ALGORITHMIC COLLUSION AND AUSTRALIAN COMPETITION LAW: TROUBLE AHEAD FOR THE NATIONAL ELECTRICITY MARKET?

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This article explores the interaction between the National Electricity Law and potential algorithmic collusion in the National Electricity Market ('NEM'). Reviewing the current state of Australian competition law, this article concludes that the law does not prohibit algorithmic collusion in the NEM, even though such collusion has serious ramifications for Australian consumers. Despite recent hesitancy to addressing algorithmic collusion, this article argues we cannot afford to 'wait and see' and proposes nuanced solutions that appropriately address algorithmic collusion in the NEM. These solutions include a notification regime, a reduction in bidding transparency, and a novel definition to 'concerted practice' that would ensure competition law captures tacit and autonomous algorithmic collusion. More generally, the approach in this article highlights the need for market-specific analysis of algorithmic collusion, particularly as the competitive impact of using algorithmic technology depends on the circumstances in which the algorithm is deployed.

> But what happens if an artificially intelligent robot engages in sustained collusion with another robot, either through the "predictable agent" or "autonomous machine" scenarios posted by Stucke and Ezrachi. My answer is … *let's wait and see.*[1]
>
> – Rod Sims, Chairman of the Australian Competition and Consumer Commission, 2017

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1 Rod Sims, 'The ACCC's Approach to Colluding Robots' (Speech, Can Robots Collude? Conference, 16 November 2017) <https://www.accc.gov.au/speech/the-accc%E2%80%99s-approach-to-colluding-robots> (emphasis added).

I INTRODUCTION

Algorithmic technology has provided many benefits to markets. Often used in digital spaces, algorithms have increased transparency and efficiency, and have decreased the cost of human capital.[2] Alongside the growth of big data, algorithmic technology's greatest power has been its ability to quickly collect, organise, and analyse large datasets to optimise decision-making processes.[3]

Competition regulators[4] and scholars[5] have nevertheless identified a burgeoning risk of collusion through the use of algorithmic technology. Indeed, there have already been decided cases involving collusion with algorithmic technology. For example, *United States v Topkins* ('*US v Topkins*')[6] involved a breach of the *Sherman Antitrust Act*[7] where sellers implemented a collusive arrangement through similar pricing algorithms deployed on the Amazon Marketplace.[8] The algorithms identified the lowest price set by non-colluding sellers and then set all colluding sellers' prices slightly below that identified price.[9] Topkins was sentenced to three years' probation and fined USD20,100.[10]

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2 See generally Michal S Gal, 'Algorithms as Illegal Agreements' (2019) 34(1) *Berkeley Technology Law Journal* 67, 70.

3 See ibid 78–9; Antonio Capobianco, Pedro Gonzaga and Anita Nyeső, *Algorithms and Collusion: Competition Policy in the Digital Age* (Report, June 2017) 18 <https://www.oecd.org/competition/algorithms-and-collusion.htm>.

4 See, eg, Sims (n 1); Margrethe Vestager, 'Algorithms and Competition' (Speech, Bundeskartellamt 18th Conference on Competition, 16 March 2017) <https://wayback.archive-it.org/12090/20191129221651/https://ec.europa.eu/commission/commissioners/2014-2019/vestager/announcements/bundeskartellamt-18th-conference-competition-berlin-16-march-2017_en> ('Algorithms and Competition Speech'); Capobianco, Gonzaga and Nyeső (n 3).

5 See, eg, Ariel Ezrachi and Maurice E Stucke, *Virtual Competition: The Promise and Perils of the Algorithm-Driven Economy* (Harvard University Press, 2016) ('*Virtual Competition*'); Gal (n 2); Joseph E Harrington, 'Developing Competition Law for Collusion by Autonomous Artificial Agents' (2018) 14(3) *Journal of Competition Law & Economics* 331; Salil K Mehra, 'Antitrust and the Robo-Seller: Competition in the Time of Algorithms' (2016) 100(4) *Minnesota Law Review* 1323; Emilio Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (2019) 55(1) *Review of Industrial Organization* 155; Rob Nicholls and Brent Fisse, 'Concerted Practices and Algorithmic Coordination: Does the New Australian Law Compute?' (2018) 26(1) *Competition and Consumer Law Journal* 82; Stephanie Assad et al, 'Algorithmic Pricing and Competition: Empirical Evidence from the German Retail Gasoline Market' (Working Paper No 8521, CESifo, August 2020); Zach Y Brown and Alexander MacKay, 'Competition in Pricing Algorithms' (Working Paper No 20-067, Harvard Business School, 29 April 2021); Emilio Calvano et al, 'Artificial Intelligence, Algorithmic Pricing, and Collusion' (2020) 110(10) *American Economic Review* 3267; Alexander Stewart-Moreno, 'EU Competition Policy: Algorithmic Collusion in the Digital Single Market' [2020] (Spring) *York Law Review* 49; Barbora Jedličková, 'Digital Polyopoly' (2019) 42(3) *World Competition* 309.

6 *United States v Topkins* (ND Cal, CR 15-00201-001 WHO, 22 March 2017) (Orrick J). See also Department of Justice (US), 'Plea Agreement', Plea Agreement in *United States v Topkins* (ND Cal, No CR 15-00201 WHO, 30 April 2015) <https://www.justice.gov/atr/case-document/file/628891/download> ('*US v Topkins* Plea Agreement').

7 15 USC §1 (2012 & Supp 2017).

8 *US v Topkins* Plea Agreement (n 6) 4 [4].

9 Ibid.

10 *United States v Topkins* (ND Cal, No CR 15-00201-001 WHO, 22 March 2017) (Orrick J).

Ezrachi and Stucke[11] identified that algorithmic technology can increase the risk of tacit collusion (the 'Predictable Agent' scenario)[12] or lead to algorithms autonomously learning to coordinate and set collusive prices (the 'autonomous machine scenario').[13] Notably, these forms of algorithmic collusion do not require communication between the parties but the outcome, namely sustained supracompetitive prices, is the same as if communication to form a collusive agreement had occurred.[14]

Some scholars suggest tacit and autonomous algorithmic collusion are not causes for concern.[15] For example, Schwalbe argues that widespread algorithmic collusion cannot eventuate without communication[16] and is limited to markets exhibiting particular characteristics[17] including high market concentration, high transparency,[18] high barriers to entry,[19] homogenous goods,[20] and frequent transactions.[21] Accordingly, Schwalbe argues that 'algorithmic collusive behaviour is not as likely or even unavoidable as some legal scholars seem to suspect'.[22]

The National Electricity Market ('NEM') is Australia's largest interconnected power system. Although not truly national, it supplies 10 million consumers across Queensland, New South Wales, Victoria, South Australia, Tasmania and the Australian Capital Territory.[23] It includes a wholesale spot market for electricity

11 Ezrachi and Stucke, *Virtual Competition* (n 5); Ariel Ezrachi and Maurice E Stucke, 'Artificial Intelligence & Collusion: When Computers Inhibit Competition' [2017] (5) *University of Illinois Law Review* 1775.

12 Ezrachi and Stucke, *Virtual Competition* (n 5) 36–7.

13 Ariel Ezrachi and Maurice E Stucke, 'Artificial Intelligence & Collusion: When Computers Inhibit Competition' [2017] (5) *University of Illinois Law Review* 1775, 1783–4, cited in Ulrich Schwalbe, 'Algorithms, Machine Learning, and Collusion' (2018) 14(4) *Journal of Competition Law & Economics* 568, 574. See also Ezrachi and Stucke, *Virtual Competition* (n 5) 71.

14 See, eg, Ariel Ezrachi and Maurice E Stucke, 'Sustainable and Unchallenged Algorithmic Tacit Collusion' (2020) 17(2) *Northwestern Journal of Technology and Intellectual Property* 217, 220–1.

15 See, eg, Ulrich Schwalbe, 'Algorithms, Machine Learning, and Collusion' (2018) 14(4) *Journal of Competition Law & Economics* 568; Cento Veljanovski, 'Pricing Algorithms as Collusive Devices' (Working Paper, Case Associates, 6 July 2020) 1–2 <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3644360>; Thibault Schrepel, 'The Fundamental Unimportance of Algorithmic Collusion for Antitrust Law', *Jolt Digest* (Web Page, 7 February 2020) <http://jolt.law.harvard.edu/digest/the-fundamental-unimportance-of-algorithmic-collusion-for-antitrust-law>.

16 Schwalbe (n 15) 592.

17 Ibid 590–1.

18 Maurice E Stucke and Ariel Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' in Woodrow Barfield and Ugo Pagallo (eds), *Research Handbook on the Law of Artificial Intelligence* (Edward Elgar Publishing, 2018) 624, 628–9; Gal (n 2) 73, citing George J Stigler, 'A Theory of Oligopoly' (1964) 72(1) *Journal of Political Economy* 44, 44–6.

19 Gal (n 2) 73–4, citing Robert C Marshall and Leslie M Marx, *The Economics of Collusion: Cartels and Bidding Rings* (MIT Press, 2012); Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 630.

20 Schwalbe (n 15) 590–1.

21 Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 630.

22 Schwalbe (n 15) 599.

23 Australian Energy Regulator, *State of the Energy Market 2020* (Report, 2020) 70.

supply to participating jurisdictions[24] and a market for ancillary services.[25] It is governed by the *National Electricity Law* ('*NEL*'),[26] a South Australian statute with equivalent counterparts in each participating jurisdiction.[27] Under the *NEL*, the Australian Energy Market Commission ('AEMC') is the rule-maker for the NEM.[28] These rules are collectively known as the *National Electricity Rules* ('*NER*')[29] and have the force of law in participating jurisdictions.[30] The NEM is regulated by the Australian Energy Regulator ('AER') and operated by the Australian Energy Market Operator ('AEMO').

The *NER* prescribe many characteristics that increase a market's susceptibility to tacit or autonomous algorithmic collusion.[31] The recent 5-minute settlement rule change, which will increase the frequency of transactions from 48 to 288 transactions per day,[32] may further raise the likelihood of algorithmic collusion once it comes into effect.[33] Moreover, these characteristics greatly increase the probability that market generators will use algorithmic technology to bid in the NEM. For example, AMS, a US-based third-party software provider, specifically targets generators in the NEM with its artificial intelligence technology.[34] Other generators are already using learning algorithm technology.[35]

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24 Australian Electricity Market Commission, 'Fact Sheet: How the Spot Market Works' (Fact Sheet, 11 April 2017); Darryl R Biggar and Mohammad Reza Hesamzadeh, *The Economics of Electricity Markets* (John Wiley & Sons, 2014) 85–6.

25 Australian Energy Market Operator, 'Guide to Ancillary Services in the National Electricity Market' (Guide, April 2015) <https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/ancillary_services/guide-to-ancillary-services-in-the-national-electricity-market.pdf>; Biggar and Hesamzadeh (n 24) 86.

26 *National Electricity (South Australia) Act 1996* (SA) sch National Electricity Law ('*National Electricity Law*').

27 *National Electricity (South Australia) Act 1996* (SA); *Electricity (National Scheme) Act 1997* (ACT); *National Electricity (New South Wales) Law (No 20a) 1997* (NSW); *National Electricity (Queensland) Law 2005* (Qld); *National Electricity (Tasmania) Law 1999* (Tas); *National Electricity (Victoria) Act 2005* (Vic).

28 *National Electricity Law* s 34(1).

29 Australian Energy Market Commission, *National Electricity Rules* (at 1 September 2021) ('*National Electricity Rules*'). See also ibid.

30 *National Electricity L*aw s 9.

31 See generally Biggar and Hesamzadeh (n 24).

32 See generally Australian Energy Market Operator, 'What Is 5-Minute Settlement?' (Fact Sheet, 2020) 2 <https://www.aemo.com.au/-/media/files/electricity/nem/5ms/program-information/2021/5ms-factsheet.pdf?la=en&hash=694750BCF9B48848052908301C30607E>. Due to the COVID-19 pandemic, the start of the 5-minute settlement rule change was delayed and is now due to begin on 1 October 2021: Australian Energy Market Commission, 'Rule Change Request Submitted on Five-Minute Settlement Contingency Plan' (Media Release, 5 August 2021) <https://www.aemc.gov.au/news-centre/media-releases/rule-change-request-submitted-five-minute-settlement-contingency-plan>.

33 See Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 630.

34 'Australia NEM', *AMS* (Web Page, 2020) <https://www.advancedmicrogridsolutions.com/solution-australia-nem>.

35 See, eg, 'Autobidder', *Tesla* (Web Page, 2020) <https://www.tesla.com/en_AU/support/autobidder>; PROS, 'Digital Transformation in Energy and Chemical Industries', *Energy & Chemicals* (Web Page, 2021) <https://pros.com/industries/chemicals-energy/>.

The cost of tacit or autonomous algorithmic collusion in the NEM would be significant. In 2019, the NEM traded AUD18.6 billion.[36] The ACCC found that wholesale electricity costs were the second-largest contributor to the increase in residential customer bills from 2007–08 to 2017–18.[37] Economists have recently estimated that the adoption of algorithmic-pricing software in the German retail gasoline market led to average margin increases of 9% to 28%.[38] It follows that algorithmic collusion could mean significantly higher electricity bills for the 10 million consumers the NEM serves.[39]

Does the *Competition and Consumer Act 2010* (Cth) (the '*Act*') prohibit such behaviour in the NEM? Reviewing current Australian case law on the price-fixing prohibitions,[40] the misuse of market power prohibition,[41] and the likely avenues for judicial interpretation of the new concerted practices prohibition,[42] this article concludes that Australian competition law does not adequately prohibit tacit or autonomous algorithmic collusion.[43] Australian case law relies on communication to prove prohibited concerted behaviour and the misuse of market power prohibition has been interpreted as targeting unilateral conduct.[44] Because tacit and autonomous collusion can occur without communication and likely falls short of prohibited unilateral conduct, there remains an ever-growing lacuna in Australian competition law to the potential detriment of consumers.

How should Australian competition law limit collusive conduct and protect Australian consumers? Given algorithmic technology can also provide pro-competitive benefits to the NEM, intervention must be sufficiently nuanced. Widespread prohibition of algorithmic technology is inappropriate because it could preclude the realisation of these pro-competitive benefits.[45]

In seeking to address tacit and autonomous algorithmic collusion, this article establishes two criteria that must be met:

1. Intervention must prevent the anti-competitive potential of algorithms in the NEM without substantially compromising their potential pro-competitive benefits;[46] and
2. Intervention must balance business certainty against the reach of a legislative solution.[47]

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36 *State of the Energy Market 2020* (n 23) 70.

37 Australian Competition and Consumer Commission, *Restoring Electricity Affordability and Australia's Competitive Advantage: Retail Electricity Pricing Inquiry* (Final Report, June 2018) v, vi ('*REPI Final Report*').

38 Assad et al (n 5) 4–5.

39 *State of the Energy Market 2020* (n 23) 70.

40 *Competition and Consumer Act 2010* (Cth) pt IV.

41 Ibid s 46.

42 Ibid s 45(1)(c).

43 See also Nicholls and Fisse (n 5).

44 *ASX Operations Pty Ltd v Pont Data Australia Pty Ltd [No 1]* (1990) 27 FCR 460, 475 (The Court), cited in *Seven Network Ltd v News Ltd* (2009) 182 FCR 160, 360 [882] (Dowsett and Lander JJ).

45 Schwalbe (n 15) 598.

46 See Harrington (n 5) 359; Gal (n 2) 112.

47 See, eg, Nicholls and Fisse (n 5) 86.

Intervention in the NEM could occur through the *NER* or the *Act*, but must meet the object of its empowering Act.[48]

Using these criteria, this article proposes a tripartite solution which should be implemented to mitigate the anti-competitive harm of tacit and autonomous algorithmic collusion in the NEM:

1. A notification regime should be implemented to allow a regulator to stay abreast of the use of algorithmic technology in the NEM, similar to the notification regime in place for conduct like resale price maintenance;[49]
2. As a preventative measure, transparency over specific bids should be reduced to mitigate the likelihood of tacit or autonomous algorithmic collusion; and
3. A novel definition of 'concerted practice', which builds on the work of Kaplow[50] and European case law,[51] should be adopted to capture tacit and autonomous algorithmic collusion without compromising business certainty or the pro-competitive benefits of algorithmic technology. Although such a definition would likely require new legislation as it is not necessarily supported by the anticipated judicial interpretation of 'concerted practice',[52] it demonstrates the possibility of a suitably nuanced legal solution for tacit and autonomous algorithmic collusion in the NEM.

More generally, the market-specific approach in this article highlights an important pathway for analysing tacit or autonomous algorithmic collusion in future, despite the uncertainty around its widespread occurrence. The competitive impact of algorithmic technology depends on the circumstances within which it is deployed. This means that further market-specific analysis of algorithmic collusion is required before a uniform approach to intervention can be adopted.

Part II briefly outlines two different types of algorithmic technology that can be deployed in the NEM. Part III explores the interaction between the *NER* and the deployment of these algorithmic technologies in the NEM. It examines the pro- and anti-competitive impacts of these algorithmic technologies and concludes that the *NER* prescribe a market highly susceptible to tacit and autonomous algorithmic

48 See *Competition and Consumer Act 2010* (Cth) s 2; *Boral Besser Masonry Ltd v Australian Competition and Consumer Commission* (2003) 215 CLR 374, 429 [159] (Gaudron, Gummow and Hayne JJ) ('*Boral Besser*'); *National Electricity Law* s 7.

49 See, eg, *Competition and Consumer Act 2010* (Cth) pt VII div 2 sub-div A; *Competition and Consumer Regulations 2010* (Cth) r 9.

50 Louis Kaplow, *Competition Policy and Price Fixing* (Princeton University Press, 2013). But see Richard A Posner, 'Review of Kaplow, *Competition Policy and Price Fixing*' (2014) 79(2) *Antitrust Law Journal* 761.

51 See *'Eturas' UAB v Lietuvos Respublikos konkurencijos taryba* (Court of Justice of the European Union, C-74/14, ECLI:EU:C:2016:42, 21 January 2016) ('*Eturas*').

52 See Michael Gvozdenovic, 'Concerted Practices and Statutory Interpretation: An Affirmation of the Jurisprudence on "Contracts, Arrangements and Understandings"' (2019) 26(3) *Competition and Consumer Law Journal* 213; Rob Nicholls and Deniz Kayis, 'Concerted Practices Contested: Evidentiary Thresholds' (2017) 25 *Competition and Consumer Law Journal* 125; Russel Victor Miller, *Miller's Australian Competition and Consumer Law Annotated* (Law Book Co of Australasia, 41st ed, 2019) 361–3 [CCA.45.90]; Arlen Duke, *Corones' Competition Law in Australia* (Law Book Co of Australasia, 7th ed, 2019) 421–6 [7.260]–[7.270].

collusion. Part IV investigates whether the *Act* adequately prohibits algorithmic collusion in the NEM. Part V establishes the criteria for optimal intervention in the NEM to prohibit tacit and autonomous algorithmic collusion. Part VI, using the criteria in Part V as its analytical framework, proposes a tripartite solution to preventing and prohibiting the anti-competitive behaviour of algorithms in the NEM. Part VII concludes.

II A BRIEF OVERVIEW: ADAPTIVE AND LEARNING ALGORITHMS

Algorithms are a set of instructions, solved by calculations or other problem-solving operations, that lead to a decision based on some pre-defined goal.[53] For example, the decision could be prices ('pricing algorithms') or bids ('bidding algorithms') while the goal could be profit or market share.

Market generators in the NEM are likely to adopt bidding algorithms to maximise profit. These could be developed in-house or purchased from a third-party supplier.[54] These algorithms generally involve optimising a market generator's bids based on real-time demand and the cost of generation.[55] However, while algorithms that directly set price are given a different title to those that set bids, the more relevant distinction is the type of underlying technology that is utilised.[56] This is because the same process of optimisation can be used for both pricing and bidding decisions.[57] Moreover, under certain electricity demand and supply conditions, some or all generators have the ability to influence the price they – and other generators – receive by altering their bids.[58]

The algorithm's process of optimisation depends on the underlying technology deployed.[59] While this technology can vary considerably in its level of sophistication,[60] scholars have generally placed algorithmic technology into one of two categories: 'adaptive' or 'learning'.[61] Both could be deployed in the NEM.

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53 See Gal (n 2) 77.

54 See, eg, 'Australia NEM' (n 34); 'Autobidder' (n 35).

55 See generally Biggar and Hesamzadeh (n 24) 122.

56 See Gal (n 2) 78; Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5) 158–61.

57 See generally Tom M Mitchell, *Machine Learning* (McGraw-Hill, 1997); Christopher Watkins and Peter Dayan, 'Q-Learning' (1992) 8(3–4) *Machine Learning* 279; Ludo Waltman and Uzay Kaymak, 'Q-Learning Agents in a Cournot Oligopoly Model' (2008) 32(10) *Journal of Economic Dynamics and Control* 3275.

58 Biggar and Hesamzadeh (n 24) 282–3.

59 See, eg, Gal (n 2) 78; Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5) 158–61.

60 Gal (n 2) 78; Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5) 158–61.

61 See Gal (n 2) 78; Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5)158–61.

A Adaptive Algorithms

Simpler algorithms are adaptive, that is, they are sets of instructions that dictate appropriate responses to defined circumstances.[62] For example, an adaptive algorithm could involve pricing X% above a competitor's price. The adaptive algorithm makes a decision, based on its instructions, after observing relevant information in the marketplace.[63]

Adaptive pricing algorithms have already been used to facilitate explicit cartel arrangements. In addition to the earlier example of *US v Topkins*, the United Kingdom ('UK') Competition Markets Authority ('CMA') found in the *Online Sales of Posters and Frames* case ('*Frames* Case')[64] that two companies were using adaptive algorithms to facilitate horizontal price-fixing arrangements when selling posters and frames on the Amazon Marketplace. In accordance with their prior arrangement, the adaptive algorithms monitored the prices of competitors on the Amazon Marketplace, and then either set prices '25p below other sellers' or matched the other collusive seller's price where it was the lowest.[65] Evidence submitted to the CMA stated that pricing algorithms were adopted because monitoring and manually adjusting prices on a daily basis in accordance with the cartel arrangement was a laborious, time-consuming, and expensive exercise.[66]

B Learning Algorithms

More sophisticated algorithms deploy machine learning technology. Rather than specifying a problem and instructing the algorithm how to solve it, machine learning technology requires the algorithm to solve the problem from experience.[67] In reinforcement learning (a type of machine learning), algorithms gain this experience by experimenting with strategies that are potentially sub-optimal in the current circumstances.[68] Experimenting may mean sacrificing profits in the short-term. In the long-term, however, the algorithm 'learns' optimal responses to more situations, potentially maximising profits over time.[69]

Q-learning algorithms are relatively simple examples of reinforcement learning algorithms, often deployed to solve pricing problems.[70] In general terms, a Q-learning algorithm works by choosing between 'exploiting' the current strategy

62 Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5) 158–60; Gal (n 2) 78.

63 See, eg, Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5) 158.

64 *Online Sales of Posters and Frames* (Competition and Markets Authority, Case 50223, 12 August 2016) <https://assets.publishing.service.gov.uk/media/57ee7c2740f0b606dc000018/case-50223-final-non-confidential-infringement-decision.pdf> ('*Frames* Case').

65 Ibid 27 [3.69].

66 Ibid 26 [3.66].

67 See generally Mitchell (n 57); Gal (n 2) 78.

68 Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5) 160.

69 69 Ibid.

70 See ibid 161–2.

or 'experimenting' with new strategies.[71] The rate at which the Q-learning algorithm exploits or experiments is determined by the programmer.[72]

To solve a profit-maximisation problem:

1. The Q-learning algorithm observes any relevant information (as defined by the programmer) such as market demand or price.[73]
2. It randomly chooses (at a rate determined by the programmer) to exploit or experiment:
   - If exploiting, it will maximise profits based on the observed information; or
   - If experimenting, it will test a strategy randomly.[74]
3. The algorithm collects the resulting profits from its exploitation or experimentation and updates its learned optimal strategy.[75]

If experimenting produced a more profitable outcome, the Q-learning algorithm is more likely to adopt that strategy in the next exploitation iteration of the problem.[76] The algorithm, therefore, learns the optimal strategy over numerous iterations.[77]

Learning algorithms are already used in online industries. For example, Uber utilises a learning algorithm to dynamically price trips based on many variables.[78] In *Samir Agrawal vs ANI Technologies Pvt Ltd*,[79] the Competition Commission of India ('CCI') considered whether Uber's dynamic pricing algorithm facilitated price-fixing behaviour amongst its drivers.[80] The CCI ultimately found that Uber did not breach Indian competition law because there was no underlying arrangement between the Uber drivers to price fix.[81] This was despite the ultimate effect of the learning algorithm being the same as if there had been such an arrangement.

III THE PROBLEM: WHEN ALL RULES LEAD TO ROME

This part explores the interaction between the *NER* and algorithmic technologies in the NEM. It begins with an overview of the NEM, analysing the pro- and anti-competitive impacts of algorithmic technologies in the NEM. It then establishes that the *NER* prescribe a market which is highly susceptible to algorithmic collusion. Despite scepticism regarding the widespread occurrence of algorithmic

71 Ibid 163.
72 Ibid.
73 Ibid.
74 Ibid.
75 Ibid.
76 Ibid.
77 See, eg, Watkins and Dayan (n 57); Waltman and Kaymak (n 57).
78 See Uber, 'How Uber's Dynamic Pricing Model Works', *Uber Blog* (Blog Post) <https://www.uber.com/en-GB/blog/uber-dynamic-pricing/>.
79 *Samir Agrawal vs ANI Technologies Pvt Ltd* (Competition Commission of India, Case No 37 of 2018, 6 November 2018).
80 See ibid [3].
81 Ibid [15].

collusion,[82] this article concludes that the impact of algorithmic collusion in the NEM has serious potential ramifications for its 10 million end-consumers, namely, substantially higher electricity bills.[83]

A The NEM

The NEM includes Australia's largest wholesale electricity spot market, supplying Queensland, New South Wales, Victoria, South Australia, Tasmania, and the Australian Capital Territory.[84] In 2019, the NEM supplied 205.5TWh of electricity to 10 million customers[85] through 89 authorised electricity retailers.[86] Electricity in the NEM is generated by 268 large generating units.[87] However, these are owned by a small pool of wholesale electricity suppliers, suggesting high market concentration.[88]

The NEM is unique in that the physical and financial markets for electricity are heavily intertwined.[89] The physical electricity system requires that supply and demand must constantly be in equilibrium.[90] Insufficient supply can lead to load-shedding or blackouts.[91] Excess supply can lead to a destabilisation of the physical assets of the grid.[92] Consequently, the spot price fluctuates in real-time to ensure supply is balanced with demand.[93] Where it is not balanced, the NEM's Frequency Control Ancillary Services ('FCAS') markets can provide rapid responses to restore stability.[94]

The NEM is operated by the AEMO[95] and regulated by the AER[96] in accordance with the *NEL*,[97] a South Australian statute replicated in each jurisdiction relying

82 See, eg, Schwalbe (n 15) 599.
83 *State of the Energy Market 2020* (n 23) 70.
84 Ibid.
85 Ibid.
86 Ibid 237.
87 Ibid 70.
88 See *REPI Final Report* (n 37) vii. See also *State of the Energy Market 2020* (n 23) 83–4.
89 'Fact Sheet: How the Spot Market Works' (n 24) 1.
90 See Biggar and Hesamzadeh (n 24) 215; 'Fact Sheet: How the Spot Market Works' (n 24); Australia Electricity Market Operator, 'Fact Sheet: The National Electricity Market' (Fact Sheet, 28 July 2020) 3–4 <https://aemo.com.au/-/media/files/electricity/nem/national-electricity-market-fact-sheet.pdf>; Australian Energy Market Operator, 'Guide to Ancillary Services in the National Electricity Market (Media Release, April 2015) 5 <https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/ancillary_services/guide-to-ancillary-services-in-the-national-electricity-market.pdf>.
91 Australian Energy Market Operator, 'Fact Sheet: Explaining Load Shedding' (Fact Sheet, 3 January 2020) <https://aemo.com.au/en/learn/energy-explained/energy-101/explaining-load-shedding>.
92 See Biggar and Hesamzadeh (n 24) 60–1; 'Fact Sheet: The National Electricity Market' (n 90) 4.
93 'Fact Sheet: How the Spot Market Works' (n 24) 2; 'Fact Sheet: The National Electricity Market' (n 90) 3.
94 See Biggar and Hesamzadeh (n 24) 232–3.
95 *State of the Energy Market 2020* (n 23) 70–1.
96 Ibid 72. See also *Competition and Consumer Act 2010* (Cth) pt IIIAA.
97 *National Electricity Law*.

on the NEM.[98] The *NEL* provides that the AEMC can make rules regulating the functioning of the NEM.[99] These are known as the *NER*.[100]

B The *National Electricity Rules*

The *NER* seek to promote the objective of the *NEL*, that is:[101]

> to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to–
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system.

The *NER* effectively prescribe the features and characteristics of the NEM. Relevantly, these rules, which have the force of law in participating jurisdictions,[102] include rules on supply, prices, and bids.

1 Supply ('dispatch')

The physical supply of electricity to the NEM is called 'dispatch'.[103] Market generators dispatch electricity to the NEM when instructed by AEMO.[104] Dispatch occurs in 5-minute intervals (the 'Dispatch Interval') to maintain equilibrium within the physical assets of the grid.[105] Small discrepancies between supply and demand in the wholesale spot market can be met through the FCAS markets[106] which provide rapid responses to restore grid frequency.[107]

AEMO determines the generators who are dispatched to meet demand, based on each generator's dispatch offers ('bids').[108] These bids state available generation capacity at various price bands for each Dispatch Interval.[109] AEMO dispatches the lowest-cost mix of generators to meet electricity demand, taking into account the constraints of the physical transmission network.[110] In the absence of transmission constraints, the dispatch price will be the highest bid in that lowest-cost mix of generators which meet electricity demand.[111]

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98 See *Electricity (National Scheme) Act 1997* (ACT); *National Electricity (New South Wales) Law (No 20a) 1997* (NSW); *National Electricity (Queensland) Law 2005* (Qld); *National Electricity (Tasmania) Law 1999* (Tas); *National Electricity (Victoria) Act 2005* (Vic).

99 *National Electricity Law* s 34(1).

100 *National Electricity Rules*. See also ibid.

101 *National Electricity Law* s 7.

102 Ibid s 9.

103 *National Electricity Rules* ch 10 (definition of 'dispatch').

104 Ibid r 3.8.1.

105 Ibid r 3.8.21(a1).

106 See ibid r 3.11.

107 See ibid r 3.11.2.

108 Ibid r 3.8.1.

109 Ibid r 3.8.6.

110 Ibid r 3.8.1; 'Fact Sheet: How the Spot Market Works' (n 24) 2.

111 'Fact Sheet: How the Spot Market Works' (n 24) 2. See also *National Electricity Rules* r 3.8.1(d).

2 The Spot Price

Due to technological constraints in the creation of the NEM in 1998,[112] the spot price is not the dispatch price. Rather, the spot price is the time-weighted average of the dispatch prices for six 5-minute dispatch intervals (the 'Trading Interval') within a half-hour.[113] All generators dispatched in the same 30-minute Trading Interval receive the same spot price.[114]

There is a recent rule change (the '5-Minute Settlement Rule Change') that will alter this spot price calculation. In 2017, the AEMC determined that the Trading Interval should be reduced to bring it in line with the Dispatch Interval, taking effect on 1 October 2021.[115] This change means the dispatch price will be the spot price. Accordingly, daily bidding intervals are expected to increase from 48 to 288 and AEMO will publish 5-minute data rather than 30-minute data.[116]

3 Bids and Rebids

Market generators can submit rebids to vary their initial bids,[117] which allow them to maximise profit by responding to recent changes in market demand or price. There are only two limitations on rebidding. First, market generators must submit brief reasons for rebids and must not submit rebids which are false or misleading.[118] Second, if market generators rebid within 15 minutes of a Trading Interval, then they must make a contemporaneous record in relation to the rebid that includes details on material circumstances giving rise to the rebid and the reasons for the rebid.[119] Otherwise, market generators are provided significant flexibility to vary bids as desired.[120]

C Trouble Ahead: Algorithmic Technology in the NEM

Algorithmic technology is already present in the NEM. Tesla has deployed its learning algorithmic technology, Autobidder, at the Hornsdale Power Reserve in South Australia.[121] Other market generators appear to use similar technologies.[122] These technologies are readily available for purchase online. For example, AMS,

112 See 'What is 5-Minute Settlement?' (n 32) 1.
113 *National Electricity Rules* r 3.9.2(h), ch 10 (definition of 'trading interval').
114 See 'Fact Sheet: How the Spot Market Works' (n 24) 2.
115 'What is 5-Minute Settlement?' (n 32) 1.
116 Ibid 2.
117 See *National Electricity Rules* r 3.8.22.
118 Ibid r 3.8.22.
119 Ibid r 3.8.22(ca).
120 While rule 3.8.22(a) prevents a generator from changing the price of any price band, rebidding under rule 3.8.22 allows the generator to vary its stated available capacity under any price band: *National Electricity Rules* r 3.8.22(b)(1). Scheduled and semi-scheduled generators are limited to a maximum of 10 price bands: *National Electricity Rules* rr 3.8.6(a)(1), 3.8.6(g). However, as there are no limitations on the available capacity that must be provided under each price band, this bidding regime provides significant flexibility to market generators to vary their bids as desired.
121 'Autobidder' (n 35).
122 Ibid.

a US-based software provider, specifically targets market generators in the NEM with its artificial intelligence technology.[123]

1 The Business Case: Pro-Competitive

For market generators, algorithmic technology can provide significant commercial benefit. As generators are required to submit bids for every Dispatch Interval,[124] algorithms can efficiently optimise the bidding decisions of generators for each Trading Interval using the vast array of public data on the NEM.[125] The short time between each Trading Interval and the fluctuating spot price also mean that algorithms can avoid the high human capital cost of manually bidding and rebidding for each Trading Interval.

These benefits mean it is likely that the use of algorithmic technology in the NEM will grow. As the number of daily bidding intervals increases from 48 to 288 with the 5-Minute Settlement Rule Change,[126] the commercial value of bidding algorithms rises while the ability to manually optimise bids falls.

The commercial benefit of algorithmic technologies also highlights their potential pro-competitive impact when deployed in the NEM. They can reduce the cost of human capital,[127] more efficiently respond to consumer demand,[128] and for companies with a diversified generation portfolio, more efficiently allocate resources.[129] Particularly in the NEM, where bidding occurs frequently and consistently, bidding algorithms can allow market generators to effectively respond to intra-day changes in the electricity market.[130] This can make generators more, rather than less, competitive and can potentially reduce the cost of electricity for end-consumers.

2 Collusion: Anti-Competitive

However, the use of algorithms increases the risk of collusive behaviour. This is because, as discussed in this section, they increase the stability of pre-existing collusive arrangements and increase the risk of tacit and autonomous algorithmic collusion.

The impact of such behaviour in the NEM would be catastrophic for Australian consumers. In 2019, the NEM traded over AUD18 billion of electricity and served 10 million end-consumers.[131] Indeed, the wholesale electricity cost was the second-largest contributor to the increase in residential customer bills from 2007–08 to 2017–18.[132] In their study of algorithmic pricing in the German retail

123 'Australian NEM' (n 34).
124 *National Electricity Rules* r 3.8.6. See also *National Electricity Rules* r 3.8.21(a1).
125 See Gal (n 2) 70; Harrington (n 5) 353.
126 'What is 5-Minute Settlement?' (n 32) 1–2.
127 Gal (n 2) 70.
128 Ibid.
129 See Gal (n 2) 70.
130 See *National Electricity Rules* r 3.8.22; Gal (n 2) 70; Harrington (n 5) 354.
131 *State of the Energy Market 2020* (n 23) 70.
132 *REPI Final Report* (n 37) v, vi.

gasoline market, Assad et al found that the decision to adopt algorithmic-pricing software led to average margin increases between 9% and 28%.[133] At these rates, such an increase in wholesale electricity prices would mean significant increases in electricity bills for Australian consumers.

For the purposes of exploring the interaction between the *NER* and algorithmic collusion, this article generalises algorithmic collusion into two broad categories, depending on the presence or absence of prior communication.[134]

(a) With Prior Communication

Orthodox economics has found that conventional collusion between human agents requires communication, some ability to monitor price, a credible reward-punishment scheme in the event of one firm cheating, and high barriers to entry in the market.[135] Without an ability to monitor prices and a credible reward-punishment scheme, a colluding firm could 'cheat' on the other colluding sellers by lowering their price. As their sales increase, other firms would be incentivised to lower their price, thereby, breaking the cartel arrangement. Without high barriers to entry, a cartel could be broken by a new entrant simply undercutting the prices of the colluding firms.[136]

Algorithms generally do not affect barriers to entry. However, they are more effective at monitoring prices, particularly when prices are publicised online. They can also increase the speed at which a firm punishes another 'cheating' firm.[137] Thus, where prior communication establishes a cartel arrangement, algorithms can increase the stability of this pre-existing cartel arrangement.

For example, in the *Frames* Case,[138] the evidence showed that parties originally attempted to implement the cartel arrangement manually.[139] However, manual pricing proved a 'laborious and time-consuming exercise'.[140] Accordingly, the parties adopted re-pricing software that successfully stabilised the arrangement. The CMA found that the parties had infringed section 2(1) of the *Competition Act 1998* (UK) by participating in an agreement and/or concerted practice to fix prices.[141] This conduct was punished with a financial penalty of GBP163,371 under section 36 of the *Competition Act 1998* (UK), which also took into account mitigating factors such as cooperation[142] and proportionality.[143]

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133 Assad et al (n 5) 4–5. For a survey of the average overcharge resulting from conventional cartels, see also John M Connor and Robert H Lande, 'Cartel Overcharges and Optimal Cartel Fines' in Wayne D Collins (ed), *Issues in Competition Law and Policy* (American Bar Association Section of Antitrust Law, 2008) 2203.

134 Cf Ezrachi and Stucke, 'Sustainable and Unchallenged Algorithmic Tacit Collusion' (n 14); Schwalbe (n 15).

135 Schwalbe (n 15); Harrington (n 5).

136 See Marshall and Marx (n 19) 23.

137 Gal (n 2) 84; Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 629–30.

138 *Frames* Case (n 64).

139 Ibid 19 [3.46].

140 Ibid 26 [3.66].

141 Ibid 4 [1.1].

142 Ibid 84 [6.30]–[6.33].

143 Ibid 84–7 [6.34]–[6.43].

Such conduct can also be subject to criminal prosecution. In *US v Topkins*,[144] the defendant pled guilty to a criminal offence under the *Sherman Antitrust Act*,[145] following an agreement between the parties to adopt a specific pricing algorithm which sought to coordinate the prices of posters for sale on Amazon Marketplace.[146] Topkins was found guilty, fined USD20,100, and sentenced to three years' probation.[147]

(b) Without Prior Communication

Where there is no prior communication, some scholars suggest there cannot be collusion between human agents.[148] Accordingly, they conclude that algorithms are similarly unlikely to coordinate sustained supracompetitive prices.[149]

However, evidence has shown that algorithms can coordinate supracompetitive prices without prior communication. Ezrachi and Stucke[150] identified that algorithmic technology can increase the risk of tacit collusion[151] or can lead to the algorithms autonomously learning to coordinate and set collusive prices.[152] This may even be possible without observing other firms' prices.[153]

(i) Tacit Collusion

Tacit collusion occurs when firms, without communicating, independently set supracompetitive prices, taking into account their competitors' probable reactions to their actions.[154] Byrne and de Roos concluded that the systematic use of prices can be sufficient to form the basis of tacit collusive behaviour[155] and this behaviour is more likely to occur in oligopolistic markets with dominant firms.[156] To illustrate, they showed how BP's price leadership and experiments as the dominant firm in the retail gasoline market in Perth appeared to have 'facilitated a mutual understanding among rivals of a new, profit-enhancing focal pricing structure'.[157]

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144 *United States v Topkins* (ND Cal, No CR 15-00201-001 WHO, 22 March 2017) (Orrick J).
145 *US v Topkins* Plea Agreement (n 6) 3 [2].
146 Ibid 4 [4].
147 *United States v Topkins* (ND Cal, No CR 15-00201-001 WHO, 22 March 2017) (Orrick J).
148 See, eg, Schwalbe (n 15) 570; Veljanovski (n 15) 1–2. But see David P Byrne and Nicolas de Roos, 'Learning to Coordinate: A Study in Retail Gasoline' (2019) 109(2) *American Economic Review* 591.
149 Schwalbe (n 15) 599.
150 Ezrachi and Stucke, *Virtual Competition* (n 5).
151 Ibid 36–7; Gal (n 2) 81–7.
152 Ezrachi and Stucke, *Virtual Competition* (n 5) 71. See also Calvano et al, 'Artificial Intelligence, Algorithmic Pricing, and Collusion' (n 5); Assad et al (n 5); Brown and MacKay (n 5).
153 Recent research suggests that it may be sufficient to instruct one's algorithm to simply observe one's own profits rather than observe the prices of rival firms: see Karsten T Hansen, Kanishka Misra and Mallesh M Pai, 'Algorithmic Collusion: Supra-Competitive Prices via Independent Algorithms' (Discussion Paper No DP14372, Centre for Economic Policy Research, January 2020) 3.
154 Gal (n 2) 74, citing William H Page, 'Tacit Agreement Under Section 1 of the *Sherman Act*' (2017) 81 *Antitrust Law Journal* 593, 601. This is to be distinguished from conventional hub-and-spoke cartels where horizontal competitors (the spokes) communicate through an intermediary (the hub): see, eg, *Eturas* (n 51).
155 Byrne and de Roos (n 148) 617.
156 Ibid 618.
157 Ibid 617.

Similar research has shown tacit collusion is more likely in concentrated markets involving homogenous goods.[158]

Algorithms increase the risk of tacit collusion because the algorithm itself acts as a commitment device containing the firm's pricing strategies.[159] By adopting an algorithm, a firm commits itself to a strategy and increases the predictability of that firm's actions. Through repeated interactions, other firms could potentially 'decode' another firm's algorithm and, therefore, their bidding strategy, allowing them to better anticipate a competitor's reactions to coordinate supracompetitive prices.[160]

An extreme example of this occurring in practice with simple algorithmic technology was seen with the selling of the textbook *The Making of a Fly* on the Amazon Marketplace. One seller deployed an adaptive algorithm dictating a price that is '1.27 times the average price of competitors'[161] while the other seller deployed an adaptive algorithm dictating a price that is '0.9983 times the lowest price of any competitor'.[162] No communication occurred between the sellers and their actions were made independently. The result was that the price of *The Making of a Fly* spiralled upwards, eventually reaching a price of USD23 million.[163] This was not a breach of European competition law as the conduct did not amount to an arrangement or concerted practice.[164]

(ii) Autonomous Algorithmic Collusion

More worryingly, recent research has shown that learning algorithms can autonomously learn to coordinate supracompetitive prices when maximising profits, despite an absence of any instruction to collude or communicate with other algorithms. For example, Calvano et al found that, in a fixed environment with two competing Q-learning algorithms, more than 50% of the time, the algorithms adopted a collusive strategy and charged a supracompetitive price.[165] On average, this resulted in a profit gain ranging from 70% to 90% of the monopoly price.[166]

However, Schwalbe suggests that the results of this research are unlikely to eventuate in actual markets given that market settings are more complicated than the experimental environments adopted.[167] He argues that markets are only susceptible to autonomous algorithmic collusion if they exhibit homogenous

158 See, eg, Ezrachi and Stucke, 'Sustainable and Unchallenged Algorithmic Tacit Collusion' (n 14) 226; Gal (n 2) 85.

159 Gal (n 2) 84–5.

160 Ezrachi and Stucke, 'Sustainable and Unchallenged Algorithmic Tacit Collusion' (n 14) 226, citing Ariel Ezrachi and Maurice E Stucke, 'Algorithmic Collusion: Problems and Counter-Measures' (Note No DAF/COMP/WD(2017)25, OECD Roundtable on Algorithms and Collusion, 31 May 2017) 7, 8.

161 See, eg, Schwalbe (n 15) 574; Marc Wiggers, Robin Struijlaart and Johannes Dibbits, *Digital Competition Law in Europe: A Concise Guide* (Kluwer Law International BV, 2019) 103, citing Margrethe Vestager, 'Algorithms and Competition Speech' (n 4); Nicholls and Fisse (n 5) 100.

162 Schwalbe (n 15) 574.

163 Ibid.

164 Wiggers, Struijlaart and Dibbits (n 161) 103, citing Margrethe Vestager, 'Algorithms and Competition Speech' (n 4).

165 Calvano et al, 'Artificial Intelligence, Algorithmic Pricing, and Collusion' (n 5) 3277–9.

166 Ibid 3277.

167 Schwalbe (n 15) 600.

goods,[168] constant demand,[169] frequent and public pricing,[170] non-frequent entry and exit,[171] and high market concentration.[172]

3 Conclusion: Trouble Ahead

The *NER* prescribe many features of a market susceptible to tacit or autonomous algorithmic collusion. Electricity is generally a homogenous good.[173] The market is highly transparent and involves frequent transactions: AEMO publishes both spot prices and bids online. Pricing will move from 30-minute Trading Intervals to 5-minute Trading Intervals. According to the ACCC, the NEM exhibits high market-concentration[174] and with new generation requiring substantial sunk costs,[175] barriers to entry are high.

These characteristics have been found to facilitate tacit and autonomous algorithmic collusion.[176] Thus, although some scepticism regarding the breadth of tacit and autonomous algorithmic collusion may be warranted,[177] the NEM is clearly susceptible. Indeed, this behaviour could occur either through market generators developing the technology in-house, or by purchasing the technology from a third-party provider.[178]

It is likely the anti-competitive impact of autonomous or tacit algorithmic collusion in the NEM significantly outweighs the potential benefits of algorithmic technology. Collusion in the NEM, whether by algorithms or by humans, would significantly harm the 10 million end-consumers the NEM serves. Given the potential detriment to consumer welfare, we may not be able to afford to 'wait and see'[179] whether the *NER* themselves facilitate tacit or algorithmic collusion.

IV THE PROBLEM THICKENS: AN INADEQUATE COMPETITION LAW

The main object of the *Act* is to enhance the welfare of Australians through the promotion of competition.[180] So does Australian competition law adequately

168 Ibid 590–1.
169 Ibid.
170 Ibid 590.
171 Ibid 591.
172 Gal (n 2) 74.
173 Tim Nelson et al, 'The Changing Nature of the Australian Electricity Industry' (2017) 36(2) *Economic Papers* 104, 104.
174 *REPI Final Report* (n 37) vii. See also *State of the Energy Market 2020* (n 23) 83.
175 See Biggar and Hesamzadeh (n 24) 203.
176 See Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 628–31; Schwalbe (n 15) 590–1; Gal (n 2) 89; Assad et al (n 5); Francisco Beneke and Mark-Oliver Mackenrodt, 'Remedies for Algorithmic Tacit Collusion' (2021) 9(1) *Journal of Antitrust Enforcement* 152, 162.
177 See, eg, Schwalbe (n 15); Harrington (n 5) 346; Veljanovski (n 15) 1–2.
178 See, eg, 'Australia NEM' (n 34); 'Autobidder' (n 35).
179 Cf Sims (n 1).
180 *Competition and Consumer Act 2010* (Cth) s 2; *Boral Besser* (2003) 215 CLR 374, 429 (Gaudron, Gummow and Hayne JJ).

prohibit algorithmic collusion in the NEM? To date, there have been no Australian cases involving algorithmic collusion. Nevertheless, it is probable that algorithmic collusion *with* prior communication is prohibited by the cartel prohibitions. International case law has focussed on the pre-existing communication and arrangement to find prohibited collusive behaviour.[181] The algorithm simply acts as a tool to facilitate the arrangement. Australian case law is likely to adopt a similar approach.[182] This is consistent with current Australian case law which does not assign algorithms agency.[183]

Consequently, this Part analyses whether algorithmic collusion *without* prior communication – that is, tacit and autonomous algorithmic collusion – is adequately prohibited by the *Act*. There are three sets of prohibitions under the *Act* relevant to answering this question:

(i) The cartel prohibitions under Part IV;

(ii) The new concerted practices prohibition under section 45(1)(c); and

(iii) The recently recast misuse of market power prohibition under section 46.

This Part demonstrates that communication is a necessary element for the Part IV cartel prohibitions. Although there have been no decided cases on the concerted practices prohibition, the possible interpretations of section 45(1)(c) show that this prohibition likely requires communication. As tacit and autonomous algorithmic collusion do not require prior communication, it is likely Part IV and section 45(1)(c) do not prohibit such conduct.

Some regulators have suggested tacit or autonomous algorithmic collusion may be subject to the misuse of market power prohibition.[184] Accordingly, this section also considers the possible interpretations of the recast section 46. However, as section 46 targets unilateral conduct that has the purpose, effect, or likely effect of substantially lessening competition, and the unilateral raising of prices has not been considered a breach of previous iterations of section 46, it is unlikely courts would interpret the recast section 46 so expansively as to include the unilateral raising of prices, whether manually or through an algorithm.

This Part concludes that the *Act* does not adequately prohibit tacit or autonomous algorithmic collusion in the NEM. This means that a significant lacuna is rapidly emerging within Australian competition law, which may act to the detriment of end-consumers in the NEM.

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181 See, eg, *United States v Topkins* (ND Cal, No CR 15-00201-001 WHO, 22 March 2017) (Orrick J); '*US v Topkins* Plea Agreement' (n 6); *Frames* Case (n 64).

182 See, eg, *Google Inc v Australian Competition and Consumer Commission* (2013) 249 CLR 435, 459 [68]–[69] (French CJ, Crennan and Kiefel JJ); *Trivago NV v Australian Competition and Consumer Commission* (2020) 384 ALR 496, 559–60 [239]–[242] (the Court), in particular the reference to '*Trivago's Algorithm*'.

183 See, eg, *Google Inc v Australian Competition and Consumer Commission* (n 182); *Trivago NV v Australian Competition and Consumer Commission* (n 182). See also *Thaler v Commissioner of Patents* [2021] FCA 879 [12] where, in the context of the *Patents Act 1990* (Cth), Beach J held that an artificial intelligence system could be an '*inventor*' but not an '*owner, controller or patentee*'.

184 See, eg, Sims (n 1).

A Part IV Cartel Prohibitions

In Australia, cartel offences are prohibited under Part IV of the *Act*. The civil prohibition against creating cartels is found under section 45AJ:

> A corporation contravenes this section if:
>
> (a) The corporation makes a contract or arrangement, or arrives at an understanding; and
>
> (b) The contract, arrangement or understanding contains a cartel provision.

Giving effect to a cartel is proscribed under section 45AK in similar terms. Parallel criminal offences are proscribed under sections 45AF and 45AG. These are worded in the same manner but require an additional fault element of knowledge or belief.[185]

There are three key elements to section 45AJ. First, the corporation must have made a contract or arrangement, or arrived at an understanding. Second, that contract, arrangement or understanding must contain a 'cartel provision'. Third, the parties to that contract, arrangement or understanding must be in competition with one another.

For tacit or autonomous algorithmic collusion, the first two elements are most relevant.[186] Indeed, analysis of the judicial interpretation of 'arrangement' and 'understanding' under Part IV reveals that the cartel prohibitions currently do not encompass tacit or autonomous algorithmic collusion, even if it resulted in sustained supracompetitive pricing, and largely irrespective of whether the technology was developed in-house or by a third-party supplier.[187]

1 Contract, Arrangement or Understanding

(a) Current Position

Australian case law has interpreted 'contract, arrangement, or understanding' as referring to a range of 'consensual dealings'.[188] While 'contract' is given its ordinary common law meaning,[189] the interpretation of 'arrangement' and 'understanding' have been more controversial. Both refer to communication that is less formal than

185 *Competition and Consumer Act 2010* (Cth) ss 45AF(2), 45AG(2).

186 It is assumed in this analysis that market generators are in competition with one another.

187 It is possible that if the same algorithm is provided to multiple competitors and the implementation of that algorithm then leads to supracompetitive pricing, a hub-and-spoke cartel could be established. However, this is distinguishable from tacit and autonomous algorithmic collusion because conventional hub-and-spoke cartels still require *some* communication between the parties (or the parties and the intermediary). Tacit and autonomous algorithmic collusion, on the other hand, do not require *any* communication: see Ezrachi and Stucke, *Virtual Competition* (n 5); see *Eturas* (n 51).

188 *Australian Competition and Consumer Commission v Leahy Petroleum Pty Ltd* (2007) 160 FCR 321, 331 [24] (Gray J) ('*Leahy Petroleum*').

189 See *Hughes v Western Australian Cricket Association (Inc)* (1986) 19 FCR 10, 32 (Toohey J).

a legally binding contract[190] and require a 'meeting of the minds' under which one or both of the parties commit to a course of action.[191]

Although earlier decisions suggested that 'arrangement' and 'understanding' are to be treated synonymously by Australian law,[192] Gray J in *Australian Competition and Consumer Commission v Leahy Petroleum Pty Ltd* ('*Leahy Petroleum*')[193] stated that 'understanding' referred to something less than an arrangement.[194] Although Gray J reached this conclusion in the context of section 45 of the *Trade Practices Act 1974*, a similar view was recently expressed by Bromwich J in *Commonwealth Director of Public Prosecutions v The Country Care Group Pty Ltd (Ruling No 11)*[195] in the context of a criminal cartel matter under section 44ZZRF(1) of the *Competition and Consumer Act 2010* (Cth).[196]

The suggested distinction between an 'arrangement' and an 'understanding' appears to be the level of communication. Perram J, in *Australian Competition and Consumer Commission v Air New Zealand Ltd,*[197] summarised the authorities, concluding that an understanding can be tacit and may arise without communication so long as there is a meeting of the minds.[198] In contrast, the use of the word 'make' in section 45AJ in conjunction with 'contract' and 'arrangement' suggests the need for express communication.[199]

Nevertheless, even under this expansive interpretation, it is likely *some* form of communication must exist to infer a horizontal understanding under Part IV. For example, in *News v Australian Rugby Football League* ('*News v ARL*'),[200] the Full Federal Court, with limited evidence of direct horizontal communication,[201] drew an inference of mutual consent between football clubs to carry out a common collusive purpose not to join a rival football league.[202] However, they based this inference on the fact that they could find a hub-and-spoke conspiracy, that is,

190 *Trade Practices Commission v David Jones (Australia) Pty Ltd* (1986) 13 FCR 446, 463–4 (Fisher J), quoting *Commissioner of Taxation (Cth) v Lutovi Investments Pty Ltd* (1978) 140 CLR 434, 444 (Gibbs and Mason JJ).

191 See *Australian Competition and Consumer Commission v Construction, Forestry, Mining and Energy Union* [2008] FCA 678 [10] (Finn J), quoting *Communications, Electrical, Electronic, Energy, Information, Postal, Plumbing and Allied Services Union of Australia v Australian Competition and Consumer Commission* (2007) 162 FCR 466 [15], [175]; *Australian Competition and Consumer Commission v Amcor Printing Papers Group Ltd* (2000) 169 ALR 344 [75].

192 See, eg, *Top Performance Motors Pty Ltd v Ira Berk (Queensland) Pty Ltd* (1975) 24 FLR 286, 290–1 (Smithers J), cited in *Australian Competition and Consumer Commission v Amcor Printing Papers Group Ltd* (2000) 169 ALR 344, 360 [75] (Sackville J).

193 (2007) 160 FCR 321.

194 Ibid 332–3 [28]–[30] (Gray J).

195 [2021] FCA 842.

196 Ibid [5]–[6] (Bromwich J).

197 (2014) 319 ALR 388 ('*ACCC v Air New Zealand*').

198 Ibid 486 [463], citing *Leahy Petroleum* (2007) 160 FCR 321, 332 [26]–[28]. See also *Australian Competition and Consumer Commission v Australian Egg Corporation Ltd* (2017) 254 FCR 311, 330 [95] (The Court), quoted in *Commonwealth Director of Public Prosecutions v The Country Care Group Pty Ltd (Ruling No 11)* [2021] FCA 842 [6] (Bromwich J).

199 Ibid.

200 *News Ltd v Australian Rugby Football League* (1996) 64 FCR 410 ('*News v ARL*').

201 See ibid 572, 574–5 (The Court).

202 See ibid 574–5.

where collusion between the clubs (the spokes) was facilitated by the League's officials (the hub).[203] There was evidence of substantial communication between the League's officials and the clubs.[204] Moreover, the clubs knew that all other clubs in the League were being offered and entering into substantially identical contracts.[205] Therefore, even where no such horizontal communication exists, a meeting of the minds has required evidence of some form of communication, for example, through an intermediary.

Communication alone is insufficient to amount to a meeting of the minds. Australian courts have held that no understanding is established just because a party expects a particular course of action. As stated by Lindgren J in *Australian Competition and Consumer Commission v CC (NSW) Pty Ltd [No 8]*:

> The cases require that at least one party "assume an obligation" or give an "assurance" or "undertaking" that it will act in a certain way. A *mere expectation that as a matter of fact* a party will act in a certain way is not enough, even if it has been engendered by that party.[206]

In *Apco Service Stations Pty Ltd v Australian Competition and Consumer Commission* ('*Apco*'),[207] even though Apco's employee was present on the telephone calls where prices were arranged and understood that the purpose of the calls was to influence price-fixing behaviour, the Full Federal Court overturned the judgment at first instance and found that Apco was not a party to a price-fixing understanding. This was because the Court found that Apco had not committed to the price increases.[208]

(b) Applied to Algorithmic Collusion

If algorithmic collusion occurs without prior communication, it is unlikely this amounts to an 'understanding' under Part IV, irrespective of whether the technology was developed in-house or purchased from a third-party supplier. Despite Perram J's expansive interpretation that an understanding can be tacit,[209] a court is unlikely to infer a horizontal understanding without prior communication.

Courts have also been hesitant to infer a meeting of the minds, as they did in *News v ARL*,[210] where there are alternative explanations for the parallel conduct.[211] For example, in *Australian Competition and Consumer Commission v Colgate-Palmolive Pty Ltd [No 4]* ('*Cussons*'), Wigney J refused to draw an inference of an

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203 Ibid.
204 Ibid 577.
205 Ibid 574.
206 (1999) 92 FCR 375, 408 [141] (Lindgren J) ('*ACCC v CC*'), quoted in *Rural Press Ltd v Australian Competition and Consumer Commission* (2002) 118 FCR 236, 257 [79] (The Court).
207 (2005) 159 FCR 452 ('*Apco*').
208 Ibid 465–6 [51]–[53] (The Court).
209 *ACCC v Air New Zealand* (2014) 319 ALR 388, 486 [463].
210 (1996) 64 FCR 410, 571, 574–5, 581 (The Court).
211 See, eg, *Australian Competition and Consumer Commission v Colgate-Palmolive Pty Ltd [No 4]* [2017] FCA 1590 [592] (Wigney J) ('*Cussons*'), cited in *Australian Competition and Consumer Commission v Colgate-Palmolive Pty Ltd* [2019] FCAFC 83 [69] (The Court). See also Genevieve Rahman and Tina Sun, 'Proof of Collusion: The Evidentiary Options When There Is No "Smoking Gun"' (2019) 47 *Australian Busines Law Review* 364.

understanding because 'any parallel conduct was explicable on grounds that had nothing to do with any arrangement or understanding'.[212] In contrast, Fisher J in *Trade Practice Commission v David Jones (Australia) Pty Ltd*[213] drew the inference that retailers of Sheridan sheets had engaged in a price-fixing arrangement as no alternative explanation for the parallel conduct was offered and evidence showed the representatives had met, providing an opportunity to fix prices.[214]

The adoption of bidding algorithms in the NEM inherently offers alternative explanations like in *Cussons*. Algorithmic technology provides significant benefits to market generators beyond the ability to set supracompetitive prices. Without communication between colluding firms, it is unlikely a court could infer a meeting of the minds to establish an understanding under Part IV.

Moreover, *Apco* highlights that even *with* prior communication, the independent raising of prices based on a competitors' expected behaviour is insufficient to amount to an understanding under Part IV.[215] There must be a commitment. Thus, without prior communication, it would be difficult for a Court to conclude that an understanding had been reached. The setting of higher prices through an algorithm is likely to be characterised as independent conduct.

This narrow scope of 'understanding' means that tacit or autonomous algorithmic collusion would not give rise to liability under Part IV of the *Act*, even if it resulted in sustained supracompetitive pricing for end-consumers in the NEM.

2 Cartel Provision

(a) Current Position

Once a contract, arrangement or understanding is established, the ACCC must then prove it contains a cartel provision. The term 'cartel provision' is defined in section 45AD and need not be a contractual provision. Rather, the High Court has held that it simply invites attention to the content of what has been, or is to be agreed, arranged or understood, rather than its particular form.[216]

Price-fixing behaviour falls under the purpose/effect condition of section 45AD(2) and is a cartel provision under section 45AD(1). Section 45AD(2) relevantly states:

> *Purpose/effect condition*
>
> (2) The purpose/effect condition is satisfied if the provision has the purpose, or has or is likely to have the effect, of directly or indirectly:
>
> (a) fixing, controlling or maintaining; or

212 *Cussons* [2017] FCA 1590 [592] (Wigney J), cited in *Australian Competition and Consumer Commission v Colgate-Palmolive Pty Ltd* [2019] FCAFC 83 [69] (The Court). Wigney J was also critical of the ACCC's characterisation of certain circumstantial evidence as direct evidence of a contract, arrangement or understanding: *Cussons* [2017] FCA 1590 [435].

213 (1986) 13 FCR 446.

214 Ibid 469 (Fisher J).

215 *Apco* (2005) 159 FCR 452, 465 [51]–[52], 466 [55] (The Court).

216 *Visy Paper Pty Ltd v Australian Competition and Consumer Commission* (2003) 216 CLR 1, 6 [7] (Gleeson CJ, McHugh, Gummow and Hayne JJ).

> (b) providing for the fixing, controlling or maintaining of;
>
> the price for, or a discount, allowance, rebate or credit in relation to:
>
> (c) goods or services supplied, or likely to be supplied, by any or all of the parties to the contract, arrangement or understanding; …

The collusive behaviour of algorithms in the NEM could also be construed as supply-restriction or bid-rigging behaviour.[217] This is because colluding market generators could achieve the same price-raising effect by jointly restricting the supply of generation through their bids. For a bid-rigging case, the ACCC would need to establish the purpose condition under section 45AD(3), rather than the purpose/effect condition. However, as the purpose/effect condition provides a wider ambit than that of the purpose condition, this article will consider the wider scope of the price-fixing prohibition.

The terms 'purpose' and 'effect' are not defined by the *Act*. Nevertheless, a majority of the High Court in *News Ltd v South Sydney District Rugby League Football Club Ltd*[218] held that 'purpose' was to be assessed subjectively from an examination of the provision itself, read with the relevant arrangement as a whole.[219] In a more recent decision, a majority of the Federal Court held that it is sufficient if one, rather than all, of the parties has the relevant purpose if that person introduced the provision.[220] Whether a provision 'has or is likely to have' a price-fixing effect is a question of connection between the provision and its result.[221] Recently, in *Australian Competition and Consumer Commission v Pacific National Pty Ltd*,[222] a majority of the Full Federal Court held that 'likely' (for an analogous provision under the *Act*)[223] means 'real commercial likelihood'.[224] There must also be an 'appropriate link' between the behaviour and the overall price of the products in question,[225] assessed objectively.[226]

(b) Applied to Algorithmic Collusion

Assuming a court were to find some contract, arrangement, or understanding despite the lack of communication, algorithmic collusion without prior communication could possibly constitute a 'cartel provision'. This is because there is a strong case that the effect of adopting the algorithm is to fix, control, or maintain prices. Purpose is not required if the effect condition is made out. Even if effect could not be established, it could be possible to evidence a purpose by

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217 See *Competition and Consumer Act 2010* (Cth) ss 45AD(3)(a), (b).
218 (2003) 215 CLR 563.
219 Ibid 573 [18] (Gleeson CJ), 580 [41]–[43] (McHugh J), 585 [59] (Gummow J), 636–7 [212], 638 [216] (Callinan J).
220 *Seven Network Limited v News Limited* (2009) 182 FCR 160, 361 [887] (Dowsett and Lander JJ).
221 *ACCC v CC* (1999) 92 FCR 375, 415–16 [180]–[181] (Lindgren J), quoting *Radio 2UE Sydney Pty Ltd v Stereo FM Pty Ltd* (1982) 62 FLR 437, 448 (Lockhart J).
222 (2020) 277 FCR 49 ('*ACCC v Pacific National*').
223 *Competition and Consumer Act 2010* (Cth) s 50.
224 *ACCC v Pacific National* (2020) 277 FCR 49, 116–17 [246] (Middleton and O'Bryan JJ).
225 *ACCC v CC* (1999) 92 FCR 375, 406 [132] (Lindgren J).
226 *Australian Competition and Consumer Commission v Pauls Ltd* [2002] FCA 1586 [104] (O'Loughlin J).

turning to internal correspondence regarding the reasoning for implementing the algorithm.[227]

3 Conclusion

As tacit or autonomous algorithmic collusion without prior communication is unlikely to constitute an 'understanding' under Part IV, it is unlikely that such conduct would amount to a contravention of the cartel prohibitions. Even though the conduct could constitute a cartel provision, the inability to establish a meeting of the minds would mean that market generators are not liable under Part IV for any tacit or autonomous algorithmic collusion in the NEM, whether developed in-house or purchased from a third-party supplier.

B Section 45(1)(c) Concerted Practices Prohibition

Section 45 prevents other restrictive trade practices. It provides:

> (1) A corporation must not:
>
> (a) Make a contract or arrangement, or arrive at an understanding, if a provision of the proposed contract, arrangement or understanding has the purpose or would have or be likely to have the effect, of substantially lessening competition; or
>
> (b) Give effect to a provision of a contract, arrangement or understanding, if that provision has the purpose, or has or is likely to have the effect of substantially lessening competition; or
>
> (c) Engage with one or more persons in a concerted practice that has the purpose, or has or is likely to have the effect, of substantially lessening competition.

Given algorithmic collusion with prior communication is adequately prohibited by the Part IV cartel prohibitions, the issue turns to whether section 45 prevents algorithmic collusion without prior communication. For the same reasons as expressed above, it is unlikely such conduct contravenes section 45(1)(a) or section 45(1)(b) because algorithmic collusion without prior communication is unlikely to amount to a contract, arrangement, or understanding.

The concerted practices prohibition, section 45(1)(c), was enacted in 2017 in response to the narrow judicial interpretation of 'understanding' in *Leahy Petroleum*[228] and *Apco*.[229] Indeed, one ACCC Commissioner stated prior to the enactment of section 45(1)(c):

> Agreements reached in a smoke filled room would be covered by the Act but not the transmission of pricing information between competitors via telephone or an electronic network absent evidence of commitment. Yet such an exchange could facilitate higher prices … any conduct which substantially lessens competition in a market should be unlawful unless authorised on public benefit grounds.[230]

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227 See, eg, *Frames* Case (n 64) [3.45]–[3.61].

228 *Leahy Petroleum* (2007) 160 FCR 321.

229 *Apco* (2005) 159 FCR 452.

230 Jill Walker, 'Agreements, Communication and Facilitating Practices: Where Is the Harm?' (Discussion Paper, Australian Competition and Consumer Commission, 21 August 2010) 6–7 [33]–[34] <https://www.accc.gov.au/system/files/20100821_Walker_Law%20Council%20AgreementsFacPracFinal.pdf>.

There are two key elements to section 45(1)(c). First, there must be a concerted practice. Second, that concerted practice must have the purpose, effect, or likely effect, of substantially lessening competition.

It is not clear how courts will interpret the concerted practices prohibition in section 45(1)(c) as there have been no Australian cases interpreting the provision. The question is one of statutory interpretation,[231] based on the ordinary meaning conveyed by 'concerted practice',[232] the purpose of Parliament,[233] and the statutory context.[234] However, international case law on parallel provisions,[235] Australian case law on 'in concert', and a strict interpretation of the provision with respect to parliamentary intent, suggest that a 'concerted practice' requires, at a minimum, communication. Therefore, it is unlikely section 45(1)(c) adequately prohibits tacit or autonomous algorithmic collusion.

1 Concerted Practice

Although the principles of statutory interpretation are clear,[236] there are generally two suggested approaches to the interpretation of 'concerted practice'. The first involves the European approach under article 101 of the *Consolidated Version of the Treaty on the Functioning of the European Union* (the '*TFEU*').[237] The second involves interpreting concerted practice with reference to Australian case law on 'in concert'[238] or 'contracts, arrangements and understandings'.[239]

(a) European Approach

Some suggest that section 45(1)(c) should be interpreted with reference to European case law regarding article 101 of the *TFEU*,[240] which relevantly states:

> The following shall be prohibited as incompatible with the internal market: all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which

231 See, eg, Gvozdenovic (n 52) 215.

232 See *Acts Interpretation Act 1901* (Cth) s 15AB(1)(a); *Visy Paper Pty Ltd v Australian Competition and Consumer Commission* (2003) 216 CLR 1, 10 [24] (Gleeson CJ, McHugh, Gummow and Hayne JJ); Michael Kirby, 'Statutory Interpretation: The Meaning of Meaning' (2011) 35(1) *Melbourne University Law Review* 113.

233 See, eg, *Project Blue Sky Inc v Australian Broadcasting Authority* (1998) 194 CLR 355, 381 [69] (McHugh, Gummow, Kirby and Hayne JJ) ('*Project Blue Sky*').

234 See *Acts Interpretation Act 1901* (Cth) s 15AA; *Collector of Customs v Agfa-Gevaert Ltd* (1996) 186 CLR 389, 396–7 (Brennan CJ, Dawson, Toohey, Gaudron and McHugh JJ), quoting *R v Brown* [1996] 1 AC 543, 561 (Lord Hoffman).

235 *Consolidated Version of the Treaty on the Functioning of the European Union*, signed 13 December 2007 [2016] OJ C 202/01 (entered into force 1 January 2009 art 101 ('*TFEU*').

236 See, eg, *Project Blue Sky* (1998) 194 CLR 355, 381 [69] (McHugh, Gummow, Kirby and Hayne JJ); *Federal Commissioner of Taxation v Consolidated Media Holdings Ltd* (2012) 250 CLR 503, 519 [39]; Kirby (n 232) 116.

237 See, eg, Australian Competition and Consumer Commission, 'Guidelines on Concerted Practices' (Guidelines, 31 August 2018) 3 [1.4]–[1.5]; Miller (n 52) 361–2 [CCA.45.90]; Duke (n 52) 425 [7.270].

238 See Nicholls and Kayis (n 52) 135.

239 See Gvozdenovic (n 52) 235–6.

240 See, eg, 'Guidelines on Concerted Practices' (n 237) 3 [1.4]–[1.5]; Miller (n 52) 361 [CCA.45.90]; Duke (n 52) 425 [7.270].

> have as their object or effect the prevention, restriction or distortion of competition within the internal market …[241]

Accordingly, these scholars suggest that Australian courts should have reference to European case law when interpreting section 45(1)(c), given the parliamentary intent signalled by adopting the same term of 'concerted practices' in section 45(1)(c).[242]

European case law defines a concerted practice as:

> any form of coordination between undertakings which, without having been taken to a stage where an agreement properly so called has been concluded, knowingly substitutes for the risks of competition practical cooperation between them.[243]

This does not include independent responses to a competitor's conduct. In *Zuchner v Bayerische Vereinsbank AG*,[244] the Court of Justice of the European Union (the 'CJEU') held that intelligent responses to a competitor's behaviour, including tacit collusion, would not bring a firm within the scope of article 101 of the *TFEU*.[245] Accordingly, the question under European competition law is whether the parallel conduct is the result of independent decision-making.

To distinguish between independent conduct and concerted practices, European courts rely on communication between the coordinating firms.[246] This can be direct or indirect communication.[247] For example, in the recent case of *Eturas*,[248] the CJEU held that there must be *some* communication to distinguish between a concerted practice and independent business conduct.[249] In this case, a concerted practice was found between travel agents using an online booking platform provided by the same third-party. Notably, there was no evidence the travel agents either knew or communicated with each other directly to engage in the concerted practice.[250] However, the third-party was able to facilitate communication by asking the travel agents to vote on common discount caps.[251]

Similar to *News v ARL*,[252] in this case communication was established between the third-party platform provider and the users of the platform, the travel agents.[253] The third-party platform provider messaged all the travel agents on the platform,

241 *TFEU* (n 235) art 101(1) (emphasis added).
242 Miller (n 52) 361–3 [CCA.45.90]; Duke (n 52) 425 [7.270].
243 *Commission of the European Communities v Anic Partecipazioni SpA* (C-49/92 P) [1999] ECR I-4125, 4202 [115].
244 *Zuchner v Bayerische Vereinsbank AG* (C-172/80) [1981] ECR 2021.
245 Ibid 2031 [14]. See also *Ahlström Osakeyhtiö v Commission of the European Communities* (C-89/85) [1993] ECR I-1307, I-1601 [71]; *Suiker Unie v Commission of the European Communities* (C-114/73) [1975] ECR 1663, 1942 [174].
246 For a more detailed analysis of 'communication' under article 101 of the *TFEU* for the purposes of determining algorithmic collusion in the form of a concerted practice, see Jedličková (n 5) 318–20.
247 *Suiker Unie v Commission of the European Communities* (C-114/73) [1975] ECR 1663, 1942 [174]; *Commission of the European Communities v Anic Partecipazioni SpA* (C-49/92 P) [1999] ECR I-4125, 4202 [115].
248 *Eturas* (n 51).
249 Ibid [34].
250 Ibid [22]–[25].
251 Ibid [8]–[12].
252 *News v ARL* (1996) 64 FCR 410.
253 *Eturas* (n 51) [9]–[10].

asking them to vote on caps to discounts.[254] After the vote was conducted, the third-party implemented technical restrictions that would make altering the caps more difficult for users.[255] The CJEU found that those travel agents who were aware of the message and did not publicly distance themselves would be part of the concerted practice under article 101 of the *TFEU*.[256] Thus, a finding of a concerted practice under article 101 of the *TFEU* was still dependent on the existence of communication between the platform provider and the travel agents.

Australian statements on this European approach with reference to section 45(1)(c) suggest a similar reliance on communication. For example, the ACCC Guidelines on Concerted Practices relevantly states:

> [A] concerted practice may consist of a one-off event or a pattern of conduct, usually involving the disclosure of commercially sensitive information. Such information exchanges may occur directly, or through an intermediary …[257]

The type of communication under this approach appears to be broader than under Part IV. The ACCC suggests that this communication can be 'in public (including through public statements to the media) or in private'.[258] Moreover, establishing a concerted practice does not require commitment. Nevertheless, if this approach were adopted, it is likely that communication would be required to establish a concerted practice under section 45(1)(c).

(b) Australian Case Law

Other scholars, such as Gvozdenovic,[259] and Nicholls and Kayis[260] have suggested that Australian case law provides a more reliable basis for the interpretation of section 45(1)(c). Comparing the text of article 101(1) of the *TFEU* and section 45(1)(c), Gvozdenovic argues European case law provides limited assistance to Australian courts because article 101(1) prohibits 'agreements between undertakings', 'decisions by associations of undertakings', *and* 'concerted practices' together.[261] Australian courts, however, will need to demarcate between a concerted practice and an understanding to show how section 45AJ and section 45(1)(c) are to be interpreted differently.[262] He concludes that a concerted practice under s 45(1)(c) requires communication, whether tacit or explicit, and some element less than a 'commitment'.[263]

Nicholls and Kayis suggest that the courts may turn to Australian case law interpreting 'in concert'.[264] In the predecessor to the *Act*, the *Trade Practices Act 1974* (Cth) section 45D relevantly read 'a person must not, *in concert* with a second

254 Ibid.
255 Ibid [12].
256 Ibid [39]–[46].
257 'Guidelines on Concerted Practices' (n 237) 3 [1.5].
258 Ibid 6 [3.8].
259 Gvozdenovic (n 52).
260 Nicholls and Kayis (n 52).
261 Gvozdenovic (n 52) 230, citing Nicholls and Kayis (n 52) 133.
262 Ibid 231, citing Nicholls and Kayis (n 52) 134.
263 Ibid 236.
264 Nicholls and Kayis (n 52) 135.

person, engage in conduct …'.[265] Even though the Explanatory Memorandum to the current legislation states that section 45D should not be considered,[266] Nicholls and Kayis argue that the 'wider context of legislation involving questions of concerted conduct make it clear that the components of acting in concert determined under section 45D are not unique to the *Trade Practices Act*' and that these will likely be considered by the courts.[267] Previous Australian decisions have concluded that the phrase 'in concert' requires communication. French J summarised the position as follows:

> The phrase 'in concert' has been construed variously in the cases as involving knowing conduct, the *result of communication* between the parties and not simply simultaneous actions occurring spontaneously.[268]

It is, therefore, similarly likely that if Australian case law was relied upon to interpret section 45(1)(c), courts would conclude that a 'concerted practice' requires, at a minimum, communication.

(c) Application to Algorithmic Collusion

It is not necessary to resolve the ongoing debate regarding the proper interpretation of section 45(1)(c). It is enough to conclude that communication is necessary (although perhaps not sufficient) to establish a concerted practice. Consequently, algorithmic collusion in the NEM without prior communication is unlikely to fall within the scope of section 45(1)(c), irrespective of whether developed in-house or purchased from a third-party.

Some scholars suggest that some functions of algorithms could constitute 'communication' sufficient to establish a concerted practice.[269] For example, Jedličková argues that:

> algorithms allow for … information to be collected, transmitted, shared and analysed. In particular, the sharing of information can be perceived as communication and, thus, the function of some algorithms can also be perceived as forms of communication.[270]

While this may be true for some algorithmic functions in which private future pricing intentions are passed between competitors through algorithms,[271] initial bids in the NEM are required to be submitted a day before generation under the *NER* rule 3.8.6. Although not necessarily determinative of the legality of such conduct,[272]

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265 *Trade Practices Act 1974* (Cth) s 45D (emphasis added).

266 Explanatory Memorandum, Competition and Consumer Amendment (Competition Policy Review) Bill 2017 (Cth) [3.18].

267 Nicholls and Kayis (n 52) 135.

268 *Australasian Meat Industry Employees' Union v Meat & Allied Trades Federation of Australia* (1991) 32 FCR 318, 334 cited in Nicholls and Kayis (n 52) 136 (emphasis added).

269 Gal (n 2) 84–5; Jedličková (n 5) 326.

270 Jedličková (n 5) 326.

271 For example, Barbora Jedličková suggests that algorithms 'can be constructed in such a way as to allow them to read other algorithms and to make a particular business decision after they take into consideration the parameters of these other algorithms': ibid 326.

272 It is not a foregone conclusion that conduct consistent with the *NER* could not, as a matter of course, constitute a violation of Australian competition law. This is an inter-statutory interpretation issue involving coherence. However, as statute is to be construed on the prima facie basis that its provisions are

it would be absurd if market generators could not comply with both section 45(1)(c) and rule 3.8.6. It would similarly be difficult to show that such information, as required under the *NER*, would constitute 'direct or indirect communication among competitors that goes beyond the nature of the market' to amount to a concerted practice.[273]

Moreover, recent research suggests that tacit and autonomous algorithmic collusion can occur without detailed market information. Calvano et al shows that autonomous algorithmic collusion can occur even if the algorithm only inputs *current* market prices and own profits.[274] Hansen, Misra and Pal suggest that own profits *alone* are sufficient to establish supracompetitive pricing between algorithms.[275] These results suggest that tacit and autonomous algorithmic collusion can occur without the conventional 'exchange of information' normally attributed to 'communication'.

Therefore, unless initial bids are shared between market generators before they are made public by AEMO, it is unlikely that tacit or autonomous algorithmic collusion without prior communication would amount to a contravention of section 45(1)(c).

2 Substantial Lessening of Competition

(a) Current Position

If a court were to find a 'concerted practice', liability under section 45(1)(c) would only arise if that practice had or is likely to have substantially lessened competition ('SLC'). SLC has been subject to judicial interpretation under other provisions of the *Act*. It is likely that the same interpretation would be adopted for section 45(1)(c).[276]

The High Court stated that SLC was a question of whether the effect of an arrangement is meaningful or relevant to the competitive process.[277] This requires the court to undertake a qualitative assessment of the impact the practice will have on competition.[278]

(b) Application to Algorithmic Collusion

In principle, the SLC test is sufficient to capture the pro- and anti-competitive effects of algorithmic technology in the NEM. Accordingly, if the issue regarding

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intended to give effect to harmonious goals, this suggests that conduct in compliance of rule 3.8.6 is not likely to amount to a contravention of section 45(1)(c): *Project Blue Sky* (1998) 194 CLR 355, 382 [70]–[71] (McHugh, Gummow, Kirby and Hayne JJ).

273 Jedličková (n 5) 320.

274 Calvano et al, 'Artificial Intelligence, Algorithmic Pricing, and Collusion' (n 5) 3271–2.

275 Hansen, Misra and Pai (n 153) 3.

276 The interpretation of 'likely' is likely to be the same as analogous provisions of the *Competition and Consumer Act 2010* (Cth). As held by a majority of the Full Federal Court in *ACCC v Pacific National*, 'likely' means 'real commercial likelihood': *ACCC v Pacific National* (2020) 227 FCR 49, 116 [246] (Middleton and O'Bryan JJ).

277 *Rural Press Ltd v Australian Competition and Consumer Commission* (2003) 216 CLR 53, 71 [41] (Gummow, Hayne and Heydon JJ), cited in Miller (n 52) 369 [CCA.45.280].

278 *Stirling Harbour Services Pty Ltd v Bunbury Port Authority* [2000] FCA 38 [114] (French J).

communication could be overcome, then the court would undertake a balancing exercise to determine whether the collusive behaviour of the algorithm substantially outweighs the potential pro-competitive benefits. In practice, there have been difficulties experienced in the application of the SLC test to novel circumstances. This generates significant uncertainty for generators. This is due to 'the regrettable fact … that no one knows with any clarity what 'substantial' means in the SLC test'.[279] For an industry already plagued by significant uncertainty,[280] the SLC test may exacerbate underinvestment, to the detriment of Australian consumers.

3 Conclusion

Despite the lack of certainty regarding the judicial interpretation of section 45(1)(c), it is likely it does not encompass tacit and autonomous algorithmic collusion in the NEM. This is because the disclosure of bids under *NER* rule 3.8.6 is unlikely to amount to a contravention of section 45(1)(c) and the lack of other communication provides no basis for courts to establish a concerted practice.

Even if courts were to find a concerted practice, the SLC test creates significant uncertainty for market generators which could operate to the detriment of the Australian consumer. Section 45(1)(c), therefore, does not adequately prohibit tacit or autonomous algorithmic collusion.

C Section 46 Misuse of Market Power Prohibition

The final suggestion by competition regulators is that misuse of market power prohibitions like section 46, which rely on unilateral conduct, may prohibit collusive conduct resulting from algorithms.[281] This could be used to hold both market generators and third-party algorithm providers to account.

The misuse of market power prohibition in section 46 states:

> (1) A corporation that has a substantial degree of power in a market must not engage in conduct that has the purpose, or has or is likely to have the effect, of substantially lessening competition in:
>
> (a) that market; or
>
> (b) any other market in which that corporation, or a body corporate that is related to that corporation [supplies goods or services] …

Although the prohibition has been present for some time, the current section 46 was recast following the *Harper Review*.[282] This was because the *Harper Review* identified that the old 'take advantage' limb[283] was not 'a useful test by

279 Nicholls and Fisse (n 5) 91.

280 See Alan Finkel et al, *Independent Review into the Future Security of the National Electricity Market – Blueprint for the Future* (Final Report, 9 June 2017) 5, 29, 31.

281 See, eg, Sims (n 1).

282 Ian Harper et al, *Competition Policy Review* (Final Report, 31 March 2015) ('*Harper Review*').

283 See *Melway Publishing Pty Ltd v Robert Hicks Pty Ltd* (2001) 205 CLR 1, 21 [44] (Gleeson CJ, Gummow, Hayne and Callinan JJ) ('*Melway*').

which to distinguish competitive from anti-competitive unilateral conduct'.[284] The government amended the section in 2017 with the following differences:[285]

Table 1: Comparison of New and Old Section 46[286]

	New Law	Old Law
Prerequisite	Substantial degree of power in a market	Substantial degree of power in a market
Trigger	Conduct or purpose	Use of that market power
Contravention	Effect or likely effect of substantially lessening competition in that or any other market in which the corporation supplies or acquires goods or services.	Purpose of: • Eliminating or substantially damaging a competitor; or • Preventing the entry of a person into that or any other market; or • Deterring or preventing a person from engaging in competitive conduct in that or any other market.

1 Prerequisite: Substantial Degree of Market Power

(a) Current Position

A substantial degree of market power is a prerequisite for enlivening section 46. This requires the court to identify the relevant market and then determine whether the corporation has a substantial degree of power in that market.[287]

Market is defined by section 4E:

> [***M***]***arket*** means a market in Australia and, when used in relation to any goods or services includes a market for those goods or services and other goods or services that are substitutable for, or otherwise competitive with, the first-mentioned goods or services.

The High Court has defined 'market power' as, in essence, the power to behave in a market, for a sustained period, in a manner not constrained by competitors in that market.[288] Barriers to entry are the predominant determinant of market power.[289]

(b) Application to Algorithmic Collusion

Due to high market concentration in the NEM (as identified by the ACCC),[290] it is possible generators in the NEM could be found to have market power.

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284 *Harper Review* (n 282) 61.

285 See *Competition and Consumer Amendment (Misuse of Market Power) Act 2017* (Cth).

286 Miller (n 52) 400–1 [CCA.46.30]; Explanatory Memorandum, Competition and Consumer Amendment (Misuse of Market Power) Bill 2016 (Cth) 7 [1.12].

287 *Boral Besser* (2003) 215 CLR 374, 459 [262] (McHugh J).

288 *Melway* (2001) 205 CLR 1, 27 [67] (Gleeson CJ, Gummow, Hayne and Callinan JJ); ibid 423 [135]–[137] (Gleeson CJ and Callinan J), citing *Queensland Wire Industries Pty Ltd v Broken Hill Pty Co Ltd* (1989) 167 CLR 177, 188 (Mason CJ and Wilson J) ('*Queensland Wire*').

289 *Queensland Wire* (1989) 167 CLR 177, 189 (Mason CJ and Wilson J), 201 (Dawson J).

290 See *REPI Final Report* (n 37) vi, vii. See also *State of the Energy Market 2020* (n 23) 83.

However, where tacit or autonomous algorithmic collusion arises form a third-party software provider, it is unlikely this market power conclusion would extend to third-party software providers.

Due to the global nature of the supply of bidding algorithms, many international firms currently compete or have the capacity to compete to supply this software to Australian energy providers. Further, supply does not require physical business assets or significant additional capital investment, meaning there are low physical barriers to enter the Australian market. Although technical expertise may hinder the creation of new bidding algorithm suppliers, it does not prevent an existing supplier from entering the Australian market. As a result, the barriers to the Australian market for the supply of bidding algorithms are low, meaning it is unlikely a supplier of algorithmic bidding software would be found to have a substantial degree of market power. They are thus unlikely to be found to have breached section 46.[291]

2 Trigger: Conduct or Purpose

(a) Likely Position

There have been no recent contested cases clearly demarcating the differences between the triggers of the new and old section 46. Nevertheless, adopting a textual approach to statutory interpretation, 'purpose' in the context of the new section 46, is likely to have the same meaning as it did in the previous section 46, that is, a subjective intention to achieve a particular result.[292]

However, the recent legislative change has arguably widened the ambit of section 46 regarding 'conduct', to no longer require a connection between the conduct and the firm's degree of market power.[293] In *Australian Competition and Consumer Commission v Tasmanian Ports Corporation Pty Ltd*,[294] Davies J was satisfied that the Court should declare that Tasmanian Ports Corporation Pty Ltd

291 See *Boral Besser* (2003) 215 CLR 374, 415 [103]–[104], 426 [148] (Gleeson CJ and Callinan J).

292 *ASX Operations Pty Ltd v Pont Data Australia Pty Ltd [No 1]* (1990) 27 FCR 460, 477 (The Court), applied in *Australian Competition and Consumer Commission v Pfizer Australia Pty Ltd* (2018) 356 ALR 582, 702 [467] (The Court); *Melway Publishing Pty Ltd v Robert Hicks Pty Ltd* (2001) 205 CLR 1, 18–19 [31] (Gleeson CJ, Gummow, Hayne and Callinan JJ). See also *Queensland Wire Industries Pty ltd v Broken Hill Pty Co Ltd* (1989) 167 CLR 177, 214 (Toohey J).

293 See, eg, Duke (n 52) 512 [9.150].

294 [2021] FCA 482. At the time of writing, *Australian Competition and Consumer Commission v Tasmanian Ports Corporation Pty Ltd* was the first and only judgment that found a contravention of the new section 46. It dealt with the admitted conduct of Tasmanian Ports Corporation Pty Ltd ('TasPorts') between 6 November 2017 and 1 July 2019 that had the 'likely effect' of substantially lessening competition in the towage and the pilotage market in Northern Tasmania. Following failed negotiations between Grange and TasPorts on a Services Agreement, Grange advised TasPorts that it would obtain towage and pilotage services from another port services provider, Engage Marine Pty Limited. At this point, TasPorts advised Grange that it would need to pay a 'Marine Precinct Tonnage Charge' for vessels calling on Port Latta once Grange's Services Agreement with TasPorts had expired. TasPorts admitted to having a substantial degree of market power in managing and maintaining infrastructure in ports (other than Port Latta) in Northern Tasmania. It also admitted that it engaged in conduct, in response to the entry or attempted entry of Engage Marine as a competitor for towage and pilotage services, that was likely to have the effect of substantially lessening competition in the markets for towage and pilotage services in Northern Tasmania.

('TasPorts') had contravened section 46 of the *Act*, based on the joint statement of agreed facts.[295] Davies J outlined that:

> [T]he test focusses on whether the conduct by a corporation with substantial market power has the purpose, effect or likely effect of substantially lessening competition. Thus, for a corporation to contravene s 46(1), the corporation, relevantly:
>
> (a) must have a substantial degree of power in *a* market; and
>
> (b) must engage in conduct which, relevantly, is likely to have the effect of substantially lessening competition in that market *or another market in which it trades or is likely to trade*.[296]

Indeed, the judgment accepts TasPorts' admissions that: (1) it had a substantial degree of market power in managing/maintaining port infrastructure,[297] and (2) that it engaged in conduct that had the 'likely effect' of substantially lessening competition in the towage market and the pilotage market.[298] However, it does not provide any reasoning on the connection between the two. Taken together, this suggests that the ambit of the new section 46 is indeed wider than its predecessor and that 'conduct' under the new section 46 could encompass any conduct of the firm in question.

Nevertheless, it is important to distinguish between conduct prohibited by section 46 and conduct prohibited by the price-fixing prohibitions and section 45(1)(c). Section 46 targets *unilateral* conduct rather than common or concerted conduct. The Full Federal Court stated, regarding the previous section 46, that 'section 46 strikes at the *unilateral* activity of a monopolist taking advantage of its power for a particular purpose'.[299]

(b) Application to Algorithmic Collusion

As third-party algorithm providers do not meet the prerequisite of section 46, it is not necessary to consider the application of the trigger to their conduct. However, market generators may be found to have substantial market power. A purpose case under section 46 could be made out for market generators if there is evidence of a subjective intention to achieve tacit or autonomous algorithmic collusion.[300] However, where this evidence is unavailable, regulators will have to turn to a conduct case which presents significant difficulties.

It is arguable that tacit or autonomous algorithmic collusion could fall within an expansive interpretation of 'conduct' under the recast section 46.[301] Given

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295 Ibid [17].

296 Ibid [12] (emphasis added).

297 Ibid [14].

298 Ibid [15].

299 *ASX Corporations Pty Ltd v Pont Data Australia Pty Ltd [No 1]* (1990) 27 FCR 460, 475 (The Court) (emphasis added), cited in *Seven Network Ltd v News Ltd* (2009) 182 FCR 160, 360 [882] (Dowsett and Lander JJ) (emphasis added).

300 For the same reasons as outlined in the 'conduct' case, evidence of a subjective intention to 'raise prices' is likely insufficient to amount to a purpose case under section 46. Evidence will likely need to establish a subjective purpose to engage in tacit or autonomous algorithmic collusion: see *Austrac Operations Pty Ltd v State of New South Wales* [2003] FCA 1013 [27] (Emmett J).

301 See, eg, Sims (n 1).

section 46 prohibits *any* conduct that gives rise to a substantial lessening of competition, it could be argued that the adoption of pricing algorithms that exhibit supracompetitive prices is conduct giving rise to liability under section 46.

However, this argument does not align with previous case law regarding the competitive impact of unilaterally setting higher prices.[302] Orthodox economic theory suggests the unilateral setting of higher prices may indeed increase rather than decrease competition. This is because there are higher economic rents for potential and actual competitors.[303]

Australian courts have approached the former section 46 in this manner. In *Austrac Operations Pty Ltd v State of New South Wales*,[304] Emmett J concluded that deriving monopoly rents from existing market power was not a contravention of section 46.[305] Further, in all of the Australian cases where there has been found to be a contravention of the former section 46 by the unilateral setting of higher prices, these have been confined to vertically integrated firms providing an essential input to competitors of their downstream business.[306]

As section 46 focusses on unilateral conduct, it follows that market generators are unlikely to be found to have breached section 46 by engaging in tacit or autonomous algorithmic collusion. Unilaterally setting higher prices is not generally a breach of section 46,[307] and there is no vertical conduct.[308] Australian case law has not distinguished between the conduct of algorithms and the conduct of persons, preferring to characterise the conduct as that of a person using the algorithm as a tool.[309] Accordingly, it is unlikely a court would distinguish between setting higher prices manually and setting higher prices through an algorithm, making it unlikely a market generator would be liable under section 46 for supracompetitive pricing resulting from tacit or autonomous algorithmic collusion.[310]

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302 See *Austrac Operations Pty Ltd v State of New South Wales* [2003] FCA 1013 [27] (Emmett J), cited in Duke (n 52) 544 [9.390].

303 See Duke (n 52) 543–4 [9.390]; Hal R Varian, *Intermediate Microeconomics: A Modern Approach* (WW Norton & Company, 8th ed, 2009) 519–20.

304 [2003] FCA 1013 (Emmett J).

305 Ibid [27], cited in Duke (n 52) 544 [9.390].

306 See, eg, *Queensland Wire* (1989) 167 CLR 177, 185 (Mason CJ and Wilson J).

307 *Austrac Operations Pty Ltd v State of New South Wales* [2003] FCA 1013 [27] (Emmett J), cited in Duke (n 52) 544 [9.390].

308 *Queensland Wire* (1989) 167 CLR 177, 185 (Mason CJ and Wilson J).

309 See, eg, *Google v Australian Competition and Consumer Commission* (2013) 249 CLR 435, 459 [68]–[69] (French CJ, Crennan and Kiefel JJ); *Australian Competition and Consumer Commission v Trivago NV* [2020] FCA 16 (Moshinksy J) (‘*ACCC v Trivago*’).

310 It is possible that a court could overcome this issue by characterising the conduct as the ‘adoption of a specific (anti-competitive) algorithm’. However, there are two main issues with this approach. First, whether the adoption of an algorithm results in pro- or anti-competitive outcomes depends on the circumstances in which it is deployed (see Part II), not necessarily on the characteristics of the algorithm. Indeed, these circumstances may be outside the control of the party implementing the algorithm. For example, an adaptive algorithm setting prices 5% above a competitor might not be anti-competitive in a competitive industry or an industry without a salient firm. However, in an industry with price leadership, this could lead to tacit collusive outcomes: see, eg, Byrne and de Roos (n 148). Second, tacit collusion does not generally amount to a contravention of section 46. Consequently, there are difficulties in concluding that the adoption of a specific algorithm resulting in tacit collusion would constitute a breach of section 46. Similarly, it is possible that ‘conduct’ under the recast section 46 could

3 Contravention: Substantially Lessening Competition

Courts are likely to adopt the same interpretation for SLC as they do for other provisions under the *Act*. Thus, the same analysis regarding SLC under section 45(1)(c) applies to section 46.

4 Conclusion

Section 46 does not adequately prohibit algorithmic collusion that occurs without communication. The reduction of price competition due to tacit or autonomous algorithmic collusion occurs via *common* or *coordinated* pricing behaviour, rather than the unilateral conduct that this provision targets.

V CRITERIA FOR OPTIMAL INTERVENTION IN THE NEM

How does one resolve the lacuna in Australian competition law? Scholars have argued that tacit and autonomous algorithmic collusion could be prevented by prohibiting the use of colluding algorithms.[311] However, an outright per se prohibition may detriment competition as it would prevent the realisation of the countervailing pro-competitive benefits of algorithmic technology.[312] Thus, a more nuanced approach is required.

There are two criteria for optimal competition law intervention. First, intervention must prevent anti-competitive conduct arising from algorithmic technology while promoting (or at least not preventing) their pro-competitive benefits.[313] Secondly, any proposed intervention must balance certainty for generators and reach of the intervention.[314] Any intervention must also meet the object of its empowering legislation, whether introduced through the *Act*[315] or the *NEL*.[316]

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be interpreted expansively so as to include facilitating practices not limited to contract, arrangements or understandings (as in Part IV above) or concerted practices (as in section 45(1)(c)). While such an expansive interpretation is unlikely given the Full Federal Court decision in *ASX Corporations Pty Ltd v Pont Data Australia Pty Ltd [No 1]* (1990) 27 FCR 460, 475 (The Court) and the prohibitions under Part IV and section 45, such a definition would still fail to capture autonomous algorithmic collusion. This is because if Australian courts continue to deny algorithms agency, the 'conduct' is likely more properly characterised as the unilateral setting of higher prices through an algorithm as firms do not engage in any facilitating practice themselves: see *Google v Australian Competition and Consumer Commission* (2013) 249 CLR 435, 459 [68]–[69] (French CJ, Crennan and Kiefel JJ); *ACCC v Trivago* [2020] FCA 16 (Moshinksy J). Such conduct is not likely to be a breach of section 46, as discussed above.

311 See Schwalbe (n 15) 598. Cf Harrington (n 5) 350. For a general discussion of remedies that could result from liability: see also Beneke and Mackenrodt (n 176) 165–76.

312 As algorithms are simply a set of instructions, usually in the form of computer code, an outright per se prohibition of colluding algorithms could also mean an outright per se prohibition of certain computer code: see, eg, Mehra (n 5); Brown and MacKay (n 5). Nevertheless, the outright prohibition of certain computer code still risks preventing the realisation of pro-competitive benefits arising from that computer code.

313 See, eg, Gal (n 2) 112; Harrington (n 5) 359.

314 See, eg, Nicholls and Fisse (n 5) 86.

315 *Competition and Consumer Act 2010* (Cth) s 2; *Boral Besser* (2003) 215 CLR 374, 429 (Gaudron, Gummow and Hayne JJ).

316 *National Electricity Law* s 7.

A Preventing Anti-Competitive Conduct without Compromising Pro-Competitive Benefits

Previous scholars, when proposing solutions to algorithmic collusion, have focussed mainly on balancing the pro- and anti-competitive effects of algorithmic technology.[317] Indeed, optimal intervention should promote (or at least not prevent) the pro-competitive benefits of algorithms whilst preventing (or at least mitigating) the anti-competitive costs to consumers. To do otherwise might be, as Posner J of the United States Court of Appeals suggests, inconsistent with 'the maxim that advises physicians to, first, do no harm'.[318]

B Balancing Certainty for Generators and Reach of the Proposed Intervention

There remains some uncertainty around the actual competitive impact of algorithmic technology. The competitive impact of algorithmic technology depends on the circumstances in which the algorithm is deployed.[319] Optimal intervention must balance certainty for generators and coverage of the various circumstances in which algorithmic collusion could arise.[320]

Legal intervention may seek to increase certainty for businesses by specifying circumstances in which the use of algorithms would be prohibited. However, this risks reducing the reach of the prohibition. Similar concerns were raised regarding an analogous suggestion for the 'concerted practices' prohibition. These were heavily criticised[321] and ultimately rejected[322] because, as the ACCC argued:

> … where laws are overly prescriptive, sophisticated firms will more readily be able to innovate to find ways to collude in a way which circumvents the law. It is therefore important that the law is sufficiently adaptable to the myriad ways in which firms can coordinate their conduct to the ultimate detriment of consumers.[323]

VI AN OPTIMAL LEGAL SOLUTION?

Based on these criteria, this article proposes a tripartite legal solution to algorithmic collusion in the NEM. First, it recommends a notification regime to allow regulators to identify and monitor the use of algorithms, despite the dynamic nature of the NEM. Second, it advocates for a reduction in bidding transparency to reduce the susceptibility of the NEM to tacit and autonomous algorithmic

317 See, eg, Gal (n 2) 112; Harrington (n 5) 359.
318 Posner (n 50) 767.
319 See Harrington (n 5) 359; Schwalbe (n 15) 590–1.
320 See Nicholls and Fisse (n 5) 86; Gal (n 2) 112.
321 See, eg, Caron Beaton-Wells and Brent Fisse, Submission to the Australian Government Treasury, *Competition Policy Review* (22 May 2015) 11 <https://treasury.gov.au/sites/default/files/2019-03/C2015-017_Beaton_Wells_Fisse.pdf>.
322 *Harper Review* (n 282) 371–2. See also *Competition and Consumer Act 2010* (Cth) s 45(1)(c).
323 Australian Competition and Consumer Commission, Submission to the Australian Government Treasury, *Competition Policy Review: Response to the Draft Report* (26 November 2014) 45 <https://www.accc.gov.au/system/files/Competition-Policy-Review-ACCC-submission-to-Draft-Report-26-November-2014.pdf>.

collusion. Third, it proposes a novel definition of 'concerted practice', which does not require communication and thus would capture both tacit and autonomous algorithmic collusion.

A Identification: The Notification Regime

(a) Existing Information Gathering Powers

Generally, the ACCC has powers under the *Act* to obtain information and documents for contraventions of the *Act*,[324] consumer goods that may cause injury,[325] and for inquiries.[326] The AER has similar powers under the *NEL* to obtain information and documents in relation to the exercise of its powers.[327] These powers could be used to obtain information on the use of algorithms in the NEM.

However, these powers are limited by their static nature. Harrington observes that 'static testing is unlikely to be an effective method for assessing whether [there is] a prohibited pricing algorithm'.[328] The use and code of pricing algorithms can change rapidly, as can the market circumstances in which such algorithms are deployed. The impact of algorithms on competition depends on the circumstances in which they are deployed. Given the dynamic nature and rapid evolution of the NEM,[329] static information gathering powers do not allow regulators to effectively observe the competitive impact of algorithms.

(b) Solution: The Notification Regime

To overcome this constraint, this article recommends requiring market generators to give notice to regulators of their proposed use of algorithmic technology to bid in the NEM. Similar measures have already been adopted under the *Act* for conduct that, like the adoption of algorithms, could have pro- or anti-competitive effects.

For example, resale price maintenance, where a manufacturer sets a minimum price that retailers can sell their product, is prohibited per se.[330] However, due to its potential pro- and anti-competitive effects,[331] the *Harper Review* recommended that the notification regime should be made available for this conduct.[332] Under this regime, once businesses notify the ACCC of the conduct, they are automatically

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324 *Competition and Consumer Act 2010* (Cth) s 155.
325 Ibid s 133D.
326 Ibid s 95ZK.
327 *National Electricity Law* s 28.
328 Harrington (n 5) 355.
329 See, eg, 'What is 5-Minute Settlement?' (n 32); Finkel et al (n 280) 3; Energy Security Board, *Post 2025 Market Design* (Issues Paper, September 2019) <https://energyministers.gov.au/sites/prod.energycouncil/files/publications/documents/EC%20-%20Post%202025%20Market%20Design%20Issues%20Paper%20-%2020190902_0.pdf>.
330 *Competition and Consumer Act 2010* (Cth) s 48.
331 See, eg, *Australian Competition and Consumer Commission v Jurlique International Pty Ltd* [2007] FCA 79 [73] (Spender J).
332 *Harper Review* (n 282) 65.

protected from legal action, commencing 14 days after notification,[333] unless the ACCC issues a draft notice objecting to the conduct due to its anti-competitive effects.[334]

A notification regime benefits both regulators and businesses when conduct is not clearly anti-competitive. Regulators are given an avenue through which they can monitor potentially anti-competitive conduct and its subsequent uses. Businesses are given increased certainty.

A similar measure ought to be adopted for the use of algorithms in the NEM. Market generators who wish to deploy an algorithm when bidding in the NEM would be required to notify the ACCC or AER, including the algorithm's code and use. Notices would be sent to the regulator if the code or use changes. This would allow regulators to dynamically monitor the use of algorithms in the NEM.[335] Information provided in this manner would be kept strictly confidential.

While this intervention does not fill the lacuna in Australian competition law, it provides greater certainty to businesses regarding the legality of their conduct and provides regulators with the ability to observe and assess the dynamic impacts of algorithms in the NEM.

B Prevention: Reducing Bidding Transparency

(a) The Competitive Impact of Market Transparency

Increased market transparency can have pro- or anti-competitive effects. Generally, increased price transparency reduces consumer search cost as consumers can easily discover and compare offers.[336] Accordingly, greater market transparency reduces price dispersion and increases price competition by encouraging consumers to choose the cheaper seller.[337] Transparent price signals also allow firms to benchmark their performance based on their competitors' prices,[338] which can encourage firms to compete more vigorously.

However, increased price transparency can also lead to greater coordination between firms,[339] with the OECD stating:

> [I]ncreased transparency may also have negative effects on the market through either directly facilitating collusion among competitors or, particularly with respect

333 See *Competition and Consumer Act 2010* (Cth) s 93(7A); *Competition and Consumer Regulations 2010* (Cth) r 9.

334 *Competition and Consumer Act 2010* (Cth) s 93(3A).

335 A potential limitation of such a notification regime is the practical constraints on the ACCC. It is possible that such a regime would be quite resource intensive and require technical expertise. Nevertheless, the creation of the ACCC's Strategic Data Analysis Unit in 2017 suggests that the ACCC may have, at the very least, the technical capabilities to undertake such a monitoring role.

336 George J Stigler, 'The Economics of Information' (1961) 69(3) *Journal of Political Economy* 213, 214, 219.

337 Organisation for Economic Co-operation and Development, 'Unilateral Disclosure of Information with Anticompetitive Effects' (Policy Roundtable, 11 October 2012) 11. <http://www.oecd.org/daf/competition/Unilateraldisclosureofinformation2012.pdf>.

338 Ibid.

339 See, eg, Edward J Green and Robert H Porter, 'Noncooperative Collusion under Imperfect Price Information' (1984) 52(1) *Econometrica* 87, 91, 93–4.

> to prices, providing them with focal points, which may be used by firms to align their behaviour.[340]

Economists have reached similar conclusions.[341] They have shown the risk of coordination is greater where there is a homogenous market or increased supply-side transparency.[342]

(b) Market Transparency in the NEM

In the NEM, bids and prices are highly transparent. All bids are collected by AEMO and made publicly available online.[343] The price is also published online in real-time.[344] This means that firms have significant transparency over each other's bids and the spot price.

What impact does this high transparency have on competition in the NEM? In its original 1997 authorisation of the *NER* (then known as the *National Electricity Code*), the ACCC identified the increased risk of tacit collusion with higher market transparency, stating: '[a] major concern in the [release of bidding information] is the scope for strategic behaviour and/or tacit collusion between competitor generators in the market'.[345]

It also noted that the lack of consumer response reduced the pro-competitive considerations for higher transparency.[346] Nevertheless, the ACCC concluded that this concern could be mitigated with market monitoring, stating:

> On balance … the Commission will permit this information to be disclosed on condition that provision is made for daily monitoring of the market … If sufficient evidence of anti-competitive conduct is available the Commission may take action under the [*Trade Practices Act*].[347]

(c) Solution: Reduce Bidding Transparency

In relation to tacit or autonomous algorithmic collusion, the ACCC's earlier conclusion is no longer appropriate. Unless provision is made for dynamic monitoring, existing market monitoring powers are static and unable to monitor the impact of colluding algorithms. The ACCC, as discussed above, is also unable to take action under the *Act* for algorithmic collusion without communication. Finally, the movement towards 5-minute settlement and algorithmic bidding greatly increases the risk of anti-competitive behaviour. These issues tip the

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340 OECD, 'Unilateral Disclosure of Information with Anticompetitive Effects' (n 337) 11.

341 See, eg, Christian Schultz, 'Collusion in Markets with Imperfect Price Information on Both Sides' (2017) 50(3) *Review of Industrial Organization* 287, 288; Green and Porter (n 339) 91, 93–4. See also Byrne and de Roos (n 148).

342 Schultz (n 341) 288.

343 See, eg, 'Data (NEM)', *AEMO* (Web Page, 2020) <https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/data-nem>; 'Market Data NEMWEB', *AEMO* (Web Page, 2020) <https://www.nemweb.com.au/>.

344 See 'Data (NEM)' (n 343).

345 Australian Competition and Consumer Commission, 'Application for Authorisation: National Electricity Code' (Authorisation Application No CA96/21, 10 December 1997) 106.

346 Ibid 103.

347 Ibid 107.

balance in favour of reducing market transparency. It is, therefore, recommended in this article that bidding transparency in the NEM be reduced.

In principle, market generators could still compete efficiently by bidding in accordance with market demand and their own costs.[348] Costs are already known to market generators. Market demand is reflected in the spot price. Notably, other bids are *not* relevant to achieve this efficient outcome.[349] Accordingly, the reduction of bidding transparency means that efficient outcomes can still be achieved in the NEM while mitigating the likelihood of tacit and autonomous algorithmic collusion.

This approach effectively balances the pro- and anti-competitive impacts of algorithmic technology. It mitigates the likelihood of tacit and autonomous algorithmic collusion without significantly compromising the potential pro-competitive benefits of algorithmic technology. While it could be argued that it reduces certainty for generators as there is less information on other competitors to 'benchmark', generators could still 'benchmark' against the real-time price. Thus, the benefits of reducing the risk of algorithmic collusion likely outweigh the cost of reduced information.

By ensuring that bids are not publicly available, the likely interpretation of the concerted practices prohibition may prevent further attempts to collude. Such conduct could possibly amount to the sharing of commercially sensitive pricing information and would likely breach section 45(1)(c).[350] Therefore, reducing bidding transparency may further reduce the likelihood of coordinated anti-competitive practices in the NEM by enlivening the concerted practices prohibition.

C Prohibition: A Novel Definition To 'Concerted Practice'

Finally, this article proposes a novel definition of 'concerted practice' that, if adopted, could prohibit algorithmic collusion that occurs without communication. This would require legislative amendment, with the current definition in section 45(1)(c) unable to prevent such collusion.

(a) Solution: The Proposed Novel Definition

It is proposed that 'concerted practice' be defined with reference to awareness and ex-post economic outcomes rather than communication. For example, this means that if a market generator becomes aware their algorithm has a high likelihood of engaging in anti-competitive conduct and the generator takes no reasonable steps to prevent the conduct, then it is liable under section 45(1)(c) for a concerted practice. Awareness should also include when notice is given by a competition regulator. This approach is derived in part from the work of Kaplow and European case law, as explored in Table 2 (below):

348 Biggar and Hesamzadeh (n 24) 122.

349 See ibid.

350 'Guidelines on Concerted Practices' (n 237) 4–5 [3.5]; Explanatory Memorandum, Competition and Consumer Amendment (Competition Policy Review) Bill 2017 (Cth) 30–1 [3.27]–[3.28]; Jedličková, (n 5) 320.

Table 2: Differences in the Approach to Proving a 'Concerted Practice'

	Likely Interpretation of Section 45(1)(c)	**Kaplow's Approach**	**European Approach**	**Proposed Novel Approach**
Evidence to Prove a 'Concerted Practice'	Communication (at a minimum)	Ex-post economic analysis	Communication, awareness, and no 'public distancing'	Ex-post economic analysis, awareness, and no reasonable steps to prevent the conduct

(b) Kaplow's Approach

Kaplow explores the *Sherman Antitrust Act*[351] §1, the United States of America's parallel prohibition against cartel conduct, and argues that it should be interpreted without exclusive regard to communications between colluders.[352] Instead, it should be interpreted with reference as well to ex-post economic analysis to determine whether firms have adopted anti-competitive pricing.[353] Although Kaplow recognises that this approach comes at the risk of increased legal uncertainty and a 'chilling effect' on competition,[354] he argues that ex-post economic analysis provides an avenue through which competition law can prevent forms of tacit collusion.[355] Indeed, recent economic research has shown that this ex-post economic analysis is possible whilst also highlighting occurrences of tacit collusion[356] and algorithmic collusion in real-world marketplaces.[357]

It is not suggested in this article that the interpretation of 'understanding' under Part IV of the *Act* should be altered. Rather, it is suggested that the definition of 'concerted practice' should be expanded so as not to require communication. While continuing to target the same anti-competitive behaviour, this definition could be proved based on ex-post economic analysis, similar to that already conducted by economists in real-world marketplaces.[358] By not requiring communication while still preventing concerted behaviour that substantially lessens competition, this definition fills the lacuna in Australian law. It also enables the balancing of the pro- and anti-competitive impacts of algorithmic technology.

Kaplow's approach does not come without its difficulties. Posner has concluded that 'any remedy for tacit collusion is likely to impose significant social costs',[359] including a 'chilling effect' on potentially pro-competitive behaviour, particularly where the competitive impact is difficult to measure.[360] Posner states that courts

351 *Sherman Antitrust Act*, 15 USC §§ 1–7 (2012).
352 Kaplow (n 50) 74–5, 138–45, 448.
353 Ibid 255–75, 448. See also Kaplow (n 50) 244.
354 Ibid 239–48, 255, 448–9.
355 Ibid 259, 261.
356 See, eg, Byrne and de Roos (n 148).
357 See, eg, Assad et al (n 5).
358 See Byrne and de Roos (n 148); ibid.
359 Posner (n 50) 767, citing Kaplow (n 50).
360 Posner (n 50) 767–8.

would have similar difficulties in determining whether collusive behaviour has occurred if they rely exclusively on economic evidence.[361]

In the NEM, the use of this approach alone would create significant uncertainty for market generators because generators who adopt algorithmic technology may not know whether they have contravened the *Act*.

(c) Addition of the Modified European Approach

To overcome this uncertainty, it is recommended that any revised definition of 'concerted practice' combine Kaplow's approach with elements of the European approach, that is, awareness and no 'public distancing'. However, in the context of tacit and autonomous algorithmic collusion, 'public distancing' should be modified to mean 'reasonable steps to prevent the anti-competitive behaviour'.

This means that a generator would be liable for anti-competitive behaviour (proven with reference to ex-post economic analysis) if they are aware of the behaviour and take no reasonable steps to prevent the conduct. Under the Australian regime, awareness should include knowledge of a high likelihood of anti-competitive behaviour that can be established by notice from the regulator. Accordingly, generators cannot escape liability simply by purposefully ignoring the behaviour of their algorithms. Even if the algorithm autonomously learns to adopt collusive strategies, the market generator could still be liable for the conduct once they become aware of its behaviour and take no reasonable steps to prevent the conduct.

(d) Assessing the Proposed Novel Definition

The novel definition proposed in this article fills an ever-increasing gap in Australian competition law. It prohibits tacit and autonomous algorithmic collusion without compromising the algorithmic technology's potential pro-competitive benefits, with liability only arising if, on the ex-post economic analysis, there is anti-competitive conduct.

One might argue the novel definition reduces certainty for market generators because it exposes market generators to liability they may not be able to prevent. For example, if a generator purchases an algorithm from a third-party supplier and that algorithm begins to autonomously collude, the generator risks being found liable for a 'concerted practice', despite lacking the technical expertise required to prevent the behaviour. Much of this risk is removed under this proposed solution by legislating that market generators can only be held liable in the event they become aware of the anti-competitive behaviour of their algorithm and fail to take reasonable steps to prevent the conduct.

However, as stated above, this does not allow generators to purposefully ignore the behaviour of their algorithms. Awareness, including knowledge of a high likelihood of anti-competitive behaviour, is sufficient. As the European Competition Commissioner, Margrethe Vestager, states: 'companies can't escape

361 Ibid 764, citing Kaplow (n 50).

responsibility for collusion by hiding behind a computer program'.[362] Further, there are other steps that a generator can take to reduce their uncertainty, including dispersing the risk of a financial penalty for breach of section 45(1)(c) between algorithm provider and generator through private agreements. Thus, on balance, the benefit of preventing tacit and autonomous algorithmic collusion likely outweighs the cost of generators preventing their algorithm from colluding.

VII CONCLUSION

There is still some uncertainty regarding the extent that tacit and autonomous algorithmic collusion will appear across markets.[363] Some scholars have suggested this conduct should not be of major concern because there are limited markets that are at risk of such behaviour.[364]

However, the NEM is a market that exhibits high-risk characteristics. It is highly concentrated,[365] highly transparent,[366] and involves a homogenous product, that is, the supply of electricity. In 2019, the NEM traded 205.5 TWh of electricity (AUD18.6 billion) and served 10 million end-consumers.[367] Wholesale electricity cost was the second-largest contributor to the increase in residential customer bills from 2007–08 to 2017–18.[368] If tacit or autonomous algorithmic collusion were to occur in the NEM, this would mean significantly higher prices for millions of Australians.

With the NEM moving to 5-minute settlements and the resulting increase in the use of algorithmic technology, this research has established that Australian competition law is not currently able to prevent tacit or autonomous algorithmic collusion in the NEM. Throughout this article, the three provisions in the *Act* that could possibly prevent tacit or autonomous algorithmic collusion were examined: (i) the cartel prohibitions under Part IV; (ii) the new concerted practice prohibition under section 45(1)(c); and (iii) the misuse of market power prohibition under section 46. This research highlighted that none of these existing approaches is fit for purpose. Communication is required to establish a breach of Part IV and is likely required to prove a concerted practice under section 45(1)(c). Further, the misuse of market power prohibition targets unilateral conduct and, therefore,

362 See Kat Hall, 'Algorithms No Excuse for Cartel Behaviour, Says European Commish', *The Register* (Blog Post, 16 May 2017) <https://www.theregister.co.uk/2017/03/16/algorithms_no_excuse_for_cartel_behaviour_says_european_commish/>.

363 See Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18); Gal (n 2); Calvano et al, 'Algorithmic Pricing What Implications for Competition Policy?' (n 5). Cf Schwalbe (n 15); Harrington (n 5).

364 Schwalbe (n 15); Veljanovski (n 15) 1–2; Thibault Schrepel, 'The Fundamental Unimportance of Algorithmic Collusion for Antitrust Law', *Jolt Digest* (Web Page, 7 February 2020) <http://jolt.law.harvard.edu/digest/the-fundamental-unimportance-of-algorithmic-collusion-for-antitrust-law>. Cf Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 628–9.

365 *REPI Final Report* (n 37) vi, vii. See also *State of the Energy Market 2020* (n 23) 83.

366 See, eg, 'Data (NEM)' (n 343).

367 *State of the Energy Market 2020* (n 23) 70 [Table 2.1].

368 *REPI Final Report* (n 37) v, vi.

it appears unlikely that a court would find a contravention of section 46 simply because a firm unilaterally sets higher prices through an algorithm.

Accordingly, this article provides some pragmatic, nuanced solutions to the threat of algorithmic collusion without communication in the NEM. To ensure that regulators can identify such algorithmic collusion, this article recommends a notification regime. To prevent and mitigate the likelihood of algorithmic coordination, it advocates for reducing the transparency of bids in the NEM. Finally, to ensure that such conduct is captured by Australian competition law, it proposes the adoption of a novel definition of 'concerted practice'. Under this definition, anti-competitive concerted behaviour would be proved by ex post economic evidence.[369] However, a generator would only be liable if they are aware of the behaviour (including aware of a high likelihood of the behaviour occurring) and do not take appropriate steps to remedy the behaviour.

More generally, the approach in this article highlights an important pathway for analysing tacit or autonomous algorithmic collusion in future, despite the uncertainty around its occurrence in markets. It is clear that the competitive impact of algorithmic technology depends on the circumstances within which it is deployed. For example, where a market is not transparent, not highly concentrated, and has low barriers to entry, then there is low risk of tacit or autonomous algorithmic collusion. However, this means that algorithmic collusion may need to be analysed *by market* rather than *by prohibition*.

The NEM is a useful example. It is unique in that it is governed by a separate set of rules and regulators which allow for more targeted and nuanced intervention. The recommendations made in the context of the NEM may not be appropriate for other markets. If, in future, we obtain a deeper understanding of the occurrences of tacit or autonomous algorithmic collusion, then it may be appropriate to undertake a more uniform approach.

In the meantime, regulators may benefit from further research on tacit or autonomous algorithmic collusion in high-risk markets, that is, those with high market concentration,[370] high transparency,[371] high barriers to entry,[372] homogenous goods,[373] and frequent transactions.[374] Potentially these markets may include petrol, banking and finance, and some online marketplaces. However, further research into the use of algorithmic technology in these industries is required.

369 See Kaplow (n 50) 448, cited in Posner (n 50) 761.

370 Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 628.

371 Ibid 628–9; Gal (n 2) 73, citing George J Stigler, 'A Theory of Oligopoly' (1964) 72(1) *Journal of Political Economy* 44, 44–6.

372 Gal (n 2) 73, citing Marshall and Marx (n 19); Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 624, 630.

373 Schwalbe (n 15) 590–1.

374 Stucke and Ezrachi, 'Antitrust, Algorithmic Pricing and Tacit Collusion' (n 18) 629–30; Schwalbe (n 15) 590–1.