect market demand, market participants will likely expect the price posted online to be the actual price. Some buyers may continue to haggle, but the norm develops that the algorithm-determined posted price is the actual price. Ironically, even if some companies yearn for the days of printed list prices and secretive discounts, they may switch to pricing algorithms to prevent being at a competitive disadvantage.

22 Samuel B. Hwang and Sungho Kim, "Dynamic Pricing Algorithm for E-Commerce," in Advances in Systems, Computing Sciences and Software Engineering, Proceedings of SCSS05, Tarek Sobh and Khaled Elleithy, eds. (Dordrecht: Springer, 2006), 149–155; N. Abe and T. Kamba, "A Web Marketing System with Automatic Pricing," Computer Networks 33 (2000): 775–788; L. M. Minga, Y. Q. Fend, and Y. J. Li, "Dynamic Pricing: E-Commerce-Oriented Price Setting Algorithm," International Conference on Machine Learning and Cybernetics 2 (2003)

23 *Supra* n. 14, para. 52

24 Alternatively, the computers can engage in parallel accommodating conduct, whereby "each rival's response to competitive moves made by others is individually rational, and not motivated by retaliation or deterrence nor intended to sustain an agreed-upon market outcome, but nevertheless emboldens price increases and weakens competitive incentives to reduce prices or offer customers better terms." Federal Trade Commission and U.S. Department of Justice, Horizontal Merger Guidelines, para. 7

25 *Supra* n. 14, para. 44

26 https://hbr.org/2016/10/how-pricing-bots-could-form-cartels-and-make-things-more-expensive

27 http://www.pros.com/about-pros/news/financial-times-policing-digital-cartels/

28 Roland Moore-Colyer, "Predictive Analytics Are the Future of Big Data," V3 (October 9, 2015), http://www.v3.co.uk/v3-uk/analysis/2429494/predictive-analytics-are-the-future-of-big-data

29 Ibid., citing Larry Augustine, chief executive at SugarCRM

2 Enforcement Challenges

We first raised algorithmic tacit collusion in 2015.[30] Since then technology and the use of dynamic pricing have advanced. So too policymakers and competition agencies are paying greater attention to the risks posed by algorithmic pricing. The U.K. House of Lords, for example, noted now the rapid developments in data collection and data analytics have created the potential for new welfare reducing and anti-competitive behaviour, including new forms of collusion. They recommended that the European Commission co-ordinate further research regarding the effects that algorithms have on the accountability of online platforms and the implications of this for enforcement.[31] In its 2016 Preliminary Report on the E-commerce Sector Inquiry[32] the European Commission noted the rise in use of monitoring algorithms:

> *"About half of the retailers track online prices of competitors. In addition to easily accessible online searches and price comparison tools, both retailers and manufacturers report about the use of specific price monitoring software, often referred to as "spiders", created either by third party software specialists or by the companies themselves. This software crawls the internet and gathers large amounts of price related information. 67 % of those retailers that track online prices use (also) automatic software programmes for that purpose. Larger companies have a tendency to track online prices of competing retailers more than smaller ones... some software allows companies to monitor several hundred online shops extremely rapidly, if not in real time... Alert functionalities in price monitoring software allow companies to get alerted as soon as a retailer's price is not in line with a predefined price."*[33]

The Commission acknowledged that, among other things, "increased price transparency through price monitoring software may facilitate or strengthen (both tacit and explicit) collusion between retailers by making the detection of deviations from the collusive agreement easier and more immediate. This, in turn, could reduce the incentive of retailers to deviate from the collusive price by limiting the expected gains from such deviation."[34] The French and German competition authorities similarly noted in their 2016 joint report, *Competition Law and Data*, that:

> *"Even though market transparency as a facilitating factor for collusion has been debated for several decades now, it gains new relevance due to technical developments such as sophisticated computer algorithms. For example, by processing all available information and thus monitoring and analyzing or anticipating their competitors' responses to current and future prices, competitors may easier be able to find a sustainable supra-competitive price equilibrium which they can agree on."*[35]

Commenting on these possible scenarios, the OECD noted in 2016 that these strategies "may pose serious challenges to competition authorities in the future, as it may be very difficult, if not impossible, to prove an intention to coordinate prices, at least using current antitrust tools."[36]

Competition law, in most jurisdictions, requires proof of an agreement among the competitors to change the market dynamics. The unilateral use of algorithms to monitor price will not amount to an illegal agreement or concerted practice. A rational reaction by competitors to market dynamics, in itself, is legal. When such legal behavior, absent communication or agreement, leads to an equilibrium above competitive levels, it does not trigger antitrust intervention. After all, one cannot condemn a firm for behaving rationally

30 Ezrachi and Stucke 'Artificial Intelligence & Collusion: When Computers Inhibit Competition' Oxford Legal Studies Research Paper No. 18/2015, University of Tennessee Legal Studies Research Paper No. 267, available at SSRN: https://ssrn.com/abstract=2591874 or http://dx.doi.org/10.2139/ssrn.2591874

31 European Union Committee, Online Platforms and the Digital Single Market, 10th Report of Session 2015-16, published 20 April 2016, HL Paper 129, para. 178 and para. 179, https://www.publications.parliament.uk/pa/ld201516/ldselect/ldeucom/129/12908.htm

32 *Supra* n. 8

33 Ibid., paras. 550-551.

34 Ibid., para. 555. Also note the European Commission investigations into online sales practices launched on 2 February 2017. As part of the investigation into consumer electronics manufacturers the commission will also consider the effects of pricing software that automatically adapts retail prices to those of leading competitors.

35 Autorité de la concurrence and Bundeskartellamt 10.05.2016 'Competition law and data', page 14 with reference to our earlier work Ezrachi and Stucke 'Artificial Intelligence & Collusion: When Computers Inhibit Competition' Oxford Legal Studies Research Paper No. 18/2015, University of Tennessee Legal Studies Research Paper No. 267, available at SSRN: https://ssrn.com/abstract=2591874 or http://dx.doi.org/10.2139/ssrn.2591874.. http://www.bundeskartellamt.de/SharedDocs/Publikation/DE/Berichte/Big%20Data%20Papier.pdf?__blob=publicationFile&v=

36 Organisation for Economic Co-operation and Development, 27.10.2016, 'Big Data: Bringing Competition Policy To The Digital Era' Daf/Comp(2016)14, para. 81, https://one.oecd.org/document/DAF/COMP(2016)14/en/pdf

and interdependently.[37] If the algorithms increase market transparency, defendants will often have an independent legitimate business rationale for their conduct. Courts and the enforcement agencies may be reluctant to restrict this flow of information in the marketplace. Its dissemination, observed the U.S. Supreme Court, "is normally an aid to commerce,"[38] and "can in certain circumstances increase economic efficiency and render markets more, rather than less, competitive."[39] Indeed, concerted action to reduce price transparency may itself be an antitrust violation.[40]

So, what actions might enforcers consider to deter online tacit collusion?

To begin with, enforcers should distinguish between pure forms of tacit collusion (which is nothing more than a unilateral rational reaction to market characteristics), and instances in which illicit concerted practice has "contaminated" or "facilitated" tacit collusion.

At times, the unilateral nature of the action may be questioned and either a horizontal or vertical agreement may be inferred. Indeed, as part of its investigation into suspected anticompetitive practices in e-commerce, the European Commission is investigating such possible illicit collusion, namely whether "Asus, Denon & Marantz, Philips and Pioneer have breached EU competition rules by restricting the ability of online retailers to set their own prices for widely used consumer electronics products such as household appliances, notebooks and hi-fi products." According to the Commission, "The effect of these suspected price restrictions may be aggravated due to the use by many online retailers of pricing software that automatically adapts retail prices to those of leading competitors. As a result, the alleged behaviour may have had a broader impact on overall online prices for the respective consumer electronics products."[41] Another example is if firms agreed to standardize their products with the primary aim of facilitating tacit collusion among their pricing algorithms.

> "Industry-wide use of pricing algorithms may increase the number of instances in which tacit collusion may be sustained."

On the other hand, condemning pure tacit collusion – i.e., without any concerted practice or agreement – is more challenging. Could the competition agency and court impute an illicit agreement or understanding when the competitors use similar algorithms that collectively dampen competition?[42] Might it treat any posting of price online as a signal or communication? Arguably not when such practices provide much needed information to customers, enable them to exercise choice, and thus are common and necessary in the online marketplace. When algorithmic dynamic pricing has become

37 See, for example, Case C-199/92, P Hüls AG v. Commission, [1999] ECR I-4287, [1999] 5 CMLR 1016; Joined Cases C-89, 104, 114, 116, 117, 125, 129/85, Ahlström Osakeyhtiö and others v. Commission (Wood Pulp II), [1993] ECR I-1307, [1993] 4 CMLR 407; Cases T-442/08, CISAC v Commission, [2013] 5 CMLR 15 (General Court)

38 Sugar Institute, Inc. v. United States, 297 U.S. 553, 598 (1936)

39 United States v. United States Gypsum Co., 438 U.S. 422, 441 n.16 (1978); See also Richard A. Posner, Antitrust Law, 2nd ed. (Chicago: University of Chicago Press, 2001), 160. Generally, the more information sellers have about their competitors' prices and output, the more efficiently the market will operate.

40 See, for example, Federal Trade Commission, Funeral Directors Board Settles with FTC (August 16, 2004), http://www.ftc.gov/opa/2004/08/vafuneral.htm (a board's prohibition on licensed funeral directors advertising discounts deprived consumers of truthful information); Federal Trade Commission, Arizona Automobile Dealers Association, FTC C-3497 (February 25, 1994) (a trade association illegally agreed with members to restrict nondeceptive comparative and discount advertising and advertisements concerning the terms and availability of consumer credit); Organisation for Economic Co-operation and Development, Price Transparency, DAFFE/CLP(2001)22 (September 11, 2001), 183, 185–186 (citing examples of U.S. enforcement agencies seeking to increase price transparency); compare InterVest, Inc. v. Bloomberg, L.P., 340 F.3d 144 (3d Cir. 2003) (lack of price transparency in bond market not illegal if consistent with unilateral conduct)

41 http://europa.eu/rapid/press-release_IP-17-201_en.htm

42 The plaintiff can allege that the defendant firms collectively agreed to use these algorithms; specifically, it was their collective agreement to use a facilitating device that fosters tacit collusion. See Todd v. Exxon Corp., 275 F.3d 191 (2d Cir. 2001). The benefit of this approach is that it may be easier to prove that the industry agreed to use algorithms (especially to ensure their interoperability) and knew that its rival firms' algorithms had similar reward structures than it is to prove an agreement to fix prices. The downsides of this approach are the cost, duration, and unpredictability of a rule of reason case, and the difficulty for the court in weighing the pro-competitive benefits of product developments with the anticompetitive effects.

the industry standard, abstaining from the use of advanced pricing algorithms may be irrational; it would be as if an investment bank or hedge fund insisted on human floor traders, when most trading is automated.

Instead of challenging the tacit collusion itself, an alternative enforcement approach may be to focus on the change in market dynamics. While the mutual price monitoring at the heart of tacit collusion is legal under competition law, one may ask whether the creation of such a dynamic through "artificial" means justifies to antitrust intervention. This approach would condemn the creation of a transparent market in which monitoring and punishment mechanisms are present. Its application may be possible through various channels:

Unfair practice

For instance, the FTC can bring claims under Section 5 of the FTC Act, without evidence of an agreement, only a showing of an "unfair practice." Many U.S. states have a similar statute. But the FTC has been unsuccessful in bringing these "facilitating practices" claims, as is evident in *Boise Cascade*[43] and *Ethyl*.[44] If the court adopts the standard in *Ethyl*, the FTC would need to show either (1) evidence that defendants tacitly or expressly agreed to use pricing algorithms to avoid competition, or (2) oppressiveness, such as (a) evidence of defendants' anticompetitive intent or purpose or (b) the absence of an independent legitimate business reason for the defendants' conduct.[45] Accordingly, defendants may be liable if, when developing the algorithms or in seeing the effects, they were (1) motivated to achieve an anticompetitive outcome, or (2) aware of their actions' natural and probable anticompetitive consequences.

Market manipulation

Another approach may be to consider the use of such algorithms as market manipulation. This approach has its obstacles; yet one could imagine legislation that targets "abuse" of excessive transparency, possibly where clear anticompetitive intent is present.

If the executives, for example, call their algorithm *Gravy*, tinker with it to better manipulate the market, and boast about this in their internal e-mails—as in the U.S. Securities and Exchange Commission's (SEC) case against Athena Capital Research—liability could be established.[46] The *Athena* case is illustrative. In 2014, the SEC for the first time sanctioned the high-frequency trading firm for using complex computer programs to manipulate stock prices.[47] The sophisticated algorithm, code-named *Gravy*, engaged in a practice known as "marking the close" in which stocks were bought or sold near the close of trading to affect the closing price: "[t]he massive volumes of Athena's last-second trades allowed Athena to overwhelm the market's available liquidity and artificially push the market price—and therefore the closing price—in Athena's favor."[48] Athena's employees, the SEC alleged, were "acutely aware of the price impact of its algorithmic trading, calling it 'owning the game' in internal e-mails."[49] Athena employees "knew and expected that *Gravy* impacted the price of shares it traded, and at times Athena monitored the extent to which it did. For example, in August 2008, Athena employees

43 Boise Cascade Corp. v. F.T.C., 637 F.2d 573 (9th Cir. 1980)

44 E. I. du Pont de Nemours & Co. v. F.T.C., 729 F.2d 128 (2d Cir. 1984).

45 Ibid., at 139

46 U.S. Securities and Exchange Commission, Administrative Proceeding File No. 3-16199 (October 16, 2014), http://www.sec.gov/litigation/admin/2014/34-73369.pdf

47 The computer trading program was "placing a large number of aggressive, rapid-fire trades in the final two seconds of almost every trading day during a six-month period to manipulate the closing prices of thousands of NASDAQ-listed stocks." U.S. Securities and Exchange Commission, SEC Charges New York–Based High Frequency Trading Firm with Fraudulent Trading to Manipulate Closing Prices, October 16, 2014, http://www.sec.gov/News/PressRelease/Detail/PressRelease/1370543184457#.VEOZlfldV8E. Ibid

48 Ibid

49 Ibid. As the SEC alleged Athena's manipulative scheme focused on trading in order to create imbalances in securities at the close of the trading day: "Imbalances occur when there are more orders to buy shares than to sell shares (or vice versa) at the close for any given stock. Every day at the close of trading, NASDAQ runs a closing auction to fill all on-close orders at the best price, one that is not too distant from the price of the stock just before the close. Athena placed orders to fill imbalances in securities at the close of trading, and then traded or 'accumulated' shares on the continuous market on the opposite side of its order." According to the SEC's order, Athena's algorithmic strategies became increasingly focused on ensuring that the firm was the dominant firm—and sometimes the only one—trading desirable stock imbalances at the end of each trading day. The firm implemented additional algorithms known as "Collars" to ensure that Athena's orders received priority over other orders when trading imbalances. These eventually resulted in Athena's imbalance-on-close orders being at least partially filled more than 98 percent of the time. Athena's ability to predict that its orders would get filled on almost every imbalance order allowed the firm to unleash its manipulative Gravy algorithm to trade tens of thousands of shares right before the close of trading. As a result, these shares traded at artificial prices that NASDAQ then used to set the closing prices for on-close orders as part of its closing auction. Athena's high-frequency trading scheme enabled its orders to be executed at more favorable prices.

compiled a spreadsheet containing information on the price movements caused by an early version of *Gravy*."[50] Athena configured its algorithm *Gravy* "so that it would have a price impact."[51]

In calling its market-manipulation algorithm *Gravy*, and by exchanging a string of incriminating e-mails, the company did not help its case. Without admitting guilt, Athena paid a $1 million penalty. This demonstrates that automated trading has the potential to increase market transparency and efficiency, but it can also lead to market manipulation.[52]

> "Speed is critical to sustain the online tacit collusion."

Finding the predominant purpose for using an algorithm will not always be straightforward. Athena, for example, challenged the SEC's allegations that it engaged in fraudulent activity: "While Athena does not deny the Commission's charges, Athena believes that its trading activity helped satisfy market demand for liquidity during a period of unprecedented demand for such liquidity."[53] A court might agree. Companies, learning from *Athena*, may be more circumspect in their e-mails.[54]

Structural change

Another approach may focus on the deterring structural changes that foster tacit collusion. As one U.S. court observed, "Tacit coordination is feared by antitrust policy even more than express collusion, for tacit coordination, even when observed, cannot easily be controlled directly by the antitrust laws. It is a central object of merger policy to obstruct the creation or reinforcement by merger of such oligopolistic market structures in which tacit coordination can occur."[55] Thus stronger merger control, in particular, may be an option. The agencies can be more sensitive to whether the elimination of a particular player would increase significantly the risk of algorithmic tacit collusion. This would require a more sophisticated understanding of the factors contributing to tacit collusion. It may be preserving a market of diverse sellers with different horizons for profits and different capacity constraints. It may be scrutinizing conglomerate mergers when multi-market contact softens competition.[56] Natural experiments would come into play, to see how the algorithms behaved in similar markets where entry or exit occurred.

Merger control, however, won't work when other factors (such as the shift to algorithmic pricing itself, or firms exiting unilaterally) foster tacit collusion. So, another approach might be to use ex-ante or ex-post mechanisms to audit the firms' algorithms to assess when they may result in the active changing of market dynamics. For example, before a firm can use its pricing algorithm, the competition authority could activate it in a "sand box" where its effects with the other firms' existing algorithms will be observed.

The obstacles to this approach are evident. Commercial secrecy and the impracticalities of auditing self-learning algorithms are likely to make this an inferior option at present. The self-learning algorithm may price competitively in the sandbox, but through repeated interactions in the field may learn of new strategies. Unlike a merger, one may find it difficult, if not impossible, to identify clear thresholds for intervention and legality once these algorithms are operating in the market. Further, one wonders which counterfactuals could be used when considering the effects of such algorithms?

50 U.S. Securities and Exchange Commission, Administrative Proceeding File No. 3-16199, para. 34
51 Ibid., para. 36
52 Peter J. Henning, "Why High-Frequency Trading Is so Hard to Regulate," New York Times, October 20, 2014, http://dealbook.nytimes.com/2014/10/20/why-high-frequency-trading-is-so-hard-to-regulate/
53 Steve Goldstein, "High-Frequency Trading Firm Fined for Wave of Last-Minute Trades," Market Watch (October 16, 2014), http://www.marketwatch.com/story/high-frequency-trading-firm-fined-for-wave-of-last-minute-trades-2014-10-16
54 Moreover, evidence of intent will likely be mixed when each firm has valid independent business reasons to develop and implement a pricing algorithm. After all, the first firm to use the pricing algorithm could not be accused of colluding, as the market was likelier less transparent, and rivals could not match the speed of the first mover's price changes.
55 F.T.C. v. H.J. Heinz Co., 246 F.3d 708, 725 (D.C. Cir. 2001) (quoting 4 Phillip E. Areeda, Herbert Hovenkamp & John L. Solow, Antitrust Law ¶ 901b2, at 9 (rev. ed.1998))
56 Federico Ciliberto and Jonathan W. William, Does multimarket contact facilitate tacit collusion? Inference on conduct parameters in the airline industry, RAND Journal of Economics, Vol. 45, No. 4, Winter 2014, pp. 764–791.

Counter measures

Rather than legally challenge tacit collusion, policymakers or consumer organizations may attempt to actively destabilize it.

One set of counter-measures involves market structure. Entry, according to the empirical economic literature, helps destabilize express collusion.[57] Thus one avenue to explore is whether promoting entry by mavericks and reducing regulatory entry barriers would destabilize algorithmic collusion.

A second set of counter-measures involves limiting transparency to the buyers' advantage. The government may explore, for example, whether giving buyers call options on multiple sellers helps destabilize seller tacit collusion.[58] Here the buyer, but not the rivals, learns the price of each seller for a future order. The government can also target public policies that help facilitate collusion without necessarily improving the buyers' welfare. As former FTC Chair Bill Kovacic observed:

> *"A major example is the process for opening bids in a sealed bid procurement. Bids ordinarily are unsealed in a public setting and are displayed for all offerors to observe. This procedure enables cartel participants to determine whether their co-conspirators abided by the terms of their agreement to rotate bids or otherwise suppress rivalry. An obvious reform would be to permit inspection of bids by a guardian internal to the purchasing organization, such as an inspector general. This simple measure would complicate the detection of cheating by cartel members and still ensure that the winning offeror has been identified correctly."*[59]

A third set of counter-measures would entail increasing the incentives to deviate. Smaller buyers can test whether pooling their orders into less frequent, less predictable larger orders yields a better price from the sellers' algorithms, in effect rewarding a seller with greater profits to deviate from the collusive regime.[60] State-sponsored algorithms or other mechanisms for joint consumer bargaining or protection may try to undermine the collusive equilibrium or affect levels of transparency. Consumer-friendly algorithms seeking to maximize consumer surplus could play against seller algorithms seeking to maximize profits.

Counter-measures pose challenges at both policy and practical levels. To begin with, most enforcement agencies are not likely to favor ongoing intervention and manipulation of market dynamics. A regulatory approach to reduce transparency may prove difficult. One may find it difficult to fine-tune the enforcement policy aimed at condemning "excessive" market transparency or undermine the collusive equilibrium. Further, such intervention will likely lead to an arms race between sellers and buyers. The former may likely benefit from resources and technological advantage. With the ability to rely on advanced algorithms to change the market dynamics and the possibility to use artificial intelligence to perfect the strategy, could competition law enforcers effectively identify and target such strategies?

3. Conclusion

Lord David Currie of the U.K. Competition and Markets Authority observed in a recent speech that, "the rise of the algorithmic economy raises potentially difficult questions for competition policy":

> *"Algorithms can provide a very effective way of almost instantly coordinating behaviour, possibly in an anti-competitive way. Where algorithms are designed by humans to do so, this is merely a new form of the old practice of price-fixing. But machine learning means that the algorithms may themselves learn that co-ordination is the best way to maximise longer-term business objectives. In that case, no human agent has planned the co-ordination. Does that represent*

57 Margaret C. Levenstein & Valerie Y. Suslow, Breaking Up Is Hard to Do: Determinants of Cartel Duration, 54 J.L. & Econ. 455, 485 (2011) (noting how entry destabilizes illegal cartels: "Cartels respond creatively to the threat of entry and take a variety of actions to prevent it. While these actions to create barriers to entry may prolong cartel life, their use reflects an active threat and is associated with increased probability of breakup. The threat of entry is an important feature to include in models of cooperative behavior.").

58 Ian Ayres & Eric Talley, Solomonic Bargaining: Dividing A Legal Entitlement to Facilitate Coasean Trade, 104 Yale L.J. 1027, 1117 (1995)

59 William E. Kovacic, Antitrust Policy and Horizontal Collusion in the 21st Century, 9 Loy. Consumer L. Rep. 97, 107 (1997)

60 Paul W. Dobson & Roman Inderst, The Waterbed Effect: Where Buying and Selling Power Come Together, 2008 Wis. L. Rev. 331, 354 (2008) ("With a large order up for grabs, suppliers may be more tempted to undercut any collusive regime and offer the large buyer a discount."); but see Margaret C. Levenstein & Valerie Y. Suslow, Breaking Up Is Hard to Do: Determinants of Cartel Duration, 54 J.L. & Econ. 455, 482 (2011) ("Although large customers may be able, in principle, to destabilize cartels, in many cases they seem instead to extract concessions that reduce their incentive to do so.")

a breach of competition law? Does the law stretch to cover sins of omission as well as sins of commission: the failure to build in sufficient constraints on algorithmic behaviour to ensure that the algorithm does not learn to adopt anti-competitive outcomes? And what if constraints are built in but they are inadequately designed, so that the very clever algorithm learns a way through the constraints? How far can the concept of human agency be stretched to cover these sorts of issues? I have suggested earlier that the competition tools at our disposal can tackle the competition issues that we face in the new digital world, but perhaps this last issue which I have touched on is one where this proposition is not true."[61]

The current online markets are far from perfect competition. The invisible hand that we rely upon can be pushed aside by the "digitized hand." The digitized hand has the capacity to be selective and generate different levels of competitive pressure. The resulting environment, with rules different from the ones we assume in the theoretical economic models, can yield new forms of anticompetitive behavior. Tacit collusion will likely become more common. The nature of electronic markets, the availability of data, the development of similar algorithms, and the stability and transparency they foster, will likely push some markets that were just outside the realm of tacit collusion into interdependence.[62]

As Lord Currie recognized, the EU and US enforcers currently cannot tackle the tacit collusion scenarios. These developments raise challenging technical, enforcement, and legal questions.[63]

In its Preliminary Report on the E-commerce Sector Inquiry, the European Commission expressed its increasing concern that monitoring software, excess transparency and advanced algorithms may be used to facilitate online collusion. US and European competition officials are increasingly warning of the anticompetitive impact pricing algorithms can have on virtual competition.[64] These indications from the enforcers are encouraging. No doubt, many challenges must still be addressed at the legal, policy and technical levels to ensure optimal enforcement. And yet, ignoring the challenges is irresponsible. The goal ultimately is a data-driven economy that's inclusive and promotes our overall wellbeing, not one where profit-maxing algorithms (and oligopolies and oligopsonies) reign supreme.

61 David Curie, 'Speech given by CMA Chairman, David Currie, at the Concurrences Innovation Economics Conference, King's College London Competition Markets Authority' (February, 3, 2017), https://www.gov.uk/government/speeches/david-currie-on-the-role-of-competition-in-stimulating-innovation

62 One would expect tacit collusion to be feasible with a larger number of participants than commonly assumed. On the common market assumptions, see generally R. Selten, "A Simple Model of Imperfect Competition, Where Four Are Few and Six Are Many," International Journal of Game Theory 2 (1973): 141; Steffen Hucka, Hans-Theo Normannb, and Jörg Oechssler, "Two Are Few and Four Are Many: Number Effects in Experimental Oligopolies," Journal of Economic Behavior and Organization 53, no. 4 (2004): 435–446

63 https://www.theguardian.com/commentisfree/2016/dec/04/how-do-you-throw-book-at-an-algorithm-internet-big-data

64 Eric Kroh, "Antitrust Enforcers Could Be Stymied By Computer Cartels," Law360, March 22, 2017, https://www.law360.com/articles/902647/antitrust-enforcers-could-be-stymied-by-computer-cartels; Sophie Lawrance and Matthew Hunt, "Will pricing algorithms be the European Commission's next antitrust target?", Lexology, March 21 2017, http://www.lexology.com/library/detail.aspx?g=b9aca10a-ba0e-4249-81a5-5eab63b90876