**Question: "How should Competition and Consumer Protection rules evolve in the age of Artificial Intelligence?"[1]**

**Abstract:**

The first modern competition law to be enacted in history, [2] the Sherman Antitrust Act,[3] was enacted in 1890. A century and a half since its writing, much of it has remained unchanged, especially in its focus on the concept of "agreements", and virtually all competition law since then has been built on this concept. [4] John Sherman wrote at a time when artificial intelligence (**AI**") did not yet exist, but a century and a half later, we continue to use the very same system, despite AI's pervasiveness.

Scholars[5] now argue that AI, when used in pricing algorithms, have the ability to tacitly collude with competitors in their markets, coordinating prices without ever actually communicating with one another. When held up to the current framework of competition law, based on a century old concept of human coordination, one finds that the use of such algorithms pervade prosecution. In its reliance on "agreements" and its evidential framework of coordination only applicable to human collusion, current competition law lacks the nuance to deal with the potential effects of AI. This essay then proposes three avenues for changing competition and consumer protection rules to adapt to collusive AI: (1) establish stricter liability for collusive behaviour of a firm's AI; [6] (2) integrate AI into existing policing measures, to monitor markets and detect suspicious behaviour; and (3) implement a testing framework for firms' AI models and a research programme to test collusive algorithms. [7]

[1] I thank Danny Quah, Director, CHP Law LLC and Daniel Kang for their helpful comments and guidance. All mistakes remain mine.
[2] Gerber (2002), p. 267
[3] Sherman Antitrust Act (2004)
[4] Gerber (2002), p.277
[5] See Ezrachi and Stucke's (2016) "Digital Eye" model pp. 71-81
[6] Based on Hennemann's (2020) model in pp.376-377
[7] Based on Harrington's (2017) model in pp.56-68.

(292 words w/ footnotes)

## Introduction[8]

Modern competition law is undoubtedly human-centric. It owes that to its age; the first modern competition law[9] being drafted over a century ago. We still continue to adopt its concept of "agreements" across competition law all around the world, despite it potentially lacking the nuance required to regulate AI.

This essay explores the capabilities of AI to tacitly collude in a market to set anticompetitive prices, without any coordination among competitors, or its developers intending for it to engage in such collusion. Thereafter, I examine how such AI falls outside of the current frameworks of competition law, due to operating in a manner divorced from "intents" or "agreements", and how it sidesteps the evidential framework relying on forms of human coordination like physical meetings, which are not required for AI to collude.

This essay proposes three avenues for competition and consumer protection laws to change in the face of AI: (1) establish stricter liability for collusive behaviour for a firm's AI; [10] (2) integrate AI into existing policing measures, to monitor markets and detect suspicious behaviour; and (3) implement a testing framework for firms' AI models and a research programme to test collusive algorithms. [11]

## AI and Tacit Collusion

Envision a scenario where pricing algorithms utilising self-learning technologies can determine pricing strategies independently.[12] These algorithms coordinate prices with competitors, and jointly achieve supracompetitive profits without actually

[8] I thank Danny Quah, Director, CHP Law LLC and Daniel Kang for their helpful comments and guidance. All mistakes remain mine.
[9] US Sherman Antitrust Act (2004)
[10] Based on Hennemann's (2020) model in pp.376-377
[11] Based on Harrington's (2017) model in pp.56-68.
[12] Considered by Ezrachi and Stucke (2016) in pp.71-81.

communicating with one another, known as tacit collusion[13]. These algorithms reach "conscious parallelism", changing their prices in response to their competitors, without even reaching an agreement with them.[14] To understand how this outcome is reached, we must first understand the AI used in these pricing algorithms.

The pricing algorithms explored in the literature covering algorithmic collusion focus on a subset of machine learning known as reinforcement learning.[15] Such algorithms aim to maximise a reward signal (the goal of the algorithm, for example, profit) and "learn" by taking actions in a fixed environment. It does so without being taught which actions are optimal, and instead learns by taking each action and observing the reward signal.[16]

Under this scenario, scholars argue that this would result in tacit collusion.[17] One of the reasons is that a price algorithm's ability to collect and process data on a massive scale make any firm's deviation from the coordinated supracompetitive price more detectable, resulting in a shorter time period between defection and detection. This means that defecting will be less profitable for each participant, making the cartel more stable.[18] This is supported by Calvano et al.'s (2020) model, where self-learning price algorithms were found to have "systematically learn[ed] to collude".[19] In their model, more than 95% of deviations from the supracompetitive price were made unprofitable by the punishment enacted by another agent.[20]

Even without any human intervention, self-learning models have been shown to tend towards a collusive outcome. This outcome does not need to have been intended by

[13] Ittoo and Petit (2017) p.1
[14] Wex Definitions Team (n.d.)
[15] Considered of particular interest by Ulrich (2018) p.8
[16] Sutton and Barto (2017) p.2
[17] Mehra (2015) pp. 1346-1351
[18] Ibid at pp.1348-1349.
[19] Calvano et al. (2020) p.3282.
[20] Ibid.

the developers and executives of each firm, nor would they have to communicate to fellow "cartelists" to enforce the elevated price. Instead, their pricing algorithms fix the price by coordinating independently with other algorithms.

How much higher is this price exactly? Calvano's (2020) model observed that the algorithms obtained an increased profit of 70% to 90%,[21] while quantitative estimates of historical data found that cartels on average overcharged by 23%[22]. This suggests that the collusive price consumers are paying is 23% higher than a competitive price.[23]

Kaplow (2018) illustrates the harms that price-fixing has on society: consumer and total welfare is reduced, firms are rewarded for avoiding competition, and better firms are less able to serve customers.[24] The Competition & Consumer Commission Singapore (the "**CCCS**") has called price-fixing "one of the most harmful types of anti-competitive conduct".[25]

**Current Law**

When the current legal framework is applied to AI, which operates outside the parameters of human coordination - for example, by not requiring any "trust" - one finds that such collusions fall out of the law's reach. This is because the "legal tools were designed to deal with human facilitation of coordination".[26] For instance, competition law limits communication between competitors, thus limiting trust between competitors, a fundamental requirement to the formation of cartels.[27]

[21] See Calvano (2020) p. 13 for specific calculations. The figure 70% to 90% is relative to the competitive outcome and perfectly collusive outcome.
[22] Connor (2014) p.86
[23] See Connor (2014) pp.7-8 for his definition of overcharge rate.
[24] Kaplow (2018) p.8
[25] CCCS (2022).
[26] Gal (2019) p.97
[27] See Leslie (2004), pp.626-629

This essay will cover Article 101 of the Treaty on the Functioning of the European Union, the governing provision regarding collusive arrangements, as this model has been adopted[28] in the United Kingdom Competition Act 1998,[29] then in the Singapore Competition Act 2004.[30] Furthermore, decisions from the European Union are "highly persuasive" in Singaporean courts.[31] Thus, understanding the European courts' views will also inform local views.

Under this framework, the concept of "agreement" is the mechanism by which authorities police the markets. This presents two issues when policing AI with the ability to tacitly collude.

**"Agreement" and Intent**

Firstly, an "agreement" is not required for price algorithms to collude. The concept of "agreement" is centred "around the existence of a concurrence of wills between at least two parties". [32] This understanding of "agreement" as requiring "wills" between parties to collude proposes a fatal flaw: AI lacks a "will", and simply acts to maximise profit.

Furthermore, colluding firms cannot be prosecuted on the grounds that the price algorithm was designed to collude, as collusion is a conclusion of the algorithm's self-learning process, arrived without any human intent.[33] Some complex AI models are currently a "black box": developers feed it with vast amounts of data, it gives an output, but the actual workings remain opaque to even the developers.[34] In other words:

[28] Ong (2006).
[29] UK Competition Act 1998
[30] Singapore Competition Act 2004
[31] *Pang's Motor Trading v Competition Commission of Singapore* (2014) at [33].
[32] *Bayer AG v Commission of the European Committees* (2000) at [69].
[33] Ezrachi and Stucke (2016) p. 78
[34] Hassenfeld (2023)

developers may never intend for the algorithm to collude, but it would anyways. Understanding why is not as simple as finding an incriminating line of code.

However, the European framework in practice relies on “expressions” of parties, rather than the presumed “intentions” behind those expressions. In other words, intention is often not required to establish a restriction to competition.[35] These “expressions” are something AI is capable of. Even so, two issues persist despite the fact that courts can prosecute on “expressions”.

Firstly, despite a broader implementation of “agreements” in practice, there must still exist some actual “agreement”. In other words, conscious parallelism, the outcome reached by the AI covered above, is not included under the framework of “agreement”. The European Commission only identifies that conscious parallelism “may… amount to strong evidence”.[36] Conscious parallelism by itself is not illegal.

Secondly, competition authorities must first identify that there is an anticompetitive market. Identifying that an algorithm colluded with another to form a supracompetitive price is simple in a controlled model such as Calvano et. al’s (2020), but real markets are far opaquer and more complex. Models illustrating collusion thus make assumptions. One of these is that the AI must be fed with data in the model that may not be so readily available in reality.[37]

Most significantly, no one knows why an algorithm sets its respective price. Even if the market price is supracompetitive, “supracompetitive prices [are] not, per se, genuine proof of collusion”.[38] All these factors make identifying when a firm’s AI colludes extremely difficult to detect.

[35] Blockx (2017). p. 7
[36] *Imperial Chemical Industries Ltd. v Commission of the European Communities* (1972) at [66].
[37] Ittoo and Petit (2017) pp.11-12
[38] Calvano et al. (2020) p.3269

### Agreement and Evidential Framework

The second issue raised by the framework's reliance on the "agreement" as a mechanism is that it creates a focus on identifying communication between competitors[39] to form agreements. As a result, the evidential framework under current law relies on signs of communication. In the case law, competition authorities often discharge their burden of proof by finding evidence of communication between parties, such as in *T-Mobile Netherlands BV and Others* (2009), where competitors held a meeting and exchanged confidential information. That meeting was used as proof of collusion.[40] This form of physical, actual communication is absent when AI colludes, making the current evidential framework of proof of communication impossible when applied to AI.

## Solutions

So, how should the law change when faced with this form of AI? There are three approaches to the matter.

### Change in Legal Principle

First, the law should establish that the use of price algorithms comes with strict liability. This means there is no need for a finding of "non-compliance or defect or malperformance" for a business to be found liable for the behaviours of its algorithms. Instead, courts must only find that the algorithm caused the anticompetitive outcome[41]. This solves two issues inherent in the current form of liability: (1) that it is nearly impossible to prove the "intent" of AI, and the developers of the algorithms may not

[39] Gal (2019) p.101
[40] *T-Mobile Netherlands BV and others* (2009) at [12] and [62].
[41] Wenderhorst (2020)

have intended the algorithm to act this way either;[42] and (2) that an "agreement" is required, when such algorithms do not require agreements to collude. Firms should thus be held accountable for any anticompetitive effects derived from its algorithms, even if unintended or undesigned, so there is no need to find evidence of communication or an "agreement".

As for how this could be worked into law, a framework such as Hennemann's (2020) could be used. He considers that for firms to be held liable, there is a need for the system's behaviour being "attributable to the respective undertaking". He proposes that AI systems can be considered the functional equivalent of an employee entrusted with the conclusion of agreements. Under this framework, "AI systems can be traced back to a specific human decision by an employee within the undertaking". Thus, firms will bear the liability for the anticompetitive actions undertaken by AI systems.[43] By implementing Hennemann's proposed framework, liability for AI will be stricter and clearer, improving the legal tools for competition authorities to prosecute firms when their algorithms adopt anticompetitive practices.

**New Monitoring Techniques**

Besides a stricter, clearer legal framework, competition authorities may also consider using AI to monitor markets. With near undetectable collusive algorithms, a suspicion may be prominent, but a lack of evidence would discourage authorities from prosecuting such anticompetitive practices. Thus, competition authorities could consider implementing AI in their monitoring framework. This could provide investigative efficiencies, processing greater amounts of data across markets, identifying market trends swiftly. AI, being far superior compared to human intelligence

[42] Ezrachi and Stucke (2016) pp.77-78
[43] Hennemann (2020) pp.376-377

in processing large sets of data, quickly, accurately and reliably[44], puts it in a far better position to monitor prices and other observable market parameters than humans. Doing so would help competition authorities find early indicators of anticompetitive practices, conduct more targeted investigative processes, and gather more evidence.[45]

Since 2006, algorithms have been used in South Korea to detect bidding anomalies and suspicious bidding patterns across large data sets, to detect cases of bid rigging.[46] Vadász et. al (2017)[47] have also created an algorithm capable of flagging out suspicions of cartel behaviour, identifying cartel cases yet unknown to the Hungarian Cartel Office. Hopefully, as AI improves and the implementation costs decrease further, such monitoring technologies will get better and cheaper.

**Testing Framework**

Ideally, competition authorities would be able to test the pricing algorithms of firms[48] with access to its properties, and thereafter evaluate its capability for anticompetitive behaviour. However, companies jealously guard their trade secrets, such as proprietary pricing software, and this reluctance to share their information with authorities will lead to resistance. Furthermore, the underlying goals of competition law, one of which is to enhance economic efficiency,[49] must be considered during policymaking. Introducing strict testing programmes may instead introduce economic inefficiencies, discouraging firms from innovating. Lastly, the opacity of the workings

[44] Korteling et al. (2021).
[45] Bonin and Malhi (2020) p.2
[46] OECD (2016)
[47] Vadász et al. (2016)
[48] As Harrington (2017) suggested at pp.56-63
[49] Khoo and Sng (2019) pp.68-69.

of machine learning technologies act as another barrier to examining price algorithms.[50]

Hence, another approach would be to adopt a research programme.[51] In this programme, competition authorities would create a "simulated market setting"[52] to test price algorithms. This programme would identify the properties present in algorithms that produce supracompetitive prices, and the properties absent when competitive prices are produced. This would help lay out a set of prohibited price algorithms.

Lastly, a regulatory sandbox for algorithms could be implemented. Financial regulators around the world, including in Singapore,[53] have implemented regulatory sandboxes, where firms can test new technology and products in an environment with relaxed regulations. In the process of experimentation, regulators provide guidance to firms to align with regulations, while regulators themselves gain insight as to how to regulate innovative products.[54] This sandbox framework can be adopted for price algorithms, containing the possible anticompetitive effects of such technology while ensuring regulation facilitates rather than stifles innovation.

## Conclusion

Singapore has a history of adopting commercial legislation from the United Kingdom[55] including its Competition Act 2004. However, Singapore is now in a unique position to be a leader in this field of law.

[50] Hassenfeld (2023)
[51] Harrington (2017) pp.64-68
[52] Harrington (2017) pp.66-67
[53] Monetary Authority of Singapore (n.d.)
[54] Federal Ministry for Economic Affairs and Climate Action (n.d.)
[55] Khoo and Sng (2019) p.70.

Owing to her small size, and her reliance on large overseas firms entering the country,[56] oligopolies and duopolies are more frequent in Singapore than in a large country with fragmented markets like the United States. This is both a challenge and an opportunity in the context of algorithms that tacitly collude. Such models collude best with fewer firms[57] and with better information on their competitors,[58] but this means the CCCS is itself ripely positioned to seize on this opportunity to become a leader in competition and consumer protection laws to adapt to the possibility of an AI dominated market, owing to its better information on firms throughout our island state and tighter enforcement capabilities than its European and American counterparts.

(2,499 words with footnotes.)

[56] The World Bank (n.d.). Singapore's Foreign Direct Investment as percentage of GDP is 30.8%, as compared to USA's 1.5%.
[57] See Calvano et al. (2020) pp. 3288-3299, where more players decreased profit.
[58] See Ittoo and Petit (2017) pp.11-12, for their criticisms on the AI collusion model, and its requirement of non-public information.

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