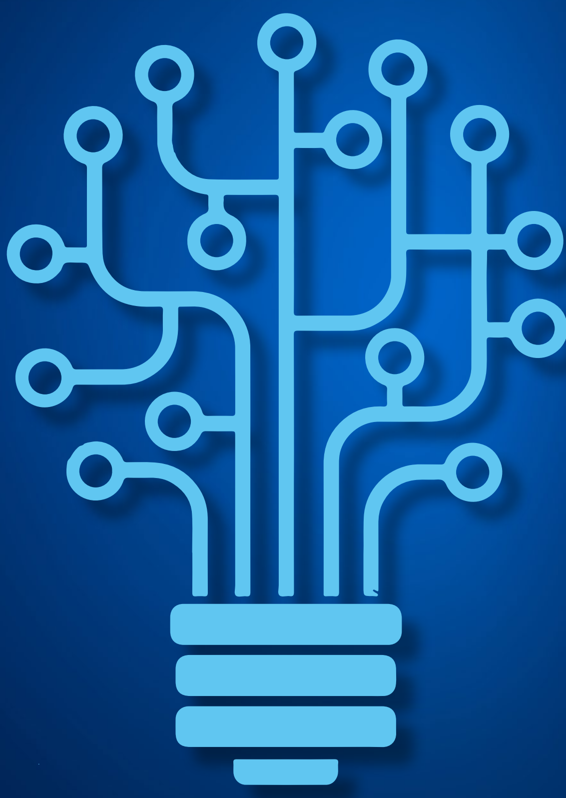
THE EVOLUTION OF ANTITRUST IN THE DIGITAL ERA:
Essays on Competition Policy

Volume One

Editors
David S. Evans
Allan Fels AO
Catherine Tucker



CPI COMPETITION POLICY INTERNATIONAL

THE EVOLUTION OF ANTITRUST IN THE DIGITAL ERA: Essays on Competition Policy

Volume 1

Editors
David S. Evans
Allan Fels AO
Catherine Tucker

Competition Policy International, 2020

111 Devonshire Street · Boston, MA 02108, USA
www.competitionpolicyinternational.com
contact@competitionpolicyinternational.com

Printed in the United States of America

First Printing, 2020

ISBN 978-1-950769-60-5 (Paperback)
ISBN 978-1-950769-61-2 (Hardcover)
ISBN 978-1-950769-62-9 (Ebook)

Publisher's Cataloging-in-Publication Data
provided by Five Rainbows Cataloging Services

Names: Evans, David S. (David Sparks), 1954- author. | Tucker, Catherine, editor. | Fels, Allan, editor.
Title: The evolution of antitrust in the digital era : essays on competition policy, volume I / David S. Evans ; Catherine Tucker [and] Allan Fels AO, editors.
Description: 1st edition. | Boston : Competition Policy International, 2020.
Identifiers: LCCN 2020945593 (print) | ISBN 978-1-950769-60-5 (paperback) | ISBN 978-1-950769-61-2 (hardcover) | ISBN 978-1-950769-62-9 (ebook)
Subjects: LCSH: Antitrust law. | Competition, Unfair. | Electronic commerce--Law and legislation. | Big data. | Consolidation and merger of corporations. | Commercial law. | BISAC: LAW / Antitrust. | LAW / Commercial / General. | LAW / Mergers & Acquisitions.
Classification: LCC KF1649 .E93 2020 (print) | LCC KF1649 (ebook) | DDC 343.07/21--dc23.

Cover and book design by Inesfera. www.inesfera.com

Editors' Note

The story of antitrust is the story of technology. The essays in this volume tell the latest chapter in this ongoing saga.

In the late 19th century, the disruptive technology of the day was the railroad. In the expanding U.S., local railroads were bought up and consolidated into broad systems by the "trusts" that gave the Sherman Antitrust Act of 1890, and the resulting worldwide body of law, its name. Moving on from transport, various technologies have formed the locus of economic growth, and therefore of antitrust scrutiny, throughout the past hundred years or so.

After the railroads came Standard Oil, and its control over the key input for 20th century economic growth. Again, this was a reflection of technology, both in other industries' need for vast sources of energy, and the improved refining technology that led to scale in the oil industry itself. Antitrust enforcement, famously, split the company up. Then, mid-century, came the telecommunications revolution. In the U.S., concerns crystallized around the role of the Bell System as an incumbent technology provider. Once more, antitrust enforcement split it up. In the 1970s and 80s, IBM's mainframe computing business became the target of enforcement. Following on from that, the banner cases of the 1990s in both the U.S. and Europe were against Microsoft's practices in the desktop computing space. In the latter two instances, however, the consequences were less radical, due, perhaps, to the intervening Chicago School critique of earlier antitrust remedies.

Despite these different outcomes, at each step along the way, antitrust thinking has been defined by the technologies that gave rise to its greatest enforcement challenges. Since the dawn of this century, attention has turned to the current generation of innovators, in what today is termed the "digital economy." The quandaries facing today's legislators, enforcers, and public, are novel and multifaceted. Nonetheless, they bear comparison with the formative struggles that policymakers grappled with throughout the first century of antitrust.

The pieces in this volume draw on the lessons of the past to set out how competition rules might deal with this new set of concerns, in various jurisdictions around the world. Each one draws on general themes, yet nevertheless addresses specific aspects of the contemporary debate.

Much of today's antitrust discussion concerns the businesses run by large companies such as Amazon, Apple, Facebook, Google, and Microsoft. Each has significant share in a given industry, and derives its revenues from what are described as "platforms." But how are such platforms different from the incumbent businesses of the past? The answer to this is not clear. Yet queries surrounding the platforms' alleged dominance, and whether their conduct amounts to an infringement of competition rules, have been a source of controversy for over a decade. The pieces in this volume address this dilemma head-on.

At a fundamental level, there is the definitional threshold of what a "platform" even is, and what rules should apply to such a business. Then there is the question of whether "platforms" have a "special responsibility" towards downstream operators that rely on them to reach customers. In other words, can platform operators favor their own businesses in those related markets? Or do competition laws require them to treat all firms in the same way? What are the risks to competition if platforms are given free rein? In antitrust parlance, these questions are assessed under the rubric of "self-preferencing," which has dominated recent headlines.

Pieces by **Thomas Kramler** and **Robert D. Atkinson** & **Joe Kennedy** report on this controversy from the trenches. The authors draw on their considerable experience in dealing with these issues to ask whether antitrust concerns in the digital economy can effectively be addressed within the confines of existing antitrust law and jurisprudence, or whether new rules are needed.

At the time of publication, this "platform regulation" debate is reaching its crescendo. In 2019, various jurisdictions, including the EU, Germany, Australia, and the Brexiting UK, commissioned detailed reports on whether competition rules need to be updated to deal with "platforms," and "self-preferencing" specifically. The coming months and years will see legislatures take action on these reports. Much is at stake in how these reports' conclusions are interpreted. The pieces in this volume form a vital part of that discourse.

Aside from these (almost existential) concerns, there is the question of how "platforms" interact with other actors in the economy. While it is productive for there to be broad discourse on the role of competition and digital regulatory policy, it is also vital for those rules to stay in their own lane. Otherwise, reforms grounded in the logic of antitrust could unduly expand its role, and counteract other policies. This debate has reached an advanced stage in Australia, where policy efforts have honed in on the media and news industry. Pieces by **Simon Bishop** & **George Siolis**, and **Andrew Low** & **Luke Woodward**, describe these developments, and discuss the risks of focusing on a narrow set of sector-specific concerns to derive broad antitrust solutions.

Then, there are even more specific concerns. Algorithms, anonymously executed in server farms, dominate modern commerce. Aside from mundane operational decisions, algorithms are increasingly used to set pricing and other commercial strategies. This can be pro-competitive and efficient. But algorithms, like people, can also restrict competition and harm consumers. If firms use algorithms that "autonomously" tacitly collude through deep machine learning, can the firms that run them be held liable? The pieces by **Andreas Mundt** and **Gönenç Gürkaynak**, **Burcu Can**

& **Sinem Uğur** underline the need for further research on how such algorithms operate in real-life settings, before creating a new head of liability.

Technology allows consumers to access and interact with offers in the digital world with remarkable ease. But it has also created the potential for new forms of consumer exploitation, and facilitates highly individualised price discrimination. This creates opportunities for business models based on exploiting incumbents' superior bargaining position, particularly in the business-to-business space. Platforms can make "take-it-or-leave-it" offers that allow the platform to enjoy all the surplus of trade. This notion of an "abuse of a superior bargaining position" is foreign to competition rules in certain jurisdictions, but is known in Japanese competition law, as discussed by **Reiko Aoki** & **Tetsuya Kanda**.

Moore's Law famously predicts that the number of transistors on a microchip will double every two years, though their cost will be halved. These remarkable advances, coupled with parallel developments in mass data gathering and storage, allow today's computers to solve tasks of extraordinary complexity, including innovative, reliable, and lucrative predictive analytics. Yet this possibility raises profound privacy concerns, as reflected in laws such as the California Consumer Privacy Act and the EU's General Data Protection Regulation. Such rules, in turn, raise novel competition issues.

This dynamic has profound implications for competition law, and how it interacts with privacy rules. Although competition and privacy law are separate disciplines, they are in tension with each other. As **Maureen K. Ohlhausen** & **Peter Huston** discuss, this problem came to the forefront in recent U.S. litigation between hiQ and LinkedIn. The latter, invoking the privacy rights of its members, employed technical measures to block hiQ's automated bots from accessing data on LinkedIn's servers. HiQ, in turn, alleged that LinkedIn's actions were in reality an attempt to restrict competition.

As the authors discuss, this case represents the archetypal conflict between data privacy and competition, and will be repeated throughout the world in years to come. The policy dilemma between privacy rules and antitrust cannot be overstated. Protecting privacy by restricting data flows can hinder competition by denying new entrants access to the data they need to compete. On the other hand, ensuring that rivals have easy access to data can diminish privacy by distributing data in ways that consumers may not anticipate or want.

The foregoing should make clear that the story of antitrust in the "digital economy" is but one chapter in a saga that is still being written. Like all sagas, it draws from universal themes, and is self-referential within its canon. Yet it is all the more interesting as a result.

The editors would like to thank Elisa Ramundo, Sam Sadden, and Andrew Leyden for commissioning, compiling, and editing this volume.

Table of Contents

Algorithmic Collusion: Fear of the Unknown or too Smart to Catch?

By Gönenç Gürkaynak, Burcu Can & Sinem Uğur[1]

Abstract

Algorithms, which businesses use more and more to set pricing strategies with each passing day, could be pro-competitive and provide significant efficiencies. Depending on how firms use them, however, they can also potentially restrict competition and harm consumers. Scholars and enforcers debate on the right scope of the theory of harm as to using algorithms in critical competition parameters, particularly in pricing strategies. Yet, one question remains open: if firms use algorithms that may tacitly collude through machine learning - particularly deep learning technologies, will that alone be sufficient to hold them liable for a competition law infringement? This article discusses the current limits of the collective knowledge on this subject and explores what guidance could still be provided to businesses. The article argues that the solution does not lie in taking premature regulatory actions without sufficient empirical evidence to justify any shift away from the traditional concepts of tacit collusion, or without proper guidance for companies to avoid the risk of legal exposure. The need is evident for further research on how self-learning algorithms operate in real-life settings, which could start defining a "red zone" for businesses to watch out and for enforcers to focus their energy and resources.

I. INTRODUCTION

The rise of algorithms in many sectors and particularly in the digital markets has triggered a debate on whether and how these advanced tools now used increasingly by

1 Gönenç Gürkaynak is the founding partner of ELIG Gürkaynak Attorneys-at-Law, and a member of faculty at Bilkent University, Faculty of Law and Bilgi University, Faculty of Law. Burcu Can is a partner at ELIG Gürkaynak Attorneys-at-Law. Sinem Uğur is an associate at ELIG Gürkaynak Attorneys-at-Law.

many businesses[2] can impede competition.[3] A number of prominent scholars, with Ezrachi & Stucke on the frontline, took a first stab at laying out the theoretical framework of this thought-provoking debate.[4] Competition authorities around the world have since lined up to voice their concerns and mark their positions with respect to this new "player" in the game.[5] While this player may be relatively new, the questions at the front and center are well-known: What is the theory of harm as to using algorithms in critical competition parameters, particularly in pricing strategies? What is the standard of proof? The latter is still somewhat an uncharted territory, although we have observed some interesting – and to a certain extent, alarming – theories on how pricing algorithms can potentially lead to restrictions of competition that may harm consumers (e.g. by increasing prices).

Algorithms are not inherently good or bad - depending on how companies use them, they can be pro-competitive or anti-competitive.[6] Their potential pro-competitive effects involve both (i) supply-side efficiencies, which can be achieved by increasing transparency, improving existing products or developing new ones, reducing production costs, improving quality and resource utilization, streamlining business

2 European Commission's Staff Working Document reported in 2017 that "*53% of respondent retailers track the online prices of competitors, and 67% of those also use automatic software programmes for that purpose*." (Commission Staff Working Document-*accompanying the document*-Report from the Commission to the Council and the European Parliament Final Report on the E-commerce Sector Inquiry, COM 229 (2017), p. 51, para. 149, available at https://eur-lex.europa.eu/resource.html?uri=cellar:9d1137d3-3570-11e7-a08e-01aa75ed71a1.0001.02/DOC_1&format=PDF) (last accessed Apr. 16, 2020). According to a market study by the Dresner Advisory Services in 2019, a significant number of the participating companies' sales and marketing departments were either currently using or evaluating data science and machine learning software (Louis Columbus, *State of AI and Machine Learning in 2019*, FORBES (Sept. 8, 2019), available at https://www.forbes.com/sites/louiscolumbus/2019/09/08/state-of-ai-and-machine-learning-in-2019/#c9df3331a8d0 (last accessed Apr. 16, 2020).

3 As pointed out by Thibault Schrepel, Google Scholar listed 141 academic articles that discussed "algorithmic collusion" from January 2017 to early 2020. (See Thibault Schrepel, *The Fundamental Unimportance of Algorithmic Collusion for Antitrust Law*, HARV. J.L. & TECH. (2020), fn. 4, available at https://jolt.law.harvard.edu/digest/the-fundamental-unimportance-of-algorithmic-collusion-for-antitrust-law) (last accessed Apr. 16, 2020).This number has now reached 171.

4 See, e.g. Ariel Ezrachi & maurice e. Stucke, Virtual Competition: The Promise And Perils Of The Algorithm-Driven Economy, Cambridge, Massachusetts: Harvard University Press (2016); Ashwin Ittoo & Nicolas Petit, *Algorithmic Pricing Agents and Tacit Collusion: A Technological Perspective*, l'intelligence artificielle et le droit, 241, 241-256 (2017).

5 See, e.g. CMA, *Pricing Algorithms – Economic working paper on the use of algorithms to facilitate collusion and personalized pricing*, Oct. 8, 2018, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/746353/Algorithms_econ_report.pdf (last accessed Apr. 16, 2020); Autorité de la concurrence & Bundeskartellamt, *Working Paper – Algorithms and Competition*, Nov. 2019, available at https://www.autoritedelaconcurrence.fr/sites/default/files/algorithms-and-competition.pdf (last accessed Apr. 16, 2020).

6 Ezrachi & Stucke, *supra* note 4, at 80.

processes and optimization of commercial strategies, and (ii) demand-side efficiencies, through supporting consumer decisions, enabling quick and effective access to information, providing up-to-date information on quality and individual preferences, and potentially lower and/or personalized prices for customers.[7]

Besides the operational efficiencies they offer to businesses, algorithms may also forecast changes in prices after analyzing historical data or help optimizing current prices to effectively respond to market conditions.8 Compared to the old-school business management techniques, where human employees set and implement pricing strategies without using any advanced technologies, algorithms can now provide significant benefits to many companies with their ability to process larger volumes of data, increased speed in dynamic pricing, and by offering more sophisticated methodologies to determine the willingness of customers to pay a certain price.

As regards potential anti-competitive effects, the mainstream controversy revolves around the concern that algorithms may facilitate, or even orchestrate, collusion among rival undertakings. If a competition authority is able to prove that the relevant companies have developed or used algorithms to implement an anti-competitive agreement which is already in place, or that they have employed such algorithms with intent to signal to or align their commercial strategies with their competitors, this will most probably be a clear-cut case. In these scenarios, it is easier to demonstrate that such algorithms are part of an illegal conduct. Incidentally, all algorithm-related antitrust cases around to world thus far have fallen into this category.[9]

But what if there is no evidence of any pre-existing agreement or even any communication between competitors to collude (that could be considered as a "concerted practice"), yet using algorithms has somehow resulted in high and parallel price levels? What if this is simply "tacit collusion" where competitors reach similar price levels by independently adjusting their strategies after observing their competitors, with a view to maximize their profits? Just because companies use algorithms that are able

7 Organisation for Economic Co-operation and Development ("OECD"), *Algorithms and Collusion: Competition Policy in the Digital Age* (2017), at 14-15, available at https://www.oecd.org/daf/competition/Algorithms-and-colllusion-competition-policy-in-the-digital-age.pdf (last accessed Apr. 16, 2020).

8 *Id*. at 11; *Algorithms and Collusion - Note by the United States*, Directorate for Financial and Enterprise Affairs Competition Committee of the OECD, DAF/COMP/WD (May 26, 2017) 41, at 2, available at https://one.oecd.org/document/DAF/COMP/WD(2017)41/en/pdf (last accessed Apr. 16, 2020).

9 See, e.g. *United States v. David Topkins*, Plea Agreement, Case No. 15-00201 WHO (N.D. Cal. Apr. 30, 2015); ECJ, Case C-74/14 – *Eturas*, judgment of January 21 2016, ECLI:EU:C:2016:42; ECJ, Case C-542/14 – *VM Remonts*, judgment of July 21 2016, ECLI:EU:C:2016:578; *Meyer v. Kalanick*, Case No. 1:2015cv09796 - Document 37 (S.D.N.Y. 2016); *Meyer v. Uber Technologies, Inc.*, Case No. 16-2750 (2d Cir. 2017).

to tacitly collude through machine learning, in particular deep learning technologies,[10] would that alone be sufficient to hold them liable for a competition law infringement?

These are undoubtedly difficult questions to answer with a simple yes or no. There are ample academic studies (some of which are based on simulation models on algorithmic pricing) and working papers from enforcers seeking these answers; yet we are still far from reaching an uncontested or even a largely accepted one. These studies and papers, however, still offer a number of potential theories of harm paving the way for a stimulating debate. Despite not being properly tested yet, these theories are worth a closer look, particularly because a number of major competition authorities, including the European Commission, appear to consider them plausible to a certain extent.

Various descriptions have been used to define the contours of this novel theory, including "collusion among black-box algorithms,"[11] "autonomous machine collusion,"[12] and "robo-sellers/robot-cartels."[13] Despite being quite catchy, these descriptions and their underlying hypotheses hardly offer sufficient guidance on how to detect and prevent a real-life algorithmic collusion scenario[14] without risking too many false-positives or premature regulatory interventions. Such excessive or unwarranted enforcement could reduce firms' incentives for investment and innovation in a way that could ultimately impede competition, which would go against the very purpose of competition law enforcement.

This article attempts to contribute to the debate by focusing on the business perspective, which appears to have been mostly neglected so far. It also explores what

10 "*Deep learning is a subfield of machine learning (…) that enables computer systems to learn using complex software that attempts to replicate the activity of human neurons by creating an artificial neural network.*" OECD, *supra* note 7, at 11.

11 E.g. CMA, *supra* note 5, at 10; see also Autorité de la concurrence & Bundeskartellamt, *supra* note 5, at 12.

12 Ezrachi & Stucke, *supra* note 4.

13 Salil Mehra, *Antitrust and the Robo-seller; Competition in the Time of Algorithms*, 100 MINN. L. REV. 1323 – 1375 (2016); Charley Connor, *When Robots Collude*, Global Competition Rev. (Sept. 27, 2019); Monika Zdzieborska, *Brave New World of 'Robot' Cartels?*, Kluwer Competition Law Blog (March 7, 2017), available at http://competitionlawblog.kluwercompetitionlaw.com/2017/03/07/brave-new-world-of-robot-cartels/ (last accessed Apr. 16, 2020); Inge Graef, *Algorithmic Price Fixing Under EU Competition Law: How to Crack Robot Cartels?*, Centre for IT & IP Law (2016), available at https://www.law.kuleuven.be/citip/blog/algorithmic-price-fixing-under-eu-competition-law-how-to-crack-robot-cartels/ (last accessed Apr. 16, 2020)., available at https://www.law.kuleuven.be/citip/blog/algorithmic-price-fixing-under-eu-competition-law-how-to-crack-robot-cartels/(last accessed Apr. 16, 2020).

14 In this article, we use the term "algorithmic collusion" to refer to this algorithm-related scenario only, where hypothetically an AI-based algorithm, which is able to self-learn from data and experience by using machine learning technologies and autonomously decide on pricing strategies, tacitly colludes with other algorithms despite not being programmed to do so. This theory is explained in more detail below.

guidance could be provided to businesses in order to avoid potential legal liabilities arising from this theory of harm and potential steps enforcers may follow to address the risk associated with self-learning algorithms. This article also adds more to the already very high pile of questions on how much control companies actually have over algorithms' decision-making process. Our goal is to highlight the limits of our collective knowledge on this subject at this stage and to caution against declaring certain algorithmic pricing scenarios illegal before properly testing these theories. We particularly focus on whether the research on the theory of tacit collusion by algorithms has come far enough to take regulatory action against such algorithms, and whether potential risk scenarios recently analyzed in the literature are helpful to illuminate the thin line between legal and illegal algorithmic pricing.

II. POTENTIAL THEORY OF HARM: UNTRACEABLE CARTELS?

Algorithms, as most technology-based mechanisms, are used in various forms, some of which are more advanced and complex than the others. In most cases, an outsider may not fully understand how these mathematical processes work or what, if any, the role of companies is in steering their algorithms towards a certain pricing strategy, in particular when artificial intelligence ("AI") is involved.[15] It is, therefore, not always an easy task to link these algorithmic processes to an illegal conduct or to hold companies liable for using algorithms in a way that leads to the restriction of competition.

Some scholars anticipate that the emergence of collusion in actual market settings would be "extremely possible in the near future, if not already occurring."[16] Sophisticated algorithms are still a mystery for competition law enforcers, but the question remains whether this mystery justifies stretching the limits of traditional antitrust concepts, or better yet, introducing a brand new legal framework for dealing with algorithms in digital markets. Is there an actual – or at least plausible – theory of harm, or is the current debate merely a reflection of the fear of the unknown related to "the rise of the machines"[17] upon the antitrust community? If there is an actual risk, how should enforcers respond to this and what guidance can they offer to businesses?

The most intriguing and controversial theory of harm has stemmed from a

15 "In deep learning, features are created as a (possibly complex) computation over multiple features, making such algorithms' decision-making hard to explain." Avigdor Gal, *It's a Feature, not a Bug: On Learning Algorithms and What They Teach Us*, Roundtable on Algorithms and Collusion, Jun. 21-23, 2017, DAF/COMP/WD(2017)50, at 5.

16 Joseph E. Harrington, *Developing Competition Law for Collusion by Autonomous Price-Setting Agents*, (2017), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3037818 (last accessed Apr. 16, 2020).

17 Mehra, *supra* note 13, at 1334.

hypothetical case where algorithms – in particular self-learning, dynamic ones based on AI – go rogue and decide to collude with other algorithms without any human intervention or instruction.[18] In this scenario, the algorithm is not programmed to collude, but instead, to find and apply the best strategy to maximize the firm's profit. By applying a highly advanced version of the game theory, the self-learning algorithm, through trial-and-error, tries first to best its competitors with discounts. But because competitors are also using algorithms that track and immediately adapt to other suppliers' pricing strategies, competitors match the first algorithm's price even before customers see this discounted price offer.[19] After playing this game repeatedly, the sophisticated algorithm is expected to realize that the best strategy to maximize the firm's profit is keeping the price high, given that it cannot get more customers through discounts anyway as competitors always match its discounted prices. The theory goes that, the price level in the market ultimately reaches a supra-competitive point (i.e. a collusive equilibrium) where all competitors are aligned, an outcome normally expected in a monopoly market. To collude on pricing strategies as such, algorithms do not need to be designed to collude, nor do they require communication among each other.[20]

According to the supporters of this theory, using self-learning algorithms may ultimately play a role in creating more durable, non-traceable cartels. These algorithms can arguably help fulfilling the criteria economists find necessary for a sustain-

18 This is defined as the "autonomous machine" scenario by Ezrachi & Stucke, *supra* note 4. Aside from the "messenger scenario," where an algorithm is used to implement pre-existing collusion, Ezrachi & Stucke identify three potential theories of harm for algorithmic pricing that could lead to collusion: (i) *hub and spoke*, where companies use the same algorithm in their pricing strategies, which can ultimately align and stabilize competitors' prices, (ii) *predictable agent*, where companies use their own algorithms, but they program these to swiftly react to the price changes of competitors, which ultimately results in parallel pricing, and (iii) *autonomous machine*, where companies use sophisticated, AI-based algorithms that can self-learn from experience and devise pricing strategies autonomously. See also Harrington, *supra* note 16, at 53.

19 In most of the articles explaining the game theory involving algorithms, authors emphasize algorithms' ability to play this game hundreds of times in a very short period of time, and in some cases, by changing their prices every few minutes (see, e.g. Emilio Calvano, et al., Artificial Intelligence, Algorithmic Pricing and Collusion, CEPR (2019), available at https://ssrn.com/abstract=3304991 (last accessed Apr.16, 2020); Michal S. Gal, *Algorithms as Illegal Agreements*, 34 Berkeley Tech. L.J. 67 (2019); Harrington, *supra* note 16, at 55). Ezrachi & Stucke refer to the famous poker tournament in 2017 to illustrate this theory, where Libratus, a poker-playing algorithm, beat the world's top poker players with an unprecedented success rate. See Ariel Ezrachi & Maurice E. Stucke, *Algorithmic Collusion: Problems and Counter-Measures*, OECD Roundtable on Algorithms and Collusion, 24 (2017).

20 Calvano et al., *id*. at 35.

able collusion in oligopolistic markets[21] and even exacerbate traditional risk factors in these markets, such as transparency and frequency of interaction.[22] It is argued that, at the very least, algorithms expand the grey area between lawful conscious parallelism (i.e. tacit collusion) and unlawful explicit collusion.[23]

This hypothetical scenario is considered as a new type of coordination that could be established and implemented without actually communicating with rivals, because self-learning algorithms can "read each other's mind."[24] Allegedly, this is the end of the collusion theory as we know it in digital markets.[25] Such advanced algorithms decide on their own which data are relevant to devise the best strategy to maximize profits, how to interpret such data and how to improve themselves to solve complex problems. At the end of the day, the firm using the relevant algorithm may not know which data and parameters were used in a certain pricing strategy and whether this strategy resulted from an independent, one-sided data processing on the basis of the customer demand and market conditions, or from collusion with other competitors.[26]

21 The main pillars of successful collusion in an oligopolistic market (in addition to homogenous products), as defined by Stigler several decades ago, are (i) a meeting of minds upon a certain price-structure, (ii) a mechanism to detect deviations from the agreed-upon prices, and (iii) an effective punishment against deviations. (George J. Stigler, *A Theory of Oligopoly*, 72 J. Political Econ. 44, 44-61 (1964)). An additional component would be entry barriers protecting the companies against the threat of actual or potential competitive pressure (Gal, *supra* note 15, at 23). OECD Background Paper classifies the relevant factors under three groups: (i) *structural characteristics*, including the number of firms, barriers to entry, market transparency and frequency of interaction, (ii) *demand variables*, such as demand growth and fluctuations, and (iii) *supply variables*, including innovation and cost asymmetry. According to this paper, algorithms increase market transparency and frequency of interaction, but the potential impact of algorithms on the rest of the factors are either ambiguous or non-existent (OECD, *supra* note 7, at 23-24).

22 Mehra, *supra* note 13, at 1324; Gal *supra* note 15, at 24-25; OECD, *supra* note 7, at 23.

23 OECD, *supra* note 7, at 25.

24 Gal argues that self-learning algorithms do not even need to play the game several times. The algorithm can learn in a one-shot game, as it can read other algorithms' minds (Gal, *supra* note 19, at 85-87). On the ability and speed of algorithms to decode each other, as if they are "communicating," see Bruno Salcedo, *Pricing Algorithms and Tacit Collusion* (Jan. 11, 2015), available at http://brunosalcedo.com/docs/collusion.pdf (last accessed Apr. 16, 2020). Based on a simulation model in a duopolistic market and homogenous product, Salcedo claims that algorithmic pricing will "inevitably" lead to tacit collusion when algorithms are able to "respond to market conditions, are fixed in the short run, can be decoded by rivals, and can be revised over time" (Salcedo (2015), 20). For a criticism of Salcedo's argument, see Ulrich Schwalbe, *Algorithms, Machine Learning, and Tacit Collusion*, J. Competition L. & Econ. 1, 23–40 (2019); and Ittoo & Petit, *supra* note 4. Schwalbe considers Salcedo's model as an explicit collusion rather than a tacit one, given that companies are in fact communicating through decoding rival algorithms.

25 Ezrachi & Stucke, *supra* note 4, at 81.

26 CMA, *supra* note 5, at 10-11.

A number of recent studies on AI-based algorithms (in particular on independent Q-learning)[27] by computer scientists and economists have given a boost to this argument.[28] Some of these studies show that, in theory, certain algorithms are able to cooperate with other algorithms – as well as humans – for maximizing their profit.[29] Others offer simulation models which result in price coordination between competing Q-learning algorithms in a duopoly with sequential[30] or simultaneous[31] price competition.

In major competition law regimes including the U.S. and the EU, tacit collusion itself is not illegal. In these law systems, tacit collusion is merely a rational economic behavior, especially in oligopolistic markets, to track competitors' prices as well as other competition parameters and to adjust one's commercial strategies accordingly.[32] To be able to condemn parallel conduct, therefore, there must be an additional element besides the parallel conduct, a so-called "plus factor" in U.S. legal terms,[33] to establish that there could be no plausible alternative explanation for this parallel behavior other than an anti-competitive "meeting of minds" between competitors. There are ample cases in traditional markets where enforcers have rejected condemning intelligent adaptations to competitors' publicly available pricing strategies, in the absence of additional evidence of wrongdoing.[34] For most jurisdictions, therefore, there is arguably no legal basis for holding a firm liable for having programmed and/or used an algorithm which "eventually self-learned to coordinate prices with other machines," unless there is clear evidence showing that companies aimed for this result in the first place.[35]

27 Q-learning is a "model-free reinforcement learning," which is able to learn to act optimally by "experiencing the consequences of actions" (Christopher J.C.H. Watkins & Peter Dayan, *Technical Note: Q-Learning*, 8 MACH. LEARNING, 279, 279-292 (1992)).

28 See, e.g. Salcedo, *supra* note 24; Harrington, *supra* note 16; Timo Klein, *Assessing Autonomous Algorithmic Collusion: Q-Learning Under Short-Run Price Commitments*, TINBERGEN INST. DISCUSSION PAPER, No. TI 2018-056/VII (2018); Calvano et al., *supra* note 19.

29 Jacob W. Crandall, et al., *Cooperating with machines*, 9 NATURE COMM. 1, 1-12 (2018).

30 Klein, *supra* note 28.

31 Calvano et al., *supra* note 19.

32 OECD, *supra* note 7, at 19.

33 According to Gal & Elkin-Koren, algorithms (or their design) could be a "plus factor" that could create competition law liability for tacit collusion (see Michal S. Gal & Niva Elkin-Koren, *Algorithmic Consumers*, 30 HARV. J.L. & TECH. 38 (2017)). "Plus factors" are defined as "economic actions and outcomes, above and beyond parallel conduct by oligopolistic firms, that are largely inconsistent with unilateral conduct but largely consistent with explicitly coordinated action" (William E. Kovacic, et al., *Plus Factors and Agreements in Antitrust Law*, 110 MICH. L. REV. 393 (2011)).

34 OECD, *Algorithms and Collusion - Note by the European Union, Directorate for Financial and Enterprise Affairs Competition Committee of the OECD*, (Jun. 14, 2017), DAF/COMP/WD (2017)12, at 6.

35 OECD, *supra* note 7, at 35 et seq.

In the realm of algorithmic pricing, the question is whether the current approach to tacit collusion falls short of capturing illegal coordination in digital markets, in particular where pricing strategies are left in the hands of self-learning algorithms. The concern is that traditional plus factors, especially communication between competitors, are very difficult to prove in these cases, because self-learning algorithms do not even need communication in order to collude with one another. Current rules and economic models are based on certain assumptions about human incentives, but not all of these are necessarily applicable to self-learning algorithms.[36] Further, a number of academic studies suggest that AI-based algorithms could spread the risk of tacit collusion to non-oligopolistic markets.[37]

III. ENFORCERS' PERSPECTIVE: TOO SOON TO ACT, BUT STAY ON GUARD

Once policy makers decide to accept and assume the risk for algorithmic collusion, they are faced with additional and – equally difficult – questions to tackle with: To what extent should individuals/companies be held liable for the actions of algorithms? Who bears the burden of proof? What is the standard of proof for competition agencies and courts to hold companies liable for the actions of their algorithms, which were not programmed to collude in the first place? In this hypothetical scenario, the presumption is that there is no underlying agreement or a "meeting of minds" in general. Given that such a common understanding is a prerequisite for prohibiting a pricing strategy under the current antitrust laws, things get quite complicated for enforcers from this point on.

Some scholars have called for either revising the current interpretation of the law on tacit collusions[38] or adopting a brand new law[39] applicable to such slippery algorithms, which are arguably too smart and sophisticated to fall under the radar of competition authorities. In response, a number of competition enforcers have started discussing how to capture the risk for algorithmic collusion under the competition law framework. The following approaches of the competition enforcers have particularly attracted the attention of the competition law community and received commentary from different sides of the debate:

36 Harrington, *supra* note 16, at 48.

37 Ezrachi & Stucke, *supra* note 19, at 2; Mehra, *supra* note 13, at 1363. For a critical analysis of this approach, see Ittoo & Petit, *supra* note 4.

38 See, e.g. Gal & Elkin-Koren, *supra* note 33, at 38.

39 See, e.g. Salil K. Mehra, *De-Humanizing Antitrust: The Rise of the Machines and the Regulation of Competition* (Aug. 21, 2014), Temple University Legal Studies Research Paper No. 2014-43, at 2.

A. Using Traditional Competition Laws, but Stretching the Concept of "Human Agency"

The U.S. competition authorities have suggested that algorithms should be treated as an employee "named Bob" when they are used as a facilitator of collusion.[40] If a firm could be held liable for its employee's conduct in a particular case, then they would also be liable for the actions of their algorithms. This analogy, however, is not necessarily applicable to the theory of self-learning algorithm. The joint contribution of the Antitrust Division of the U.S. Department of Justice ("DOJ") and the U.S. Federal Trade Commission ("FTC") to the OECD roundtable acknowledges that "computers equipped with artificial intelligence (AI) or machine learning could, in theory, make decisions that were not dictated or allowed for in the programming," but finds that "these scenarios seem too speculative to consider at this time."[41] They, however, also emphasize the significant value of research in this field and indicate that, where necessary, "enforcers may need to consider stepping up [their] aggressiveness with respect to coordinated effects analysis."[42]

The European Commission appears to be keen on adopting the employee analogy also for the "autonomous machine" scenario.[43] According to the Commission, companies are expected to ensure "compliance by design," and to adopt sufficient safeguards to prevent their algorithms from colluding. The Commission further suggests that, as the algorithms are under the firms' "direction or control," firms would be liable for their actions, as would be the case in a traditional employer-employee relationship.[44] On the other hand, similar to its counterparts across the ocean, the Commission acknowledges that "there is a need to examine whether current legislation is able to address the risks of AI and can be effectively enforced, whether adaptations of the legislation are needed, or whether new legislation is needed."[45]

---

40 Maureen K. Ohlhausen, Chairman, Fed. Trade Comm'n, Keynote Address at the F.T.C: *Should We Fear the Things That Go Beep in the Night? Some Initial Thoughts on the Intersection of Antitrust Law and Algorithmic Pricing* (May 13, 2017), available at https://www.ftc.gov/system/files/documents/public_statements/1220893/ohlhausen_-_concurrences_5-23-17.pdf (last accessed Apr. 16, 2020).

41 OECD, *supra* note 8, at fn 1.

42 Terrell McSweeny, Commissioner, *Algorithms And Coordinated Effects*, (May 22, 2017) University of Oxford Center for Competition Law and Policy, Oxford, UK, available at https://www.ftc.gov/system/files/documents/public_statements/1220673/mcsweeny_-_oxford_cclp_remarks_-_algorithms_and_coordinated_effects_5-22-17.pdf (last accessed Apr. 16, 2020), at 5.

43 OECD, *Algorithms and Collusion – Note from the European Union*, OECD (2017), available at https://one.oecd.org/document/DAF/COMP/WD(2017)12/en/pdf (last accessed Apr. 16, 2020).

44 *Id*. at 9.

45 *Commission White Paper on Artificial Intelligence: A European approach to excellence and trust*, 9-10, COM (2020) 65 final (Feb. 19, 2020).

B. Risk is Likely, but Further Research is Necessary before Taking Action

A joint discussion paper recently published by the German and French competition enforcers is relatively more reluctant about distinguishing between algorithms and humans, in terms of intelligent adaptations to competitors' pricing strategies.[46] While acknowledging that it is too early to decide which types of algorithmic actions could be illegal, the relevant authorities suggest that the standard for assessing liability for algorithmic collusion could ultimately fall somewhere between holding companies liable (i) simply for developing and/or using an algorithm that ultimately engages in anti-competitive conduct, and (ii) when the firm does not comply with a reasonable standard of care and foreseeability regarding this conduct.[47]

The Portuguese competition authority (Autoridade da Concorrência, "AdC") has taken a similar approach. The AdC has signaled potential liability for firms using pricing algorithms that directly or indirectly lead to pricing collusion, but also highlighted the need to "understand the full impact of learning algorithms and of algorithms [sic] developers."[48]

C. Identifying the Highest-Risk Scenarios

In tackling this issue, the Competition and Markets Authority ("CMA")[49] in the UK opted to start with an economic analysis of algorithmic collusion, rather than jumping head-first into the legal analysis. The purpose of the CMA study was to first identify which theories of harm would raise the highest risk of collusion and under which market conditions. While the CMA acknowledged the possibility of autonomous collusion by sophisticated and complex algorithms, it identified a more immediate risk in the "hub-and-spoke" scenario, where companies in a particular market utilize the same algorithm to set their prices. The CMA considered the analysis on the likeliness of collusion risk due to self-learning algorithms to be a matter for the future, when the pricing algorithms in question will have become sufficiently widespread and technologically advanced.[50] The CMA also found that potential audit mechanisms to detect collusion depending on "whether and if a firm could know that its algorithm is implementing a collusive outcome" would be an ideal candidate as a topic for further research.[51]

---

46 Autorité de la Concurrence & Bundeskartellamt, *supra* note 5.

47 *Id.* at Section III.

48 Arezki Yaïche, *Retailers should be responsible for algorithms leading to pricing collusion, Portuguese regulator says* (Feb. 26, 2020), available at https://mlexmarketinsight.com/insights-center/editors-picks/antitrust/cross-jurisdiction/retailers-should-be-responsible-for-algorithms-leading-to-pricing-collusion-portuguese-regulator-says (last accessed Apr. 17, 2020).

49 CMA, *supra* note 5.

50 *Id.* at 31.

51 *Id.* at 52.

Similarly, the Australian Competition & Consumer Commission ("ACCC") has been taking steps that aim to "build the expertise to analyze algorithms" and to identify potential risk areas. While the ACCC considers the current case law insufficient to warrant adopting a new law against the risk of algorithmic collusion, the enforcers have also explicitly warned firms that they cannot avoid competition law liability by simply saying "[M]y robot did it."[52]

As summarized above, some of the major competition authorities around the world appear to have already started discussing potential risk areas self-learning algorithms may have created. While some authorities have issued warnings about the potential liability of firms stemming from collusions by their algorithms, their research on this field appears to be far from complete, and thus the enforcers' eventual stance on this issue remains to be seen.

IV. WHAT IS THE TAKEAWAY FOR BUSINESSES?

The debate among scholars, the simulation models constructed by economists and computer scientists, and the reactions of various enforcers to the theory of algorithmic collusion are no doubt quite thrilling to watch from the sidelines. The message to the business community is, however, somewhat ambiguous and inconsistent, which probably make these developments less than entertaining to follow from a business perspective.

Today, we have quite a voluminous set of studies indicating that the risk of algorithmic collusion may not be fictional after all, at least in theory.[53] The concerns raised on this point may have some merit, so does the call for more research on algorithmic pricing and its potential effects on competition. That said, a majority of the solutions explored thus far lack a properly defined risk area to target (which we will call the "red zone" for the sake of argument) or a road map that competition enforcers can follow to decide how to approach algorithmic pricing issues.[54]

From a business standpoint, we will focus on two issues in the rest of this article that could greatly affect the question of legal certainty. The first issue is related

52 ACCC, *New competition laws a protection against big data e-collusion* (Nov. 16, 2017), available at https://www.accc.gov.au/media-release/new-competition-laws-a-protection-against-big-data-e-collusion (last accessed Apr. 17, 2020).

53 There are also some recent commentaries arguing against the need to focus on the algorithmic collusion scenarios and that they are not a fundamentally important issue for antitrust law (see, e.g. Schrepel, *supra* note 3).

54 An exception to this is Gal's systematical analysis of a potential "rule of reason" assessment on algorithms as facilitating practices, which offers five relatively more straightforward cases that are more likely to raise competitive concerns (Gal, *supra* note 19). These "straightforward cases," however, are also based on certain assumptions that have not yet been unequivocally proven with empirical data and real-life cases. A brief commentary on this proposal is provided below.

to the eagerness to condemn all potential tacit collusion scenarios involving self-learning algorithms before properly testing the underlying theory of harm. Most of the studies on this subject are based on a limited number of experiments, which are not yet sufficient to clearly define the conditions for such conduct to harm competition beyond tolerable when compared to and balanced against the expected efficiencies. The second issue relates to the recent studies aiming to identify the relatively more "straightforward" risk scenarios, which – albeit most welcome as an attempt in the right direction for assuring legal certainty – could also lead to over-enforcement concerns. It is worth noting that the underlying assumptions of these studies have not yet been substantiated by empirical evidence either.

As regards the first issue, certain academic contributions go so far as suggesting intervention in algorithmic pricing that could lead to tacit collusion in all markets, be it oligopolistic or otherwise.[55] It is, however, not yet clear whether algorithms can actually collude autonomously, even in oligopolistic markets, which are usually considered more prone to collusion. Indeed, as explained above, all current cartel cases around the world involving algorithms are related to pre-existing collusions implemented by algorithms, but not "humanless tacit collusions."[56] In other words, there would have still been an infringement had the relevant companies not used algorithms in these cases. Further, studies so far have offered ambiguous results on whether algorithms can indeed deteriorate the market structures that were once considered competitive. While there is an often-repeated argument that algorithms may increase the market transparency and the frequency of interactions, no negative impact has been proven as to the other factors affecting the likelihood and success of collusion, such as barriers to entry, or demand and supply variables.[57] In fact, the impact of algorithms on supply conditions, such as innovation and cost asymmetry, can arguably have the opposite effect and reduce the risk of collusion.[58]

As regards the simulation models indicating that self-learning algorithms have a tendency to collude, these models were largely carried out in controlled environments and under the assumption that critical market conditions – such as the number of competitors – remain the same throughout the simulation.[59] In some models, rival firms use the same algorithm in a static duopolistic market, where it is much

55 See Ezrachi & Stucke, *supra* note 19, at 2; Mehra, *supra* note 13, at 1363. For a critical analysis of this approach, see Ittoo & Petit, *supra* note 4. See also OECD, *supra* note 7, at 33; Gal, *supra* note 15, at 28.

56 Ittoo & Petit, *supra* note 4, at 2-3; Schwalbe, *supra* note 24, at 5.

57 Antonio Capobianco & Pedro Gonzaga, *Algorithms and Competition: Friends or Foes?*, Cpi Antitrust Chron. 2, (2017), available at https://www.competitionpolicyinternational.com/algorithms-and-competition-friends-or-foes/ (last accessed Apr. 16, 2020).

58 *Ibid.*

59 Ittoo & Petit, *supra* note 4, at 5.

easier to monitor and align with a competitor's price.[60] Such simulations also disregard several factors that are likely to impact an algorithm's decision to adjust its prices in accordance with those of its rivals, such as the risk for potential entries, demand fluctuations and cost shocks.[61] Moreover, there is no empirical data showing that this theory can actually occur in the real world and, if so, how that can happen.[62] Most importantly, a majority of scholars and enforcers agree that not all types of algorithmic pricing facilitate collusion and that algorithms may actually have pro-competitive effects offsetting potential risks as well.[63]

In light of the above, we observe that it would be helpful to receive some guidance from enforcers to identify the circumstances in which algorithmic pricing could expose companies to legal liability, before excessively expanding the scope of enforcement and turning digital markets into a legal minefield.[64] It is, of course, not realistic to expect an exhaustive or "one-size-fits-all" set of rules applicable to all algorithmic pricing cases. First, there are still so many unknowns regarding self-learning algorithms. Second, although many researchers around the world have started working on this crucial topic, their findings show that so far we have only seen the tip of the iceberg.

Yet, it could still be possible to identify a set of factors that would be helpful in determining when the risk of legal exposure is higher, some sort of a "red zone" for companies to avoid. Needless to say, potential liability scenarios would not be limited to this zone, but it would at least provide a benchmark against which the risk level of other algorithm scenarios could be compared. This "red zone" could also serve as a focal point for enforcers to concentrate their energy and resources at this stage, rather than trying to monitor all markets where algorithmic pricing is used, the number of which has been growing exponentially in the last several years.[65]

---

60 See, e.g. Salcedo, *supra* note 24. On the shortcomings of the theory, in particular the argument that most experiments are based on one-to-one games and that the theory collapses when a third party joins, see Kai-Uwe Kühn & Steve Tadelis, *Algorithmic Collusion* (2017), available at https://www.cresse.info/uploadfiles/2017_sps5_pr2.pdf (last accessed Apr. 16, 2020).

61 See, e.g. Calvano et al., *supra* note 19, at 35-36.

62 Schwalbe, *supra* note 24, at 29; OECD, *supra* note 7, at 49; Ittoo & Petit, *supra* note 4, at 2; Kühn & Tadelis, *supra* note 60.

63 See, e.g. Ittoo & Petit, *supra* note 4, at 13; Salil L. Mehra, *Robo-Seller Prosecutions and Antitrust's Error-Cost Framework*, CPI ANTITRUST CHRON. 5 (2017), 36; Ezrachi & Stucke, *supra* note 4, at 15 et seq.; Anita Banicevic, et al., *Algorithms: Challenges and Opportunities for Antitrust Compliance*, ABA SECTION OF ANTITRUST LAW 7 et seq. (2018).

64 As regards the need for a clear guidance for the market participants, see also Gal, *supra* note 19.

65 See Schrepel, *supra* note 3.

A. The Zoning Exercise

Since there are still so many unknowns with respect to how self-learning algorithms work and under which circumstances they opt for collusion, such a zoning exercise could start with what we already know: the available research indicates that algorithms are more likely to collude (i) under particular market conditions, and (ii) when certain types of algorithms are involved.

Accordingly, a useful first step for the zoning exercise could be to identify the problematic market conditions. Based on the research so far, algorithmic collusion is more likely to occur, *inter alia*, in concentrated markets with high barriers to entry, a limited number of players, a homogenous product, a high degree of transparency, effective deterrence and retaliation mechanisms, and no significant buyer power.[66] In other words, factors restraining humans' ability to tacitly collude are also applicable to self-learning algorithms.[67] If enforcers provide guidance on such factors, companies would realize that the risk for their algorithms to collude and for them to be held liable for such collusion could be higher in certain markets. The more we move away from these problematic markets, the more it will be likely for the market dynamics themselves to eliminate the risk for algorithms to successfully coordinate and/or sustain such coordination, in the absence of explicit collusion among the relevant firms. Enforcers would then be expected to offer more evidence on why and how a certain algorithmic pricing strategy could restrict competition in other markets and, more importantly, could be illegal.

Another critical point to consider at this juncture is that a concentrated (in particular, oligopolistic) market that satisfies some or all of the conditions above is already an alarming market setting, regardless of the pricing method to be used. A differentiating factor here could be whether the relevant market is already prone to tacit collusion – meaning a purely human-controlled and independent pricing strategy in this market could also lead to the same result – or whether price-setting algorithms are the actual reason for the market to become more conducive to collusion.[68]

While we consider this analysis as a helpful starting point, it should not lead to an assumption that algorithmic pricing will inevitably result in collusion in certain markets every single time, and thus should be *per se* illegal when used in such markets.[69] If that were the case, the message to the business community would be to "avoid algorithmic-pricing in these markets altogether." There is no sufficient empirical data

66 See, e.g. Ezrachi & Stucke, *supra* note 19, at 3-4; Schwalbe, *supra* note 24, at 25; Ittoo & Petit, *supra* note 4, at 11-13.

67 See Ittoo & Petit, *supra* note 4, at 5.

68 *Id*. at 3.

69 Mehra, *supra* note 13, at 1371.

indicating that algorithmic pricing in certain markets will always restrict competition.[70] Assuming otherwise and deviating from the mainstream approach towards tacit collusion, which currently allows such conduct, would not be justified at this stage. Nor would it meet the standard of proof currently applied to price-fixing collusions.[71]

A second step could be, as also discussed to a certain extent in the literature,[72] determining the characteristics of algorithms which could make collusion more likely. Simulation models mentioned above mostly assume that all competitors would use a specific – and often the same – type of algorithm and employ a pre-determined pricing method in controlled, static market conditions.[73] In real life, however, there are a vast number of algorithm options that companies can choose from.[74] Further, the way these algorithms behave significantly differs depending on the market dynamics and due to the complexity of their pricing and learning mechanisms.[75] Starting the analysis with a presumption that all algorithms have the ability and incentive to collude (and

70 "Oxera reported that "The degree to which such collusion among algorithms is likely to happen in practice is not yet clear." (Oxera, When Algorithms Set Prices: Winners and Losers, 2 (June 19, 2017), available at https://www.oxera.com/publications/when-algorithms-set-prices-winners-and-losers/ (last accessed Apr, 16, 2020). Furthermore, in some of these models, collusion would be more difficult to sustain as the profitability decreases (see, e.g. Calvano et al., *supra* note 19, at 27). Accordingly, "algorithmic collusive behavior is not as likely or even unavoidable as some legal scholars seem to suspect." (Schwalbe, *supra* note 24, at 32).

71 According to the U.S. law, in order to prove collusions on price-fixing (i.e. a cartel), the courts and enforcers must evince the existence of such collusion "beyond a reasonable doubt." To be able to meet this standard of proof, the case law suggests that, in addition to parallel conduct, there must be a plus factor proving that this is not the result of oligopolistic interdependence, but a coordination among competitors. (See, e.g. Monsanto Co. v. Spray-Rite Service Corp., 465 US 752, 768 (1984); Matsushita Electrical Industrial Co. v. Zenith Radio Corp, 475 US 574 (1986); In re Flat Glass Antitrust Litigation, 385 F 3d 350, 359-60 (3d Cir. 2004). See also Kovacic et al., *supra* note 33, at 395 et seq.) As regards the EU law, while the standard of proof is not defined as clearly as their counterparts did across the Atlantic, a similar approach has also been adopted by the EU courts regarding whether parallel conduct alone would be sufficient to prove a price-fixing cartel. The EU case law indicates that parallel conduct would not be sufficient to prove collusion unless "concentration constitutes the only plausible explanation for such conduct," which rules out oligopolistic interdependence (see, e.g. Cases 48, 49, 51-7/69, ICI v. Commission (Dyestuffs) [1972] ECR 619, [1972] CMLR 557; Ahlström Osakeyhtiö and Others v. Commission (Woodpulp II), [1993] 4 CMLR 407.

72 See, e.g. Harrington, *supra* note 16, at 64 et seq.; Gal, *supra* note 19, at 113 et seq.; Schwalbe, *supra* note 24, at 24.

73 Schwalbe, *supra* note 24, at 24.

74 Schwalbe exemplifies the types of algorithm models used in real life as "*bandit-type models, customer choice models, econometric regression models, machine learning models, and greedy ad-hoc approaches*" (*supra* note 24, at 24).

75 Van de Geer et al., *Dynamic Pricing and Learning with Competition: Insights from the Dynamic Pricing Challenge*, in INFORMS RM & Pricing Conference, at 1 (2018), available at https://arxiv.org/pdf/1804.03219.pdf (last accessed Apr. 16, 2020).

extending this presumption to all types of algorithms in every market setting) would lead to a significant over-enforcement.

Which types of algorithms, then, could land businesses in the "red zone"? When could enforcers conclude that tacit collusion was "a conscious, avoidable act"[76] for the firm using the algorithm? The lack of real-life examples limits one's ability to make an educated guess on this point.[77] Yet, the literature suggests a few suspicious cases to focus on. This brings us to the second potential concern for businesses with respect to their need for legal certainty.

The most frequently discussed "red zone" scenario is the case where all competitors use the same or similar algorithms and the result is parallel price levels in the relevant marketplace.[78] Unless there is a plausible justification for using the same or very similar algorithms (e.g. there is no better or equally efficient algorithm available) which had similar outcomes for all competitors, this could be an indication for the firms' "intent" to coordinate their pricing strategies when the market dynamics allow it. If this scenario is to be included in the red zone, however, enforcers should again leave room for firms to rebut this allegation.[79]

For all algorithmic pricing scenarios, including the one above, one of the critical questions that come to mind is whether the algorithm's programmer (and ultimately the firm) could have been perceived to have control over the algorithm's pricing decisions. While certain scholars respond to this question in the affirmative,[80] the research available on this subject – albeit not yet very extensive – suggests that the response may in fact not be that straightforward, given our limited understanding of how self-learning algorithms work.[81]

Scholars have pointed out that certain algorithms, in particular those with deep-learning capabilities, comprise many layers of neurons to process the data received from various sources (including publicly available content, customer feedback and the

76 Gal, *supra* note 19, at 108.

77 Harrington proposes that certain types of pricing algorithms (such as estimation-optimization algorithms) could be considered illegal by distinguishing between properties of algorithms that generate efficiencies and those promoting collusion (Harrington, *supra* note 16, at 49 et seq). This may not be an easy task in practice, as we have not yet seen any real-life examples to guide enforcers through such distinctive properties of algorithms.

78 Dylan I. Ballard & Amar S. Naik, *Algorithms, Artificial Intelligence and Joint Conduct*, Cpi Antitrust Chron., 32 (2017); Calvano et al., *supra* note 19, at 36.

79 Using the same or similar algorithms may not always lead to the same price levels, given the differences between competitors' cost and demand structures. Therefore, the similarity in the algorithm alone would not be sufficient to prove an underlying collusion (Gal, *supra* note 19, at 113).

80 Gal, *supra* note 19, at 108 et seq.

81 Oxera, *supra* note 70, at 19; Schwalbe, *supra* note 24, at fn. 30.

firm itself) and to find the optimal pricing level in order to maximize the firm's profit.[82] These numerous layers could create a so-called "black box," which might be difficult to understand, even by the firms using such algorithms, let alone by the competition law enforcers.[83] If we are to follow these scholars' approach, businesses should either choose not to use sophisticated algorithms that they do not understand,[84] or be prepared for the legal repercussions, as it could be argued by enforcers that the firms must have foreseen (and accepted) the risk of collusion if they are using complex algorithms.

This line of reasoning appears to comply with the standard of "reasonable foreseeability" the Franco/German Study explores and the "compliance by design" system the European Commission calls for. But when it comes to application of this standard, we once again hit the brick wall of unfounded presumptions problem. Indeed, unless we are committed to presuming that all deep-learning algorithms are capable of tacitly colluding at some point and in any market when the stars align, all external conditions to facilitate collusion fall into place and collusion inevitably becomes the "optimal" choice for all algorithms involved; businesses will need some proper guidance on what exactly "reasonability" entails. Are there specific safeguards they can adopt to ensure that collusion will never ever be the optimal pricing strategy? Is it realistic to expect firms to be able to program sophisticated algorithms "not to collude,"[85] without risking excessive intervention in their algorithms to the detriment of the efficiencies they expect to derive from these algorithms? What if a firm took all precautions technologically available to prevent its algorithm from tacitly colluding with others, but its prices are still parallel with other competitors – could this still be an infringement? Where do we draw the line? There are arguments both in favor of and against firms' ability to control their self-learning algorithms, which clearly indicates that further research and empirical evidence will be needed to resolve this issue.

When firms use different algorithms, another critical point to consider would be whether certain algorithms are able to communicate with one another. The answer to this question would be particularly important to meet the standard of proof for anti-competitive agreements, at least within the current legal framework. A number of scholars have argued that self-learning algorithms can communicate by decoding the

82 CMA, *supra* note 5, at 14.

83 *Ibid.*

84 Francisco Beneke & Mark-Oliver Mackenrodt, *Artificial Intelligence and Collusion*, 50 IIC 109, 125-134 (2019). The authors suggest that firms may, in fact, not prefer using black-box algorithms as "they have an incentive to know what drives the prediction in order to obtain better market insights" (see p. 129). There is, however, insufficient information on whether we can assume that this is the business reality and there is in fact no such thing as a black-box algorithm that even the programmer himself cannot completely comprehend (see Gal, *supra* note 19, at 108, for an argument that treating algorithms as a black box is "fallacious").

85 For an argument that an algorithm's goals are set and can be revised by their programmers in a way not to collude, see Harrington, *supra* note 16, at 65; see also Gal, *supra* note 19, at 108.

decisional parameters of each other.[86] Such decoding would then serve as an exchange of information between competing algorithms. That said; decoding sophisticated algorithms by other algorithms may not be an easy task in real life. This is because some algorithms include millions of lines of code which could include the firm's proprietary information and software besides the elements other algorithms can access.[87] Unless firms take some additional actions to make these codes and the underlying information transparent to their competitors, other algorithms may not be able to decode these by simply observing their behavior on the market.

Even scholars favoring a conservative approach suggest that, additional actions from firms would be needed for a certain algorithmic pricing to fall in the red zone, at least based upon the limited information we currently have on self-learning algorithms. These additional actions could include, *inter alia*, (i) feeding the same or similar datasets to algorithms although better or more reliable alternatives are available, in a way that enables the pricing strategies of all algorithms to align, and (ii) designing algorithms in a way that only competitors will be able to monitor their potential reactions to market conditions and future strategies.[88] Once again, we should caution against taking a *per se* approach to these scenarios, as companies may be able to offer objective justifications for these actions. Lowering the standard of proof and applying a presumption of illegality without any evidence of additional facilitating actions or intent would be dangerous and unwarranted. Such a presumption should only be built upon a well-established understanding of a certain practice as being so inherently harmful that such a practice should always be illegal, and certainly not without an elaborate analysis of its potential effects or underlying objective justifications.[89] The current state of the research clearly shows that we are not there yet.

In light of the above, the third step in the zoning exercise appears to be less controversial: policy makers should expand their research on how self-learning algorithms work in real-life settings, investigate the conditions under which they are more likely to collude and explore whether these algorithms can indeed autonomously collude without the assistance of their firms' additional facilitating actions. The existing literature offers some options for the methodology of this research, such as devising "an algorithmic pricing incubator" by the authorities to analyze whether a certain price level is competitive or a result of an algorithmic collusion.[90] The starting point of

86 See, e.g. Salcedo, *supra* note 24, at 4 et seq., and Gal, *supra* note 19, at 109.

87 Oxera, *supra* note 70, at 19; Schwalbe, *supra* note 24, at 22. See also Kühn & Tadelis, *supra* note 59, for a criticism of the theory that algorithms can communicate without the assistance of firms/humans.

88 Gal, *supra* note 19, at 114.

89 *Northern Pacific R. Co. v. United States*, 356 U.S. 1, 5, 78 S. Ct. 514, 518, 2 L.Ed.2d 545 (1958).

90 Ezrachi & Stucke, *supra* note 19, at 28.

this research could be the red-zone scenarios discussed above, as these are considered more likely to restrict competition.

Once the policy makers obtain sufficient empirical data to form a reliable view on this issue, a fourth step could be to analyze whether the current legal framework is able to capture any potential competition risks these scenarios may generate. If the answer to this question is a clear "no," only then the fifth and final step should be considered, i.e. exploring the validity of either a novel approach to the concept of tacit collusion or designing a brand new legal framework to address such concerns.

V. CONCLUSION

The competition law enforcers should acknowledge and closely watch the technological developments redefining market dynamics in the modern global economy. They, however, should also be wary of too much – and too soon – intervention as that could lead to false-positives, remove legal certainty for businesses, and reduce the incentive to innovate and invest. The theory of self-learning algorithms rebelling against humans and colluding outside the control of companies, which once sounded like a good sci-fi, appears to be no longer a myth. Nevertheless, blindly venturing into this new territory and taking drastic actions could turn enforcement efforts in this area into a horror movie for the business community. Enforcers should be cautious against over-enforcement without sufficient empirical evidence to justify any shift in the approach to the traditional concepts of collusion, or a proper guidance for companies to enable them to avoid the risk of legal exposure.

Assurance of some foreseeability would be beneficial before the competition enforcers start to take action against tacit collusion by algorithms. Admittedly, it could be too soon to lay out a full-fledged action plan. Yet, for the sake of legal certainty, enforcers could first define the boarders of the battlefield rather than starting a random gun fire. In this regard, when defining the red-zone risk scenarios, one should always mind the dangers of acting on the basis of unfounded presumptions. Setting the zone too widely to render all tacit collusion scenarios illegal, or assuming that all self-learning algorithms can communicate under all circumstances, would defeat the purpose of the whole exercise. The need is evident for conducting comprehensive research on how self-learning algorithms work in actual market settings and thereby determining when they are more likely to raise material competition law risks.

Despite some early research signaling potential liability for companies simply because of their choice to use certain algorithms, enforcers appear to have taken, at least for the moment, the sensible approach outlined above. Indeed, it is somewhat comforting for businesses to observe that the leading antitrust enforcers are conducting market studies one after another to gain a better understanding of what the use of algorithms may entail for competition, rather than hastily condemning such algorithms for collusion purely on theoretical grounds. Given that the voices warning against potential risks are getting louder, the time appears to be ripe for enforcers to delve into a comprehensive research plan on the potential risk scenarios and to test how effective the current legal framework is to capture and mitigate such risks.

Editors' bios

David S. Evans' academic work has focused on industrial organization, including antitrust economics, with a particular expertise in multisided platforms, digital economy, information technology, and payment systems. He has authored eight books, including two award winners, and more than one hundred articles in these areas. He has developed and taught courses related to antitrust economics, primarily for graduate students, judges and officials, and practitioners, and have authored handbook chapters on various antitrust subjects.

David's expert work has focused on competition policy and regulation. He has served as a testifying or consulting expert on many significant antitrust matters in the United States, European Union, and China. He has also made submissions to, and appearances before, competition and regulatory authorities with respect to mergers and investigations in those and other jurisdictions. David has worked on litigation matters for defendants and plaintiffs, on mergers for merging parties and intervenors, and for and in opposition to competition authorities.

Allan Fels AO graduated in economics (first class honors) and law from the University of Western Australia in 1965. He has a PhD in Economics from Duke University and was a research fellow in the Department of Applied Economics at the University of Cambridge from 1986-1972, where he wrote The British Prices and Incomes Board (Cambridge University Press, 1972).

On his return to Australia Professor Fels joined the Economics Department of Monash University as a Senior Lecturer, before becoming Professor of Administration and Director of the Graduate School of Management from 1984 until 1991.

The career of Professor Fels in Australia falls into two parts. He was generally regarded as the nation's leading regulator, serving as inaugural Chair of the Australian

Competition and Consumer Commission (and its predecessor bodies) from 1989 until 2003. The Australian Competition and Consumer Commission is the country's regulator of competition law and consumer law; it also regulates public utilities in the telecommunications and energy industries (in a similar manner to industry-specific bodies such as Ofcom in the UK and FCC in the US). He has had numerous other regulatory roles (for example, in insurance, agriculture, telecommunications, and aviation).

Professor Fels remains a leading figure globally in competition policy. He co-chaired the OECD Trade and Competition Committee from 1996 to 2003 and continues regularly to be a keynote speaker at major global competition events including the world's two peak events, the International Competition Network Annual Conference and the OECD Global Competition Forum.

He was a participant in the 15-year process of drafting the Chinese Antimonopoly Law 2008 and currently advises the Chinese government on the law's implementation. Academically, he is co-director of the Competition Research Centre at the Chinese Academy of Science, a prestigious position, and an international adviser to the Chinese Academy of Social Science.

The second part of Professor Fels' career has been academic. He was appointed Foundation Dean of the Australia and New Zealand School of Government and served in that position from 2003 until 2012. The predominant activity of the School has been the provision of management development programs to senior public servants in the two countries. There is also a substantial research program and other professional and outreach activities.

Catherine Tucker is the Sloan Distinguished Professor of Management and a Professor of Marketing at MIT Sloan. She is also Chair of the MIT Sloan PhD Program.

Her research interests lie in how technology allows firms to use digital data and machine learning to improve performance, and in the challenges this poses for regulation. Tucker has particular expertise in online advertising, digital health, social media, and electronic privacy. Her research studies the interface between marketing, the economics of technology, and law.

She has received an NSF CAREER Award for her work on digital privacy, the Erin Anderson Award for an Emerging Female Marketing Scholar and Mentor, the Garfield Economic Impact Award for her work on electronic medical records, the Paul E. Green Award for contributions to the practice of Marketing Research, the William F. O'Dell

Award for most significant, long-term contribution to Marketing, and the INFORMS Society for Marketing Science Long Term Impact Award for long-run impact on marketing.

She is a cofounder of the MIT Cryptoeconomics Lab which studies the applications of blockchain and also a co-organizer of the Economics of Artificial Intelligence initiative sponsored by the Alfred P. Sloan Foundation. She has been a Visiting Fellow at All Souls College, Oxford. She has testified to Congress regarding her work on digital privacy and algorithms, and presented her research to the OECD and the ECJ.

Catherine Tucker is coeditor at Quantitative Marketing and Economics, associate editor at Management Science, Marketing Science, and the Journal of Marketing Research and a research associate at the National Bureau of Economic Research. She teaches MIT Sloan's course on Pricing and the EMBA course "Marketing Management for the Senior Executive." She has received the Jamieson Prize for Excellence in Teaching as well as being voted “Teacher of the Year” at MIT Sloan.

She holds a PhD in economics from Stanford University and a BA from the University of Oxford.

Authors' Bios

Reiko Aoki has been Commissioner of the Japan Fair Trade Commission since 2016. She has conducted research and published on the economics of patents, patent pools, standards, innovation and intergenerational political economy in academic positions at the Ohio State University, SUNY Stony Brook, University of Auckland and Hitotsubashi University. She is Professor Emeritus of Hitotsubashi University. She has served as Executive Member of the Council for Science and Technology Policy, Japanese Cabinet Office 2009-2014, Member of the Information and Communication Council 2014-2016 and Member of Science Council of Japan 2014-2016. Prior to joining the JFTC, she was Executive Vice-President (International, Gender Equality, and Intellectual Property) at Kyushu University. She received her B.S. in mathematics from University of Tokyo, M.A. in economics from University of Tsukuba, and PhD in economics and MS in statistics from Stanford University. She is currently President of the Japanese Law and Economic Association, and Executive Board Member of the Japanese Economic Association.

Robert D. Atkinson is founder and president of the Information Technology and Innovation Foundation ("ITIF"), the world's leading think tank for science and technology policy. He is an internationally recognized scholar, a widely published author, and a trusted adviser to policymakers around the world, with expertise in the broad economics of innovation and specific policy and regulatory questions around new and emerging technologies. Rob's most recent book, co-authored with Michael Lind, is Big Is Beautiful: Debunking the Myth of Small Business.

Before founding ITIF, Atkinson was Vice President of the Progressive Policy Institute and Director of PPI's Technology & New Economy Project. He received his Masters in Urban and Regional Planning from the University of Oregon and was named a distinguished alumnus in 2014. He received his Ph.D. in City and Regional Planning from the University of North Carolina at Chapel Hill in 1989.

Simon Bishop is co-founder and Partner at RBB Economics. He has over 20 years' experience of providing expert economic advice in competition law matters and has advised on several hundred cases before competition authorities and courts around the world. Clients for whom Simon has acted as lead economist on several occasions include GE, British Airways, FA Premier League, Bertelsmann, Sony, and BHP Billiton.

Simon has published widely including reports and articles on market definition, non-horizontal mergers, bidding markets, loyalty rebates and vertical restraints. He is the co-author of The Economics of EC Competition Law (3rd edition, Sweet & Maxwell, 2009), a leading textbook on the application of economics to European competition law, and is co-editor of the European Competition Journal.

Aleksandra Boutin is a Founding Partner of Positive Competition. She is featured in the Who's Who Legal: Thought Leaders - Competition, a ranking listing the world's leading competition professionals. She has more than fifteen years of experience in competition policy as an enforcer, consultant and academic. She is a member of the Scientific Council of the GCLC and a Non-Governmental Advisor for Poland in the ICN.

Aleksandra advises clients on a wide range of competition issues in the context of competition proceedings in front of the European Commission, National Competition Authorities and Courts. Her recent experiences involve cartel overcharge analysis, vertical and horizontal mergers, exclusionary and exploitative abuses, state aid and information exchanges. She has also advised clients in antitrust cases involving digital platforms in e-commerce and in the software industry.

On the policy front, she was the lead author of the European Commission's Guidelines on Horizontal Cooperation Agreements and Block Exemption Regulations, she participated in preparing the communication of the Commission on quantifying harm in antitrust damage actions and in the Commission's IP Guidelines.

Aleksandra holds a Master in Theoretical Economics and Econometrics from Toulouse School of Economics, and a Master in European Law and Economic Analysis from the College of Europe. She completed her PhD studies at the Université Libre de Bruxelles.

Xavier Boutin is a founding partner at Positive Competition and an adjunct professor of economics at the Université libre de Bruxelles. He holds a PhD in Economics from EHESS (Paris School of Economics). He is featured in the Who's Who Legal Thought Leader: Competition, a ranking listing the world's leading competition professionals. Xavier is also a founding and board member of l'Entente, the association of French speaking antitrust practitioners in Brussels.

Xavier leads a team of consultants advising clients in the context of merger, State Aid and antitrust proceedings in front of the European Commission and national competition authorities. Prior to founding Positive Competition, Xavier was an expert in an international consultancy. Before joining the private sector, he spent almost eight years in the Chief Economist Team of the European Commission's DG Competition.

Xavier made a major contribution to the EU Commission's Article 102 guidance paper, its Article 101 horizontal guidelines and the accompanying Block Exemption Regulation ("BER"). He also contributed to the State Aid Modernization, in particular, in the areas of R&D&I and Regional Aid.

Xavier's most recent work includes the assessment of vertical and horizontal mergers. In addition, Xavier has led many investigations involving exclusionary and exploitative abuses in the digital platform sector. These include the assessment of vertical restraints and self-preferencing in e-commerce, as well as Article 102 cases in the software industry.

Burcu Can graduated from Ankara University, Faculty of Law in 2008. Over five years of her close to 10 years of career in competition law was devoted to the Turkish Competition Authority as a competition expert case handler. Burcu has obtained her LL.M. degree from Harvard Law School and worked for many years at the Brussels office of one of the top international law firms as a competition lawyer. During her years at the Turkish Competition Authority, Burcu took part in leading antitrust and merger cases concerning banking, finance, motor vehicle and transportation sectors, contributed to the preparation of secondary legislation for competition law and several International Competition Network projects. In addition to her LL.M. degree from Harvard Law School, Burcu also has a master's degree in commercial law from Gazi University in Turkey. Burcu is a member of the New York Bar and the Istanbul Bar.

Sayanti Chakrabarti is the Joint Director in the Economics Division of the Competition Commission of India, where she is responsible for carrying out economic analysis of antitrust and merger cases. She has also contributed to several research outputs of the Division on competition law and policy. Prior to joining the CCI in 2010, Sayanti worked with the Economic Affairs Team of the Federation of Indian Chambers of Commerce and Industry, where she contributed to a number of surveys and studies on issues of importance to the Indian business and economy. She holds an MSc in Economics from Calcutta University.

Naval Satarawala Chopra is a partner at Shardul Amarchand Mangaldas and has been practicing competition law since its inception in India. He is the first Indian lawyer in GCR's top "40 under 40" competition lawyers in the world (2015);

listed as a global "thought leader" (Who'sWhoLegal); and recognized regularly as a leading advisor in Chambers & Partners.

Naval has been involved in some of the most prominent abuse of dominance cases in India. He is particularly skilled in advising on antitrust aspects of technology related matters, having successfully defended WhatsApp in relation to its privacy policy and separately digital payments services, Microsoft Corporation in relation to software licensing terms and Uber in relation alleged predatory pricing, before the Competition Commission of India ("CCI").

Naval has recently advised Facebook in its acquisition of minority shareholding in India's fastest growing telecom company. He has also advised in Avago's acquisition of Broadcom, Ctrip's investment in MakeMyTrip, the failed merger of Publicis and Omnicom as well as the conditional approval for Bayer AG's acquisition of Monsanto Company.

Naval also advises a number of clients in cartel cases and is involved in challenges on account of due process and natural justice issues before the Supreme Court of India.

David S. Evans' academic work has focused on industrial organization, including antitrust economics, with a particular expertise in multisided platforms, digital economy, information technology, and payment systems. He has authored eight books, including two award winners, and more than one hundred articles in these areas. He has developed and taught courses related to antitrust economics, primarily for graduate students, judges and officials, and practitioners, and have authored handbook chapters on various antitrust subjects.

David's expert work has focused on competition policy and regulation. He has served as a testifying or consulting expert on many significant antitrust matters in the United States, European Union, and China. He has also made submissions to, and appearances before, competition and regulatory authorities with respect to mergers and investigations in those and other jurisdictions. David has worked on litigation matters for defendants and plaintiffs, on mergers for merging parties and intervenors, and for and in opposition to competition authorities.

Máté Fodor is an Economist at Positive Competition. Prior to joining the company, he was an assistant professor of Econometrics and Game Theory at the International School of Economics, a University of London affiliate institution. Máté holds a MSc. in Economics from Trinity College Dublin, where he was the recipient of the Terrence Gorman Prize for valedictorian. After consulting missions for the public sector authorities, he joined ECARES at the Université libre de Bruxelles to obtain his PhD in Economics. He has secured research funding from several prestigious grants, such as the Marie Curie Framework and FNRS. His research profile is diverse with peer-reviewed publications in political economy, labor, energy, development, and media economics.

Since joining Positive Competition, Máté has worked on abuse of dominance cases involving digital platforms in the e-commerce and software industries. Máté has also been involved in overcharge and damages estimations in the construction and primary resources industries. He has also contributed to the economic assessment of mergers.

Gönenç Gürkaynak is a founding partner of ELIG Gürkaynak Attorneys-at-Law, a leading law firm of 90 lawyers based in Istanbul, Turkey. Mr. Gürkaynak graduated from Ankara University, Faculty of Law in 1997, and was called to the Istanbul Bar in 1998. Mr. Gürkaynak received his LL.M. degree from Harvard Law School in 2001, and is qualified to practice in Istanbul, New York, Brussels, and England and Wales. Before founding ELIG Gürkaynak Attorneys-at-Law in 2005, Mr. Gürkaynak worked as an attorney at the Istanbul, New York, and Brussels offices of a global law firm for more than eight years of his total of 23 years of career in private practice so far. Mr. Gürkaynak heads the competition law and regulatory department of ELIG Gürkaynak Attorneys-at-Law, which currently consists of 45 lawyers. He has unparalleled experience in Turkish competition law counselling issues with more than 23 years of competition law experience, starting with the establishment of the Turkish Competition Authority. Mr. Gürkaynak frequently speaks at local and international conferences and symposia on competition law matters. He has published more than 200 articles in English and Turkish by various international and local publishers, and he has published three books. Mr. Gürkaynak also holds teaching positions at undergraduate and graduate levels at two universities, and gives lectures in other universities.

Peter K. Huston is a partner in the San Francisco office of Baker Botts. He has 30 years of experience in high-stakes civil and criminal antitrust litigation, trials, government investigations, class actions and merger clearance work, both in and out of government. In 2020 he was recognized in the 27th Edition of Best Lawyers in America. Prior to joining Baker Botts, Peter served as Assistant Chief in the San Francisco Office of the Antitrust Division of the United States Department of Justice where he led and supervised both criminal price-fixing matters and civil merger matters. For his government service, Peter was awarded the Attorney General's Distinguished Service Award and was twice awarded the Antitrust Division's Award of Distinction. He also received the California Lawyer Attorney of the Year Award in 2013 and was named to the Daily Journal Top 100 Lawyers in 2012. Peter currently serves on the Executive Committee of the California Lawyers Association Antitrust, Unfair Competition and Privacy Law Section and the ABA International Cartel Task Force.

Tetsuya Kanda has been a Senior Planning Officer in Legal System Planning Division, Consumer Affairs Agency ("CAA") of Japan, since July 2019. In the current capacity, he is in charge of an initiative to reinforce the Whistleblower Protection Act.

Prior to the current position, he held various positions in the Japan Fair Trade Commission ("JFTC"), in both fields of investigation and policymaking. Mostly recently, he was a Senior Planning Officer for Investigation from 2017 to 2019, where he dealt with procedural and substantive issues of investigations against major technology firms. His past responsibility in the JFTC includes drafting of law amendments strengthening public enforcement of the Japanese Antimonopoly Act and its "monopoly" guidelines.

He was seconded to the Directorate-General for Competition of the European Commission from 2012 to 2013.

He holds a Master of Public Policy from the University of Michigan and a Bachelor of Laws from the University of Tokyo. He also teaches the Japanese competition law at the Graduate School of Law, Meiji University in Tokyo.

Joe Kennedy is a senior fellow at ITIF. For almost 30 years he has worked as an attorney and economist on a wide variety of public policy issues. His previous positions include chief economist with the U.S. Department of Commerce and general counsel for the U.S. Senate Permanent Subcommittee on Investigations. He is president of Kennedy Research, LLC, and the author of Ending Poverty: Changing Behavior, Guaranteeing Income, and Transforming Government (Rowman & Littlefield, 2008). Kennedy has a law degree and a master's degree in agricultural and applied economics from the University of Minnesota and a Ph.D. in economics from George Washington University.

Maria Khan is a Research Associate in the Economics Division of the Competition Commission of India. She has over five years of work experience in the field of Competition Law and Policy. She is responsible for carrying out economic assessment of antitrust conduct cases and mergers and acquisitions, competition advocacy and research related to competition law and policy. Maria is an Economist by qualification and holds an M.Phil. in Economics degree from Jawaharlal Nehru University, New Delhi and a Post Graduate degree in Economics from Jamia Millia Islamia, New Delhi.

Thomas Kramler is head of the unit dealing with e-Commerce and the data economy in the European Commission's Directorate General for Competition. Before that, he was Head of the Digital Single Market Task Force responsible for the e-commerce sector inquiry. Mr. Kramler holds a law degree and a PhD from the University of Vienna, Austria. He has graduated with a Master's degree in European Community Law from the College of Europe (Bruges).

Previously Mr. Kramler was deputy head of the unit responsible for antitrust cases in the information industries, internet and consumer electronics sectors. Before joining the European Commission, Mr. Kramler worked as agent representing the Austrian government before the European Courts in Luxemburg.

Andrew Low is a senior lawyer in Gilbert + Tobin's competition and regulation group. Andrew's practice is directed to providing complex advice and advocacy for clients in complex and high-profile matters across each core area of the Competition and Consumer Act (including complex merger clearance, enforcement investigations, industry inquiries, and dispute resolution).

Andrew has a particular expertise and interest in, and has contributed significant thought leadership to, digital issues for competition policy and regulation. This includes chairing sessions including with the ACCC Chairman and international experts Maurice Stucke and Ariel Ezrachi on reflections on the Digital Platforms Inquiry and whether Robots Can Collude?. He has authored a number of papers including Decoding the Data Lifecycle, ACCC signals a changing approach to digital M&A, Digital Reform unfolds, and Impact of competition policy on data access and management, and the soon to be published Digital Competition Australia 2021 (Lexology/GTDT). He has spoken at the Law Council of Australia's Rising Stars 2019 Conference on digital competition policy.

Such thought leadership is supported by in-depth commercial experience advising large tech companies. He is widely recognised by key clients as a rising star competition lawyer and is sought after by clients for his digital economy expertise.

Payal Malik is Adviser, Economics and Head of the Economics Division at the Competition Commission of India. She is on secondment from PGDAV College, University of Delhi, where she is an Associate Professor of Economics. Her areas of expertise are competition law, policy and regulation. She has several years of research and economic consulting experience in network Industries such as power and telecommunication, ICTs, Innovation systems, and Infrastructure.

Her research and professional collaborations have been with NCAER, Delhi, OECD, Orbicom, IDEI, University of Toulouse, University Of Québec at Montreal, CEPR, JRC, European Commission, IPTS Seville, ICEGEC, Hungary, Department of Information Technology, TRAI, Ministry of Power, Ministry of Information and Broadcasting, Planning Commission of India, CSO, India, WSP-SA, World Bank and AFD, Paris. She was on the team that drafted the Electricity Act of India ushering competition into the sector.

She has a BA (Hons.) in Economics from Lady Shri Ram College, University of Delhi and an MA and MPhil in Economics from the Delhi School of Economics. She also has an MBA in finance from University of Cincinnati, Ohio.

Vinicius Marques de Carvalho is Partner at VMCA Advogados and Professor of Commercial Law at the University of São Paulo. He holds a PhD in Commercial Law from the University of São Paulo and a PhD from the University Paris I (Pantheon-Sorbonne) in Public Comparative Law. He was a Yale Greenberg World Fellow (2016), President of the Administrative Council for Economic Defense ("CADE") (2012-2016), Vice-President of the International Competition Network (2013-2016), Secretary of Economic Law (2011-2012) and Commissioner at CADE (2008-2011).

Marcela Mattiuzzo is Partner at VMCA Advogados and PhD Candidate in Commercial Law at the University of São Paulo. She holds a Masters in Constitutional Law from the same institution and was Visiting Researcher at Yale Law School. She was Advisor and Chief of Staff at the Office of the President at the Administrative Council for Economic Defense ("CADE"), Commissioner at the Federal Fund for the Defense of Collective Rights and CADE's representative before the National Strategy for the Fight Against Corruption and Money Laundering.

Andreas Mundt has been President of the Bundeskartellamt since 2009, member of the Bureau of the OECD Competition Committee since 2010 and the Steering Group Chair of the International Competition Network since 2013.

After qualifying as a lawyer, Andreas Mundt entered the Federal Ministry of Economics in 1991. In 1993 he joined the staff of the Free Democratic Party in the

German Parliament. In 2000 he joined the Bundeskartellamt as rapporteur and later acted as Head of the International Unit and Director of General Policy.

Maureen K. Ohlhausen chairs the antitrust group at Baker Botts LLP, where she focuses on competition, privacy and regulatory issues and frequently represents clients in the tech, life sciences, energy, and retail industries. She served as Acting FTC Chairman from January 2017 to May 2018 and as a Commissioner starting in 2012. She directed all FTC competition and consumer protection work, with a particular emphasis on privacy and technology issues. Ms. Ohlhausen has published dozens of articles on antitrust, privacy, regulation, FTC litigation, and telecommunications law issues and has testified over a dozen times before Congress. She has received numerous awards, including the FTC's Robert Pitofsky Lifetime Achievement Award. Prior to serving as a Commissioner, Ms. Ohlhausen led the FTC's Internet Access Task Force and headed the FTC practice group at a leading communications law firm. Ms. Ohlhausen clerked at the U.S. Court of Appeals for the D.C. Circuit and received her J.D. with distinction from the George Mason University School of Law and her B.A. with honors from the University of Virginia.

Dr. Burton Ong, LLB (NUS); LLM (Harv); BCL/DPhil (Oxon) is an Associate Professor at the Faculty of Law, National University of Singapore ("NUS"), where he teaches and researches in the fields of competition law, intellectual property and contract law. He is an Advocate and Solicitor of the Supreme Court of Singapore, as well as an Attorney and Counsellor-at-Law in New York State. He is a member of the Ministry of Trade and Industry's Competition Appeal Board, an IP Adjudicator with the Intellectual Property Office of Singapore and sits on the dispute resolution panel of the Casino Regulatory Authority. He is a Director (Competition Law) at the EW Barker Centre for Law and Business at the National University of Singapore. He is the editor of "The Regionalisation of Competition Law and Policy Within the ASEAN Economic Community" (2018), published by Cambridge University Press.

Alejandra Palacios, Chair of Mexico's Federal Economic Competition Commission (Comisión Federal de Competencia Económica; "COFECE") is the first woman to head the Mexican antitrust authority. Following a major constitutional reform that set forth a new framework for competition in Mexico, Alejandra was appointed by Congress in 2013 to head the COFECE. She was reelected in 2017 for a second four-year tenure that will end in September 2021.

Before her current role at COFECE, Alejandra worked as Project Director at the Mexican Institute of Competitiveness (the Instituto Mexicano para la Competitividad; "IMCO") for research projects focused on economic regulation, telecom, public procurement and other issues related to competition.

Since June 2016, she is Vice-President for the International Competition Network ("ICN"), the most prominent international network on competition, composed of 138 competition authorities around the world, and as of 2017, Member of the Bureau of the Competition Committee of the Organisation for Economic Cooperation and Development ("OECD"). Alejandra is also a member of the International Women's Forum, Mexico chapter. In 2019 the Women@Competition organization included her in its list of "40 in their 40s" as one of the 40 most notable women in competition in the Americas, Asia and Europe.

Alejandra holds a bachelor's degree in Economics, as well as an MBA from the Instituto Tecnológico Autónomo de México ("ITAM"). She completed a second master's degree in public policy at the Centro de Investigación y Docencia Económicas ("CIDE").

Her academic work includes teaching as well as serving as the Academic Coordinator for the ITAM Economics faculty.

Aman Singh Sethi is a Principal Associate at Shardul Amarchand Mangaldas. He has a diverse work experience, and has been closely involved on matters pertaining to anti-competitive agreements and abuse of dominance before the CCI, the National Company Law Appellate Tribunal as well as the Supreme Court of India. He has also been involved in a number of challenges seeking due process and the preservation of natural justice rights for clients against the CCI before the High Court of Delhi.

Aman has worked for several clients in the high-tech/disruptive industry, agrochemicals and agricultural traits, cement, petrochemicals, and telecommunication sectors in contentious cases. He also writes, and advises clients, on issues related to the interplay of competition law and intellectual property.

Along with co-authors Naval Satarawala Chopra and Yaman Verma, he successfully represented Matrimony.com in an abuse of dominance case against Google. Aman has also represented Uber and Indian hospitality disruptor OYO in wins against abuse of dominance claims before the CCI.

George Siolis joined the Melbourne office as a Partner when RBB Economics was established in Australia in 2009, and since then he has advised clients on a number of contentious mergers before the ACCC as well as a variety of behavioral matters involving the alleged misuse of market power. He is a member of the Consumer and Competition Committee of the Business Law Section of the Australian Law Council and is listed in Who's Who Legal of Competition Lawyers and Economists. George has worked as a micro-economist for 20 years. Prior to joining RBB Economics George worked with Telstra and was an economic consultant based in the UK for eight years where he developed and led the communications practice at Europe Economics.

Celestine Song is an Assistant Director at the Competition and Consumer Commission of Singapore, where she leads teams working across a wide range of competition enforcement, policy formulation, outreach and advocacy work, including providing competition advice to government agencies. Prior to joining CCCS in 2014, Celestine worked on manpower and productivity policy formulation matters in the Ministry of Manpower. Celestine holds a bachelor's degree in Economics from the Nanyang Technological University of Singapore and a masters' degree in Public Policy from Peking University.

Hi-Lin Tan is the director of the policy and markets division and a member of the senior management at the Competition and Consumer Commission of Singapore, where he is involved in engaging and advising other government agencies on competition matters, and conducting market studies, investigations, and other competition law enforcement activities. Among the cases he has supervised include a market study on online travel booking, and abuse of dominance investigations into online food delivery and payment terminals.

Prior to joining CCCS in 2007, he was a teaching fellow at Boston College, a trading member of the Singapore Exchange, and an economist at the Monetary Authority of Singapore. He holds a PhD in economics from Boston College and master's and bachelor's degrees from the London School of Economics.

Sinem Ugur is a senior associate at ELIG Gürkaynak Attorneys-at-Law. She graduated from Istanbul Commerce University, Faculty of Law in 2011. She is admitted to the Istanbul Bar and has experience close to 10 years in competition law in a variety of industries. She provides legal consultancy to global and domestic clients in all areas of competition law including vertical agreements, abuse of dominance, cartel cases, concentrations, joint ventures, and compliance programs. Sinem Ugur has co-authored numerous articles relating to competition law and international trade matters in English and Turkish. She is also fluent in German.

Yaman Verma is a Partner at Shardul Amarchand Mangaldas with over 10 years' experience practicing competition law. He is recognized as a "future leader" (Who'sWhoLegal, 2017-20); a "rising star" (Competition/Antitrust, Expert Guides, 2018-20) and included in the list of "next generation lawyers" for India (Legal 500, 2017-20).

Yaman has successfully defended WhatsApp against abuse of dominance allegations in relation to its privacy policy, Microsoft Corporation against allegations of unfair and discriminatory software licensing terms, and e-tailer Flipkart against allegations of preferential treatment and discrimination.

Yaman has recently advised on Facebook's acquisition of minority shareholding in India's fastest growing telecom company. Previously, he helped obtain unconditional approvals for Vodafone India's merger with Idea Cellular Limited, the capital alliance between Suzuki Motor Corporation and Toyota Motor Corporation, the Fiat/Peugeot merger, Walmart's acquisition of Flipkart (and successfully defended the approval in follow on litigation), and Microsoft's acquisition of Nokia's mobile telephony business. He has also advised on obtaining conditional approvals for several major global transactions, including Dow/DuPont, Agrium/PotashCorp, and Linde/Praxair.

Yaman has represented Globecast Asia in their leniency application before the Commission, and was successful in obtaining a 100 percent reduction in penalty for Globecast and its officials. He advises several trade associations in relation to compliance with competition laws.

Beth Webster is Director of the Centre for Transformative Innovation at Swinburne University of Technology. She is also Pro Vice-Chancellor for Research Impact and Policy. Her expertise centers on the economics of the way knowledge is created and diffused through the economy. She has a PhD in economics from the University of Cambridge and an M.Ec and B.Ec (hons) from Monash University. She is a fellow of the Academy of Social Sciences Australia.

Professor Webster is responsible for providing advice and leadership on policies relating to the economic and social impact of research, public industry and innovation policies. She is also responsible for measuring university research engagement and impact.

Professor Webster has authored over 100 articles on the economics of innovation and firm performance and has been published in RAND Journal of Economics, Review of Economics and Statistics, Oxford Economic Papers, Journal of Law & Economics, the Journal of International Economics and Research Policy. She has been appointed to a number of committees including the Bracks' review of the automotive industry, Lomax-Smith Base funding Review, CEDA Advisory Council, and the Advisory Council for Intellectual Property. She is a past President of the European Policy for Intellectual Property Association and is the current General Secretary of the Asia Pacific Innovation Network.

Luke Woodward heads Gilbert + Tobin's Competition and Regulation group, advising and representing clients on competition and consumer law investigations and prosecutions, ACCC acquisition and merger clearances and infrastructure regulation, including in the digital, telecommunications, gas, electricity, water, airports, sea ports and rail industries in Australia.

He has over 30 years competition and consumer law enforcement experience, both on the enforcement side with the former Trade Practices Commission ("TPC") and Australian Competition and Consumer Commission ("ACCC"), and in private practice. Prior to joining the firm in 2000, Luke held senior positions at the ACCC as General Counsel, Executive General Manager, Compliance Division (responsible for enforcement) and Senior Assistant Commissioner, responsible for mergers and asset sales.

Luke was awarded "Competition Lawyer of the Year" in Best Lawyers 2021 and is recognized as "the ultimate strategist" by a client who notes: "He knows the law, knows the ACCC inside and out and knows the best way to approach a matter from a strategic perspective; it's a real value-add." (Chambers Asia-Pacific 2020).

THE EVOLUTION OF ANTITRUST IN THE DIGITAL ERA:
Essays on Competition Policy

Volume One

Editors
David S. Evans
Allan Fels AO
Catherine Tucker

This collection of essays represents the first in a series of two volumes that set out to reflect the state of the art of antitrust thinking in digital markets in jurisdictions around the world. The issues it tackles are many: the role of innovation, the conundrum of big data, the evolution of media markets, and the question of whether existing antitrust tools are sufficient to deal with the challenges of digital markets. Each author tackles the overarching themes from their unique national perspective. The resulting tapestry reflects the challenges and opportunities presented by the modern digital era, viewed through the lens of competition enforcement.

CPI COMPETITION POLICY INTERNATIONAL