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Strategies for Dealing with Algorithmic Collusion in the Era of E-commerce

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Abstract: In the rapidly evolving e-commerce landscape, algorithmic collusion has emerged as a sophisticated method for businesses to engage in anti-competitive behavior without explicit agreements. This paper delves into the complexities of algorithmic collusion, examining how modern information technologies facilitate these covert practices. This study underscores the profound impact on market competition and consumer rights by categorizing the different types of algorithmic collusion and analyzing their implementation mechanisms. Furthermore, it highlights the deficiencies in current antitrust frameworks and the urgent need for legal and regulatory reforms. The paper concludes with strategic recommendations to enhance market transparency and fairness, ensuring that technological advancements do not undermine competitive equity.

Keywords: Algorithmic Collusion, Anti-competitive Behavior, Antitrust Laws

1. Introduction

With the rapid advancement of modern information technology, emerging fields such as algorithms have significantly altered traditional ways of life and production. The expansion of e-commerce, in particular, has revolutionized how business is conducted, changing the competitive landscape substantially. Traditionally, cartels are understood as agreements among competitors to fix prices, limit production, or divide markets. However, algorithms' efficient and high-speed processing capabilities challenge these conventional notions. Algorithms can process large batches of data swiftly, and with precisely defined instructions, they can deliver optimal results and operational steps, saving significant amounts of money, time, and resources.

Consequently, their use has become increasingly favored by businesses. The emergence of algorithms has introduced new avenues for anticompetitive behaviors. E-commerce platforms, equipped with vast repositories of consumer data and powerful analytics tools, offer companies unprecedented opportunities to engage in subtle and hard-to-detect collusive practices. Algorithms used in pricing and inventory management, while boosting operational efficiency, also facilitate implicit cartel behaviors. They can automate price fixing and supply adjustments, a phenomenon often called "algorithmic collusion", which represents a critical evolution in cartel practices, which necessitates a thorough examination of its implications for market competition and consumer rights. This paper aims to conduct an in-depth analysis of algorithmic collusion across four distinct dimensions. The first dimension explores algorithmic collusion's concept and implementation mechanism, detailing how algorithms are designed and used for anticompetitive purposes. The second

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dimension makes an in-depth analysis of the four types of algorithms and understands how various algorithms are used to manipulate market competition in practice, which is of great significance to regulators, enterprises and consumers. The third dimension pair assesses the damage caused by algorithmic collusion and its challenge to existing legal frameworks, highlighting that traditional law may not deal with this complex collusion. Finally, the fourth dimension Outlines recommendations to effectively address and prevent algorithmic collusion, proposing legal and regulatory reforms and technological solutions to improve market transparency and fairness.

2. The Concept of Algorithmic Collusion

Law has long been seen as lagging behind technological innovation.[1] Access to technology, data, and the Internet drives economic opportunity and efficiency.[2] We must first understand this new thing to make corresponding rules to limit. Algorithmic collusion uses intelligent algorithms as a technical factor to promote collusion and make automatic decisions through coding and data by using algorithms' "black box" characteristics so enterprises can complete collusion without communication and interaction.[3] *Algorithmic collusion* is a monopoly agreement that uses an algorithm as a tool. It can be divided into explicit and implied collusion. Explicit collusion refers to, with computers' help, the human extension of the technical level of monopoly agreement with the algorithm as the medium, which cannot get rid of the shackled by people's subjective will and belongs to explicit collusion. Implied collusion refers to the "feeding" of algorithms by big data and the independent optimization of algorithms. In the predictive and autonomous algorithm collusion, the algorithm can form a self-concept based on an advanced artificial intelligence neural network, operate independently from human beings, make automatic decisions based on analyzing and learning market changes, and independently reach implied collusion. In implied collusion, business operators do not make clear-meaning contact but cooperate through algorithms, grasp the market, spontaneously adjust product prices to maintain consistency, and reach collusion. Although there is an intention to collude among the operators, there is no explicit collusion agreement. Compared with explicit collusion, implied collusion is more challenging to reach. At the same time, the concealment of implied collusion and the immaterial and changeable nature of the algorithm itself brings significant obstacles to the anti-trust regulation of algorithm collusion.

3. Classification of Algorithmic Collusion

There are specific application links and interactions between the types of algorithms and the types of algorithmic collusion. By grasping competitors' information, the algorithm captures their price data and changes and adjusts the price of its products accordingly to converge or float with them. Due to the concealment of the algorithm itself, it is easier to reach collusion. With the innovation of the Internet business model and the development and change of practice, the algorithm provides more ways to achieve collusion. There are many ways to realize algorithmic collusion, which is a big challenge to the antitrust regulation of collusion. First, the widely used algorithm types are analyzed to determine their nature, followed by targeted regulation. Professors Ariel Ezrachi and Maurice Stucke outline four classes of algorithms that raise price collusion concerns.[4] The first is messenger-like collusion, where computers enforce human willingness to collude to limit competition with the identity of a human messenger. In this case, the purpose of human collusion is to voluntarily reach a cartel using computers to implement, monitor and manage the cartel, executing its orders on behalf of humans. Such behaviour may be consistent with the traditional way of conspiracy. With computers' help, humans can reach agreements or act in concert. In this kind of collusion, humans are the manipulators and masters of the cartel, and computer algorithms act as mere "messengers" programmed by humans to help implement, monitor, and punish deviations from the cartel. In this

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type of conspiracy, the stronger the proof of an anticompetitive agreement, the less is the need to prove an intent to collude. Of course, the intentions of cartel members play an important role in determining the illegality of the conduct. In a particular act, the law considers the actor's intention. In the messenger scenario, the performance of the contract is likely to violate Part IV Division 1 of the CCA and give rise to liability on the part of the parties themselves.[5] The second is hub-and-spoke conspiracy, in which multiple firms use the same computer algorithm to determine or react to market prices. At this point, a single vertical agreement cannot have the effect of restricting competition by itself, nor does it necessarily reflect the intention of actors to distort market prices.[6] However, suppose many competitors in the same industry reach similar vertical agreements simultaneously. In that case, it may lead to the hub and spoke conspiracy, and then, with the help of computer algorithm developers, it may form an industry-wide conspiracy, leading to price increases. Because evidence of the competitive effects of these vertical agreements is intertwined, evidence of collusive intent can help competition authorities assess the purpose of the agreement and its likely competitive effects. In hub-and-spoke collusion, there is no horizontal competition between developers and users of algorithms, so the contractual relationship between them should be defined as a vertical agreement. The third is predictive collusion, in which computer algorithms developed by different firms and similar designs monitor market activities and rationally implement price-following behaviour.[6] In this case, there is insufficient evidence to prove the existence of an agreement (whether horizontal or vertical). Each operator independently develops machine algorithms but knows that his competitors develop similar ones. Using similar algorithms across the industry increases firm dependence, which can lead to anticompetitive effects. Although there is no written or oral agreement, there are conditions for forming implied collusion or conscious parallel behaviour in the market. Because implied collusion is not illegal, evidence of intent to change market conditions is particularly important in such a conspiracy. This situation brings many challenges to the enforcement of antitrust law. In essence, conscious parallelism occurs at two levels: first, when designing the computer algorithm, each party, independent and not colluding, understands that, whenever possible, the dominant strategy of the computer algorithm is to follow the price increase of the others. Second, each side understands that if the other side sets up similar procedures, it will establish a market equilibrium that exceeds the competitive level. This division of conscious parallel actions according to agent criteria leads the programmed computer to recognize conscious parallel actions in the market. Thus, human-controlled computers can monitor markets and explore the possibility of establishing mutual behaviour without taking risks to achieve coordinated behaviour or implied collusion. At the same time, computers are programmed to punish deviations from implied agreements and to identify disagreeing firms that deviate from market equilibrium. There is nothing inherently illegal about computers reacting rationally to market dynamics. In the absence of communication and collusion, even if such behaviour results in a market equilibrium above the competitive level, it does not necessarily lead to the intervention of the antitrust law. The relevant institutions cannot condemn firms for engaging in rational and independent behavior in the market. Because the parties do not have an agreement to change market conditions, most competition authorities lack other regulatory tools. The fourth is autonomous collusion, in which competitors independently develop and use computer algorithms to achieve established goals such as profit maximization.[6] Through self-directed learning and experimentation, computer algorithms can decide how to optimize profits. In such a conspiracy, legal thinking and agreement qualified by intent are difficult to apply. Based on self-learning and feedback from data gathered from the market, the computer can implement whatever strategy it deems best. Because of its unique nature, autonomous conspiracy is the most intractable for the legislature.

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4. The Urgency of Improving Algorithmic Collusion Rules

As the product of technological progress, algorithmic collusion can stimulate market innovation and pose a severe threat to market competition and consumer rights and interests, presenting a "double-edged sword" effect. Because of this, this paragraph will focus on the urgency of regulating algorithmic collusion and comprehensively examine its harmful effects and the challenges the current legal framework faces in regulating such behavior. This paragraph will be divided into two main parts: first, an in-depth discussion of how algorithmic collusion damages the fairness of market competition and consumer interests by affecting the pricing mechanism and market information flow; Secondly, it analyses the dilemma of the existing legal system in the face of algorithmic collusion, especially in the context of rapid technological development and changing market dynamics, how the existing laws respond to these challenges and protect the market and consumers from unfair competition.

4.1. The harm of algorithmic collusion

The assistance of the algorithm, on the one hand, makes it easier for operators to reach or maintain collusion without a substantial agreement, which reduces the difficulty of operators in achieving and implementing the conditions of collusion and also reduces the risk. On the other hand, advanced algorithm technology is used for collusion, leading regulators to update their technology before they can supervise this behaviour, further increasing the difficulty of relevant authorities to supervise algorithm collusion.[7] Algorithm collusion has a significant impact on market competition. The harm of algorithm collusion can be divided into two types: damaging market competition, infringing on consumer rights and delaying economic efficiency. The first is for markets. Algorithmic collusion will disrupt the order of market competition. Collusive behaviour will break the balance of free competition in the market, while applying algorithms will aggravate the tilt of the balance. Companies with competitive relations reach an agreement through algorithm collusion and increase product prices to maximise profits, destroying the competition regulation mechanism of market freedom. Survival of the fittest is the key to the market. Collusion threatens the regular operation of the survival of the fittest market law, making these companies involved in algorithmic collusion group together and control the market by unconventional means, which is unfair for those companies not engaged in algorithmic collusion, thus compressing the vitality of the market and leading to the gradual extinction of small and medium-sized companies. At the same time, it also reduces the stimulus of market competition to innovation and lowers market efficiency. The second is for consumers. For consumers, algorithmic collusion will violate their rights and interests. The company mines data through algorithms, adjusts prices through big data to meet consumer demand, and even predicts market demand. No matter which algorithm operators use to formulate sales strategies, the advertising and object positioning they provide are based on consumers' individual needs. The algorithm improves the accuracy of consumer demand, offers better services or products, and is conducive to consumers choosing products that meet their needs. According to consumers' consumption level and intention, operators put non-market price determinants in the first place when presetting algorithms. When pushing products, the products that can reach the highest price consumers are expected to pay are often forced to maximise the revenue under the condition that consumers voluntarily shop. The platform's algorithmic collusion leads consumers to choose more expensive products, and consumers do not detect such behaviour. Ultimately, the range price difference is borne by consumers, which damages the interests of consumers.

4.2. The dilemma of algorithmic collusion in law-making

Algorithmic collusion has not been defined as illegal in Australia, but any form of market manipulation or price collusion, algorithmic or otherwise, could violate existing antitrust rules. Many

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companies have received antitrust penalties for using algorithms to collude, but it is difficult to progress on algorithmic collusion rulemaking. Both operators and anti-monopoly agencies must understand the complex algorithm logic and the new market mode to better discuss the regulations under the new technology and maintain fair competition in the Internet market. Traditional anti-monopoly law takes human competition behaviour as the content of regulation. Compared with traditional collision behaviour, algorithmic collusion is beyond the scope of conventional law because of its unique nature. So, the current rules related to algorithmic collusion need to be revised. The first is that the nature of collusive agreements is complex to determine.

The application of algorithms makes the achievement of collusion more complicated. Suppose two or more enterprises do not participate in the discussion and successively carry out the same or consistent behaviour. In that case, they cannot be deemed to have reached a monopoly agreement. The Sherman Act's requirement for agreement, both implicit and explicit, makes the act an ineffective tool in the face of firms that need to explicitly coordinate with each other, as outlined in the predictable agent and numerator scenarios. However, the subsequent FTC bill addressed the issue. The second point is that the subjective intention of collusion is challenging to clear. As a computer program, algorithms are immaterial and diverse, challenging to handle and analyse. Especially in the collusion formed independently by artificial intelligence algorithms, algorithmic collusion may be carried out by human beings but by algorithms with the knowledge of developers after continuous updating and evolution. In this way, it is difficult to prove that the collusion behaviour autonomously implemented by the algorithm has a human will. The third point is that it is challenging to allocate legal responsibility. For formulating algorithmic collusion rules, finding the right subject to accept legal accountability is necessary. The traditional imputation mechanism is no longer applicable. Under algorithmic collusion, the subjects who reach collusion include operators, algorithm developers, and computer algorithms. It is difficult to identify the subject responsible for algorithm collusion because the current law needs to stipulate the proper ability and behavioural ability of computer algorithms. Humans research and develop computer algorithms, and the developers do not necessarily intend monopoly or collusion. Suppose the designers or users of computer algorithms are allowed to bear the responsibility. In that case, it must be proved that the developers or users intend collusion and have reached collusion. The issue clearly demonstrates whether it makes sense to place antitrust blame on someone when a business strategy is delegated to a computer algorithm, and humans can influence the way such decisions are made. Algorithmic collusion raises legal liability problems, which require further discussion on liability allocation according to specific circumstances.

5. The Strategy of Improving Algorithmic Collusion Rules

With the rapid development of modern information technology, algorithmic collusion has gradually become a new challenge in market regulation. Algorithms, especially in pricing and market decisions, have brought unprecedented efficiency and dynamism to business operations. However, the progress of this technology also brings new regulatory problems -- how to effectively identify and prevent illegal collusion among algorithms and protect fair competition in the market and the interests of consumers. In this context, it is particularly urgent to strengthen the improvement and enforcement of algorithmic collusion rules. This paragraph will explore this issue in depth in two parts. Firstly, from the regulators' perspective, this paper analyses how to improve the ability to monitor and respond to algorithmic collusion through technology and personnel training. Secondly, from the perspective of legislation, it discusses how to curb the occurrence of algorithmic collusion more effectively by clarifying legal liability and adjusting regulatory strategies to ensure the balance between technological development and market regulation.

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5.1. Part of the supervisory organ

The algorithm belongs to modern information technology and has yet to be integrated with traditional law. The watchdog must be equipped with powerful tools to detect price changes. Technicians with rich knowledge of algorithms are needed first. Regulatory agencies should carry out targeted knowledge training for law enforcement personnel, popularise relevant algorithm knowledge, and fill the information gap caused by professional barriers. In this way, anti-monopoly law enforcement personnel can avoid regulatory omissions caused by backward technology to a certain extent, monitor operators' algorithmic collusion behaviour, and carry out more accurate identification. Expertise in statistical algorithms is essential. The supervisory authority must be equipped with appropriate information-gathering capabilities because it is vital to detect potential violations to maximize deterrence.[8] To analyze large amounts of data, process the collected information and carry out further investigations, supervisory authorities rely on the knowledge and experience of their staff. Modern technology and software are also needed for staff with expertise. The algorithm captures and identifies big data. Regulators can cooperate with other departments to design a set of algorithms dedicated to price change supervision, which can destroy the activities of algorithm collusion on the one hand, capture the signal of algorithm collusion on the other hand, quickly retain the evidence of suspected monopoly through algorithm collusion, and significantly reduce the work pressure of supervisors while improving the accuracy of monitoring. The idea is to monitor the price movements of a variety of products in a variety of markets. Where there is a clear allegation of conspiracy, an investigation can be initiated in the context of an antitrust division investigation. The use of price monitoring and verification software can support the work of competition and regulatory authorities. If algorithmic price adjustment anomalies may collude, one approach is for the department to introduce policies to reduce the speed at which sellers adjust prices or to reduce the frequency at which sellers adjust prices. Price setting changes no longer require days or hours of trading but can be achieved in seconds. As a result, price manipulation may become more effective.[9] Policymakers may introduce delays in adjusting prices or require firms to concede a minimum amount of time to new price increases to reduce the high frequency of communication in digital markets. This measure is implemented in the fuel industry in Austria and western Australia, where individual sellers limit their ability to bid against each other more than once a day. This mechanism attempts to allow competitors to cut collusive prices and give sellers a reputation as discounters to reduce the number of price changes. While continuously monitoring competitors' prices and business manipulations, pricing algorithms now face a delay in price changes. In this case, if the delay is long enough, the colluding person may profit from the initial monopoly price to the discount. No wonder state intervention in markets, through disruptive algorithms or other means, may lead to suboptimal outcomes. For example, limiting the speed at which prices change may lead to conditions preventing sellers from discounting. Another option is for the government to implement price cuts immediately but impose a delay in price increases for some time. The government's pricing delay will destroy the collusion behaviour to a certain extent, resulting in the loss of the interests of the conspirators. However, some scholars argue that delay may simply impose a price increase, which is considered suboptimal because it may inadvertently stimulate further tacit collusion. Therefore, the implementation of this scheme still needs to be tested.[6]

5.2. Part of the legislature

Algorithmic collusion is anti-competitive, seriously damaging consumers' interests and affecting economic efficiency. In addition to reliable personnel and regulatory software development, governments could consider legislative action against algorithm-enabled collusion.[10] Clarifying the responsibility allocation of algorithmic collusion is a necessary prerequisite for determining that it

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constitutes a monopoly and punishing it.[11] The property of algorithmic collusion determines that the participants are two or more operators. However, the role of algorithm developers must be addressed. Legal liability is the mandatory legal consequences that the behaviour implemented by the actor should bear. The reasonable distribution of legal liability for algorithmic collusion is essential to regulating algorithmic collusion. Fundamentally speaking, algorithms cannot express meaning, have no behavioural capacity, and cannot become legal subjects to bear responsibility, so they do not have the possibility of bearing responsibility in algorithmic collusion. Linear analysis of algorithm collusion's implementation process shows that the algorithm developer is at the front end of algorithm collusion and should be responsible for the logic of algorithm design. It is necessary to thoroughly investigate whether the designed algorithm technology is legal, bear the consequences and responsibilities brought by the maintenance of algorithm operation, and always pay attention to the possible technical deviations in algorithm operation. It can be summarised as follows: the algorithm developer is responsible for explaining the algorithm technology. The algorithm user is at the end of the algorithm collusion behaviour and should be accountable for his/her subjective intention. Subject to technical reasons, the user has no factual control over the algorithm technology and does not have a decisive influence on whether the result of the algorithm operation is consistent with the original intention. It can be summarised that the algorithm user's responsibility mainly considers his subjective intention, indirectly supplemented by the algorithm operation results as evidence. However, a complete ban on specific classes of algorithms that might facilitate collusion would deter innovation. Therefore, the formulation of algorithm rules should also consider the impact on the industry.[12]

6. Conclusion

In the era of big data, as people increasingly explore the competitive advantages offered by algorithms, operators are also deepening their exploration and application of such technologies. While we cannot ignore the significant conveniences that automated systems bring to our lives, it is crucial to pay close attention to the potential adverse effects of implicit collusion facilitated by algorithms in dynamic markets and competition. The technology of algorithms is dual-faceted; it not only improves operational efficiency and enhances competitiveness but also poses specific threats to the market order, thereby introducing new challenges for antitrust enforcement. The advancement of technology often precedes the development of regulatory measures, highlighting the urgent need for a timely analysis of the dilemmas faced by antitrust laws in controlling algorithmic collusion, which includes challenges such as the difficulty of defining what constitutes an algorithmic collusion agreement and the complexities involved in assigning legal liabilities within the existing legal frameworks. It is imperative to strengthen and refine antitrust laws to address these issues, particularly the concepts related to collusion regulation. The analysis should begin with a clear definition and categorisation of algorithmic collusion. Following this, the third part of the discussion should delve into the detrimental impacts such collusion can have on market dynamics. The next step would be to enhance the mechanisms for assigning legal liability in collusion cases, thereby fortifying the legal framework against such challenges. In doing so, it is essential to effectively leverage the regulatory capabilities of antitrust laws to mitigate the risks associated with deploying emerging technologies in competitive environments. This approach aims to fulfil the legislative objectives of maintaining market order and promoting free competition. Given the intricate nature of algorithms, it is clear that legislators alone cannot tackle these complex issues. Instead, a collaborative approach involving regulators, consumer protection agencies, and organisations specialising in computer science and technology is required. Such collaborations should include experts in fields like deep learning and artificial intelligence. Finally, any future regulatory measures must undergo deep evaluation and careful implementation to ensure they are effective and appropriate for addressing the unique challenges posed by algorithmic technologies in the digital age. This comprehensive approach will help ensure that the benefits of

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technological advancements are balanced with the need to maintain fair and competitive market practices.

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