

The Role of Algorithmic High-Frequency Signaling in Collusion¹

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Section 1

Research Context

Contributions

- 1 A literature review of algorithm-based collusion
- 2 A focus on the use of algorithmic price signals to achieve collusive equilibria
 - On financial markets, high frequency orders may be used to mislead competitors
 - In the field of competition, price movements may signal a will to collude and to identify a focal point for coordination or cooperation
- 3 for oligopolists: decipher the algorithms and identify weak signals despite the noise
- 4 For antitrust enforcers: identifying collusive patterns and searching for weak signals to characterize facilitating practices

Context

- A burgeoning literature on algorithmic collusion, price discriminations. . . contrasting with the initial promises of algorithms
- Some contradictory views: collusive patterns vs prices instability proliferation, and opacity
- Focusing on the case of algorithmic based collusions
 - Issue of plausibility
 - Issue of capacity to detect and to sanction
- Presenting the whole scope of algorithm-based collusion
- Focusing on one of them: signaling algorithms (unilateral communication / artificial transparency)

Outline

- 1 A review of literature
- 2 Ensuring the cartel police through algorithms
- 3 Coordinating prices through parallel algorithms
- 4 Signaling an intention to collude
- 5 Letting algorithms collude
- 6 Concluding remarks

Section 2

Literature Review

Literature Review

Algorithmic collusion:

- Pioneering contribution of Ezrachi & Stucke (2015) : the bot-led collusion
- A scenario challenged : legal sci-fi, economist catnip. . .
- Algorithms – especially AI based ones- may overcome the conventional pitfalls of oligopolistic collusion
- Imperfect monitoring and retaliations capacities can be addressed by spiders (see Asus case, 2018)

Literature Review

Algorithmic collusion:

- The difficulty to achieve a tacit collusion equilibrium may be overcome without requiring communications among competitors
- A parallel conduct and a rational adjustment to market signals is not anticompetitive in itself
- Facilitating practices might be necessary in some situations

Literature Review

Tacit collusions and facilitating practices:

- The identification of the focal point may be realized through a trials and errors process or through facilitating practices
- Coordination through a barometric firm
- Unilateral act from a Stackelberg leader

Literature Review

Tacit collusions and facilitating practices:

- Invitation to collude: offer of a unilateral contract according to Posner (Fructose Corn Syrup, 2002)
- Successive rounds to test competitors' preferences (Airlines Tariff Publishing Co., 1994; Containers Shipping, 2016)

Research Question

- Algorithms as game changers?
 - Weak signal: invitation hidden in proliferating price signals
 - Information treatment capacities, instantaneous adjustments

Section 3

Ensuring the cartel police through algorithms

Ensuring the cartel police through algorithms

The algorithm and the police of the cartel:

- Overcoming the hazards of cartel agreements enforcement and tacit collusion equilibrium maintenance by
 - Acquiring a God view
 - Gaining the capacity to engage immediate retaliation measures
- The role of surveillance algorithms (EU Commission enquiry on e-commerce, 2017; Stigler Center report, 2019)

Ensuring the cartel police through algorithms

The algorithm and the police of the cartel:

- A dual role?
 - Using spiders is not anticompetitive in itself
 - Price monitoring can also be used by enforcement authorities
 - Justifying abnormal price patterns
 - Reversal of the burden of proof (Crémer, de Montjoye, and Schweitzer, 2019)
 - Otherwise, a black box based defense. . .

Section 4

Coordinating prices through parallel algorithms

Coordinating prices through parallel algorithms

Coding for colluding: parallel algorithms

- Using the same algorithm (Topkins case)
- Opting for the same algorithm developer than its competitors (Chinese wall related issues, data set used for the training. . .)
- Implementing a hub & spoke device through an intermediary platform (Heinemann and Gebicka, 2016)

Coordinating prices through parallel algorithms

Coding for colluding: parallel algorithms

- Colluding through awareness (Eturas case, 2016)
 - How to express a disagreement in such cases?
- Increasingly convergent algorithms through training, exploration and exploitation decisions
 - Cooperation emerging through rational behavior
 - Give-and-take logic, iterated prisoners dilemma, tit-for-tat (Axelrod, 1984)

Section 5

Signaling an intention to collude

Signaling an intention to collude

Signaling algorithms:

- The signal produced by the Stackelberg leader acts as an invitation to invitation to align on a focal price – possibly on future price
 - The reactions of the competitors indicate their acceptances (see Air Tariff Publishing Co analysed by Borenstein, 2003)

Signaling an intention to collude

Signaling algorithms:

- An analysis in terms of non-cooperative games (Kaplow, 2011)
 - Reasoning in terms of super-games (indefinitely repeated interactions)
 - A multiplicity of possible equilibria: algorithms and equilibrium selection
 - Cooper et al. (1989) show that in a coordination game, the probability of reaching a mutually favorable balance is
 - 48% without communication
 - 55% with bilateral communication
 - 95% in unilateral communication

Signaling an intention to collude

Signaling algorithms:

- An unilateral announcement is a credible commitment
 - reputational effect:
 - Friedman (1971) : “the act is the message”
 - Schelling (1960): “talk can be cheap when moves are not”

Signaling an intention to collude

Signaling algorithms:

- A communication through (unilateral) transparency (Salcedo, 2015)
 - the leader periodically and unilaterally makes its algorithm possible to decipher.
 - If third parties are not “cooperative,” the leader may lose his algorithmic advantage
 - By enabling other algorithms to “read their minds”—either directly (by exposing the algorithm), even before any action was taken by them, or indirectly (through its actions and reactions)—they limit the need for direct communication or physical meetings” (Gal, 2020)

Signaling an intention to collude

Signaling algorithms:

- An unilateral announcement is equivalent to a communication according to EU Commission
 - Container Shipping decision (2016) – influencing competitors' future behavior
 - Receiving the signal is sufficient to be incriminated
 - The signal is supposed to be accepted (Anic case presumption)
 - What about algorithmic signals?

Signaling an intention to collude

Signaling algorithms:

- A parallel with financial markets and high frequency trading
 - Scintillating orders
 - Weak price signals
 - Kaplow (2011) : “suppose that a consulting firm creates and sells to all the firms in an industry a detailed signaling system using, say, the fifteenth and sixteenth decimal place of a price announcement or of the number of milliseconds that elapse between electronic transmissions dollars and cents, reconstructing all forbidden magic words or anything else that may prove useful”

Signaling an intention to collude

Signaling algorithms:

- Enforcement issues
 - Monitoring prices, detecting weak signal
 - Financial market based regulatory tools

Section 6

Letting algorithms collude

Letting algorithms collude

AI, machine learning, and Bot initiated collusions:

- A scenario crafted by Ezrahi and Stucke (2015), challenged by Ito and Petit (2017) and confirmed by Calvano et al. (2019)
 - Q-learning algorithms, numerical simulations
- Compliant with the framework of evolutionary games
 - Hingston and Kendall (2004); Agrawal and al. (2011)
 - ML leads to better results than tit for tat

Letting algorithms collude

AI, machine learning, and Bot initiated collusions:

- Enforcement issues
 - Reversal of the burden of proof
 - [A] showing that the defendant acted contrary to its legitimate economic self-interest. . . is sufficient to satisfy the requirement that the plaintiff show 'plus factors' beyond mere consciously parallel action - City of Tuscaloosa v. Harcros Chems., Inc, 1998
 - AI-based algorithm: a facilitating practice per se
 - Algorithmic collusion incubators (Ezrachi and Stucke, 2017)

Section 7

Conclusion

Conclusion

- Renewing with the special responsibility standard?
 - A negligence rule
 - A reversal of the burden of proof as soon as an abnormal price pattern is observed
- Increasing false positive risks
- Paradoxical injunctions
 - Transparency vs decipherability
 - Data and algorithms as essential facilities

Conclusion

Symmetric & Asymmetric	Information Nature	Instrument
Algorithms & Collusion	Passive information	Ambiguity
	Active Information	Random signaling
	Active information	Retaliation
Keystones & Market Dominance	Eviction	Threat
		Innovation rate
		Innovation timing
	Exploitation	Tourists and Natives

Conclusion

Instrument	Resulting Mechanisms
Ambiguity	Cooperation
Random signaling	Cooperation
Retaliation	Coordination
Threat	Cooperation
Innovation rate	Forced coordination
Innovation timing	Forced cooperation
Tourists and Natives	Forced cooperation

Section 8

References

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