

**DIRECTORATE FOR FINANCIAL AND ENTERPRISE AFFAIRS
COMPETITION COMMITTEE**

Algorithmic competition – Note by Denmark

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More documents related to this discussion can be found at
<https://www.oecd.org/competition/algorithmic-competition.htm>

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Hands-on experiences with algorithms and competition from Denmark

1. The Danish Competition and Consumer Authority (DCCA) has gained a number of insights with regards to investigating algorithms from a competition perspective. This note will briefly present those learnings and insights, structured along the headings suggested in the annex to the OECD's call for contributions dated 1 February 2023. The note concludes with a discussion on how these findings can shape future enforcement activities and policy initiatives.

Key takeaways

2. Algorithms have become the backbone of the digital services and solutions utilised by both individuals and firms on a daily basis. These powerful tools have the capability to solve a wide range of complex problems, often working behind the scenes to support the seemingly simple interfaces we interact with. Various digital platforms and firms leverage algorithms to disrupt traditional models and enhance market efficiency in numerous ways. They are used to e.g. create effective production processes, inform or automate strategic business decisions, or improve user experiences.

3. While algorithms offer numerous benefits, they also have the potential to harm competition among businesses. Certain algorithmic practices can indeed enable anti-competitive agreements and facilitate the abuse of dominant market positions.

4. Algorithms vary widely in complexity and function. It is important for competition authorities not to shy away from investigating algorithmic practices but to carefully consider the available investigation strategies and methods on a case-by-case basis, such as: manual inspection of code, simulating algorithm output, or analysing actual output data. In all cases, particular attention should be given to the data collection strategies employed by competition authorities, to ensure that data are relevant for the investigation and of high quality.

5. Competition enforcement can get far in combatting harmful algorithmic conduct via the traditional prohibitions, as well as with initiatives like the EU's Digital Markets Act. However, competition authorities may need to enhance their enforcement capabilities to effectively tackle competition-related issues arising from algorithmic practices. Possibilities to require A/B testing – i.e. controlled experiments where a specific feature of e.g. an algorithmic code is altered to analyse how it impacts the algorithm's output – could be a way to strengthen the toolbox of competition authorities, and so could market investigations. It may also be beneficial to require firms to store and make available version histories and log files of the algorithms they employ.

1. Types of algorithms and their prevalence in Denmark

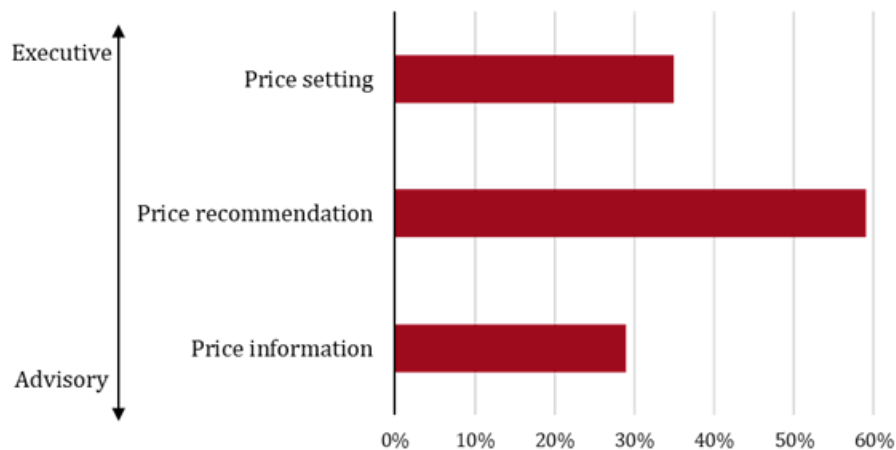
6. A 2016 survey commissioned by the DCCA revealed that around 25% of Danish e-commerce firms were already using or planning to adopt pricing algorithms.¹ Additionally, a text-based analysis of Danish job advertisements showed a threefold increase in the demand for professionals with pricing algorithm-related skills between 2007 and 2018. Most of these job ads were posted by companies in the retail and transport sectors. The DCCA anticipates that the deployment of pricing algorithms has significantly increased since these data were collected.

7. Among the e-commerce firms that were already utilising pricing algorithms, the predominant use case (approximately 60%) involved algorithms providing price *recommendations* to the firms, cf. Figure 1. The final decisions regarding price setting were still made manually by the companies.

8. However, it was not uncommon for firms to use pricing algorithms that directly *set* firms' prices (approximately 35% of use cases). An example is a Danish electronics e-retailer that utilised algorithms to scan competitors' prices and automatically adjusted its own prices online and in stores up to 12 times per day.

9. At the other end of the advisory-executive algorithm spectrum, approximately 30% of the use cases reported by Danish e-retailers involved algorithms that generate information used by the firms in their manual price-setting decisions. These algorithms do not directly recommend a specific price or price range but provide valuable insights for the firms' pricing strategies.

Figure 1. Danish e-retailers' use of pricing algorithms by type of output



Note: The shares sum to more than 100 since some firms use more than one (type of) algorithm.

Source: DCCA, 2021, *Prisalgoritmer og deres betydning for konkurrencen*. In Danish. Survey conducted in 2016.

10. Moreover, the firms utilising pricing algorithms indicated that the most prevalent type of input data used was related to their own business, such as current stock status (around 65% of use cases). Approximately half of the use cases incorporated competitors'

¹ DCCA, 2021, *Prisalgoritmer og deres betydning for konkurrencen*. In Danish. 17 per cent of the surveyed e-commerce firms reported that they are using pricing algorithms, and another 10 per cent that they will start using them.

prices as input data, while only a small portion (one-tenth) relied on data about their own customers. Interestingly, some firms mentioned in their comments that they had access to data that could enable individualised price setting. However, they expressed concerns about potential negative reactions from consumers, fearing that such individual pricing practices could be perceived as unfair or greedy.

2. Theories of harm related to the use of algorithms

11. The use of algorithms can impact competitive parameters, such as prices, firm behaviour, strategic choices, and market dynamism. This section briefly presents some of the DCCA's analyses of markets where algorithms play a central role influencing the competitive dynamics in different ways.

2.1. Restricted market dynamism in markets where algorithms are important

12. In 2021, the DCCA released a report specifically examining competition dynamics in markets featuring digital platforms.² The report highlights the role of data collection, particularly through monitoring algorithms, in facilitating market participants' abilities to set "cartel-like" prices. It also emphasizes the ability of these algorithms to detect and penalize any deviations from the agreed-upon price.

13. In addition, the report discusses market characteristics that play a crucial role in determining whether a market tends towards a "winner takes it all" outcome. Such an outcome refers to a situation where a single firm, e.g. a platform provider, achieves significant growth and establishes a dominant position in the market, facing limited competition once it has emerged as the market leader, or "market winner". This outcome occurs when the winning platform successfully captures e.g. a significant share of users, resources, and network effects, making it challenging for new or smaller competitors to effectively challenge its market dominance.

14. Even if a potential competitor possesses the resources and capabilities to invest in developing a competitive algorithmic code, their ability to effectively compete with the incumbent "winner" is heavily reliant on the volume and quality of training data available to train their algorithm. In markets where algorithm-enabled services and solutions are central competitive factors, there is an elevated risk of high market concentration and imbalanced dependencies for businesses and end user on a few major incumbents. This is primarily because incumbents typically have access to larger, high-quality datasets compared to challengers, creating a significant advantage in terms of algorithmic performance and competitiveness.

2.2. Price matching may lead to higher prices

15. According to a 2018 report by the DCCA, around 10% of Danish businesses in the retail sectors adopted a marketing strategy involving price guarantees for consumers.³ This strategy allowed consumers to inform the seller of a lower price offered by a competitor and subsequently purchase the product or service at that lower price. A smaller portion of firms offered price matching, where their prices automatically adjusted based on their competitors' prices. The utilisation of price guarantees and matching was particularly

² DCCA, 2022, *Konkurrencen på markeder med digitale platforme*. In Danish.

³ DCCA, 2018, *Prismatching og prisgarantier kan føre til højere priser*. In Danish.

prevalent in the online retail sector for physical products such as clothing, shoes, toys, and electronics.

16. Although price guarantees or price matching strategies can initially result in lower prices for consumers, there is a potential long-term impact that may lead to higher prices.⁴ The presence of widespread price guarantees or matching can reduce the competitive pressure on individual firms to lower their prices over time. As a result, the incentive for any one firm to decrease prices diminishes, as the likelihood of gaining a significant increase in sales volume decreases in a market with widespread price matching.⁵ Thus, price matching strategies may very well lead to generally higher price levels for consumers than would otherwise be the case, since price reductions will be less common.

17. Price matching and price guarantees are not new concepts, but with the advent of algorithms and the growing digitisation of commerce, markets have become more transparent. The use of price-setting algorithms empowers firms to automatically match or adjust their prices in response to competitors' pricing. This automation and near-instantaneous adaptation further diminish the incentives for firms to lower their prices. Particularly, when firms publicly declare their commitment to automatically adjusting prices in response to competitors' price changes, the incentives for individual firms to initiate price reductions are significantly reduced.

2.3. Ranking and advertisement algorithms contribute to platforms' market powers

18. The DCCA has also published a trilogy of articles on the general online search engine market⁶ and another article regarding a large online B2C service intermediary platform is forthcoming. These articles focus on the analysis of search result rankings and display, which are primarily determined by the platforms' search and display algorithms and ad auction mechanisms.

19. Whenever a user submits a search query, the platforms' algorithms determine the search results to be displayed and their order of appearance. This determination is based on various input parameters, including the willingness-to-pay of advertising firms as well as organic (i.e. non-paid) relevance factors. Notably, advertising firms cannot anticipate their competitors' actions or behaviour before a user enters a search query. This means that at the point of a firm's decision-making regarding advertising expenditures or ranking boosts to the platform provider, they lack information on their competitors' actions. They can only observe such information retrospectively and utilise it to inform their future advertising or boost decisions.

20. While we as competition authorities generally favour non-coordination among competitors, the analyses are based on the underlying "theory of harm" that platform providers structure their advertising or boost systems in a manner that results in a transfer of value from businesses and consumers to the platform provider. One instance of this could occur when the setup incentivises business users to increase their payments to the platform provider for enhanced visibility in search results, even when competitors are not advertising

⁴ See, for example, Zhuo, R., 2017, *Do low-price guarantees guarantee low prices? Evidence from Amazon and big-box stores*, for an empirical analysis.

⁵ See, for example, Arbatskaya, M., Hviid, M., & Shaffer, G., 2006, *On the Use of Low-Price Guarantees to Discourage Price Cutting*.

⁶ DCCA, 2022, *Indlejrede moduler på generelle onlinesøgemaskine*; DCCA, 2023a, *Betydningen af annoncer for forbrugernes adfærd på onlinesøgemaskiner*, and DCCA, 2023b, *Virksomheders selvannoncering på generelle onlinesøgemaskine*. All in Danish.

and the advertising firm thus would be displayed as the top result organically. Another example is when boost setups encourage a sufficient number of business users to pay for boosts, maintaining the ranking without significant alteration despite the boost payments made by business users.

21. To conduct the analyses, the DCCA did not directly examine the algorithmic code itself. Instead, the focus was on analysing different types of input and output data. Data was obtained through information requests to platform providers and web scraping of the platform's search results. Given the considerable complexity of the algorithms involved, the analytical emphasis was placed on understanding how these algorithms affect key competitive parameters, such as advertisers' expenses, click traffic and search ranking positions. The primary objective was not a detailed examination of the algorithmic code but rather to assess the impact of the algorithms on relevant competition-related factors.

22. The DCCA's analytical approach facilitated an examination of how the search-advertising setup affects various parameters. Notably, the analysis revealed that over 75% of Danish firms' expenses to Google for search queries related to their own business names result in transforming organic clicks, which would have been obtained for free without advertising, into paid advertisement clicks.

2.4. Algorithms can uphold platforms' strong market positions

23. In another of the articles regarding the online search engine market, the DCCA analysed how integrated modules on e.g. Google Search and Bing impact web traffic to third-party websites.⁷ Such modules are popular among users as they often provide the desired information directly.

24. The DCCA identified a pattern via data from Google Trends, suggesting that Google introduces specific modules in response to a rise in search activity for specialised search engines. This suggests that Google, leveraging its market position as a general search engine, data access, and programming capabilities, can adapt to market developments and retain users within its digital ecosystem for longer periods. The DCCA's experiences from analysing the relevant algorithms in relation to the article are further elaborated upon in section 3.2.

3. Investigating algorithmic harms

25. Over the past years, the DCCA has gained valuable experiences in analysing algorithms from various competition perspectives.

3.1. Initially unclear how complex or central algorithms are to the case

26. The DCCA has recognised that algorithms come in various forms and should be evaluated within the specific context of each case. Some algorithms may be complex, utilising pre-trained AI algorithms and advanced optimisation processes to make decisions. Other algorithms may be simpler, performing basic operations based on a few user inputs. Additionally, while algorithms may be an essential component of a company's business model, their presence does not automatically imply that they are the root cause of potential harm in a case.

⁷ DCCA, 2022, *Indlejrrede moduler på generelle søgemaskiner*. In Danish.

27. During a competition investigation concerning a Danish digital platform, the DCCA encountered such a scenario. The platform acted as an intermediary between buyers and service providers, using an algorithm to automatically determine the prices offered by each provider for individual buyer requests. To assess the algorithm's impact on competition, the DCCA requested the platform to provide the code related to the price calculation. Upon manual inspection, it was revealed that the algorithm was relatively simple, involving a basic multiplication of a few parameters. This case highlights that even seemingly complex platforms may employ straightforward algorithms that play a significant role in their operations.

28. Therefore, competition authorities should not hesitate to request algorithmic code from a firm, as conducting a manual inspection of the code can be both feasible and effective in understanding the algorithm's relevance to a case. Such an inspection may uncover that what appears to be a complex algorithmic setup is, in fact, relatively simple.

3.2. Understanding the code and accessing detailed log files is important for investigation efforts

29. The findings presented in the DCCA's sector enquiry of Google's search engine did not involve a direct study of the code used by the company for ad ranking or module display. Instead, the insights were derived from click and web traffic data provided by Google. Similarly, for the upcoming article on a large B2C service online intermediary platform, web scraping was utilized to obtain relevant data. These methods prove valuable when analysing intricate systems with multiple algorithms.

30. In the case of Google, the investigation aimed to explore how Google's presentation of search results in integrated modules affects web traffic to third-party websites that offer similar information or products. These modules encompass various features such as shopping options, flight and hotel availability, weather updates, exchange rates, and more. The focus was to understand the impact of these modules on user behavior and web traffic patterns.

31. However, the DCCA was not able to obtain precise dates at which Google's module codes had been significantly changed. These changes were implemented gradually into the production service, making it difficult to pinpoint specific time points when the behavior of Google's search engine was altered. Additionally, the DCCA was informed that Google does not maintain detailed log files that would allow for a comprehensive study of every algorithm change.

32. Furthermore, the DCCA identified that the most relevant moments for observation and analysis were when Google made changes to the algorithms determining the display of integrated modules for specific search queries. Simply observing the introduction of a module was not sufficient to understand its impact on third-party web traffic. Due to the lack of information regarding the timing of these algorithm changes and the version histories of the relevant algorithms, the DCCA faced limitations in fully conducting the initially planned analysis.

33. Regarding the analysis of the B2C online intermediary, the DCCA obtained valuable insights into the impact of different ranking parameters on the platform's rankings. Through web scraping, the DCCA gained a relatively good understanding of how factors such as business users' payments to the platform provider for ranking boosts influence the overall ranking on the platform.

34. While web scraping provided valuable insights into certain aspects of the algorithms used by the platform, it has limitations in enabling a detailed understanding of

how the algorithms and boosts impact ranking. Recognising this, the DCCA took proactive steps to enhance its understanding by directly contacting the platform provider. Through this communication, the DCCA obtained a thorough description of how the relevant algorithms operate.

35. The DCCA acknowledges the value of web scraping as a valuable approach to gaining insights into the impact of algorithms on competitive parameters. However, the DCCA also recognises that for a more comprehensive understanding, it may be necessary to supplement web scraped results with additional information about how the algorithms operate. The willingness of the firm under investigation to cooperate and provide insights plays a significant role in achieving this goal. By combining web scraping with cooperative efforts from the firm, competition authorities can enhance their understanding of algorithmic systems and their effects on competition.

3.3. Getting the timing right

36. The DCCA recently encountered a challenge in obtaining timely data through web scraping from a digital platform. The agency anticipated the adoption of a new feature offered to business users by the platform provider in the upcoming months. The DCCA deployed a web scraper to collect first-hand data to observe the adoption of the new feature. The objective was to analyse how the evolving adoption of the feature influenced rankings on the platform. Thanks to prior web scraping experiences, the DCCA incurred minimal setup costs for this particular scraping initiative.

37. The DCCA set up the web scraper to collect data from the platform's search result page for a duration of four months. However, during this period, the anticipated adoption of the new feature did not occur as expected. Although the web scraping did not provide the desired basis for analysis, the DCCA considered it successful as it saved the desired data and relevant parameters. The DCCA acknowledges the value of "pre-event" web scraping in future endeavours but emphasises that the costs associated with setting up the web scraper should be weighed against the strength of indications that the anticipated event will occur in the market.

4. Discussion

38. The experiences discussed highlight the importance of data-based evidence and analysis that align with the specific theory of harm of a case or scope of a sector inquiry. When suspicions arise regarding the central role of an algorithm, competition authorities must strive to develop a comprehensive understanding of the necessary information for the investigation. This may involve accessing a code repository to analyze the algorithm directly or focusing on input and/or output data to assess its impact.

39. Furthermore, understanding the storage and location of relevant code or data becomes crucial, particularly in dawn raid situations where authorities need to know where to search for information, whether it's stored in-house or in external cloud servers.

40. The investigation strategy should also be tailored to the size of the company under scrutiny. Advanced algorithm investigations require specialized knowledge and significant manpower to thoroughly analyze how one or multiple algorithms impact competitive parameters in a market. Adapting the approach accordingly ensures a thorough examination of the relevant aspects involved.

41. The DCCA acknowledges the challenges involved in formulating a request for information to gain insight into an algorithm. The term "algorithm" can be interpreted

differently by firms, leading to difficulties in obtaining the desired information. It often requires a learning-by-doing approach and ongoing communication to ensure the cooperation of the company. Hence, the willingness of the company to cooperate becomes crucial when requesting algorithmic code and test data.

42. In cases where specific time periods are of importance, accessing log files or specific versions of the code that were operational during that period becomes relevant. It may be worth exploring the need for regulatory intervention to ensure that firms using and/or developing algorithms are required to store log files and maintain version histories of their code. This would facilitate investigations and enable authorities to analyze the algorithmic processes effectively.

43. The idea of using A/B testing as a regulatory tool is worth exploring further. A/B testing involves making specific alterations to an algorithm and randomly exposing users to both altered and non-altered versions. This allows for a better understanding of the impact of the altered feature on the algorithm. While many tech firms already use A/B testing, its potential as a regulatory tool for competition authorities needs to be further examined and developed.

44. Additionally, the DCCA believes that market investigation powers, which empower competition authorities to impose remedies on firms to address significant harms to competition that are not a result of competition law violations, can be valuable in addressing algorithmic harms to competition. These powers can be particularly useful in addressing situations involving tacit collusion, where algorithmic practices lead to collusive outcomes without explicit coordination among the involved firms.

45. Finally, the DCCA's analyses of ranking algorithms have highlighted the challenge posed by the individualisation of search results. When search rankings are tailored to each user based on their data and profiles, drawing general conclusions about the algorithm becomes more difficult. In order to prove harm, it may be necessary for a competition authority not only to demonstrate that an algorithm has contributed to a violation of competition law but also to credibly show that a significant number of users have been exposed to the harmful features. A comprehensive analysis that considers the real-world impacts of algorithms on users becomes crucial, rather than relying solely on a "neutral user" perspective.

46. The DCCA will continue to closely follow the market developments regarding algorithms and how they impact competition.

DCCA'S Published Analyses Involving Algorithms

Market analysis: Pricing algorithms and their effects on competition (Jan. 2021) (In Danish)

[Prisalgoritmer og deres betydning for konkurrencen](#)

Market analysis: Price matching and price guarantess may lead to higher prices (Aug. 2018) (In Danish)

[Prismatching og prisgarantier kan føre til højere priser](#)

Market analysis: The market for advertising on online general search engines (Jun 2022, Mar. 2023) (All in Danish)

[Indlejrede moduler på generelle søgemaskiner](#), [Betydningen af annoncer for forbrugernes adfærd på onlinesøgemaskiner](#), and [Virksomheders selvannoncering på onlinesøgemaskiner](#).

[Online reklame i Danmark](#).

Market analysis: Digital platforms' collection of user data in Denmark (Oct. 2020) (In Danish)

[Digitale platformes indsamling af brugerdata](#)

Article: Competition in markets with digital platforms (Jun. 2021) (In Danish)

[Konkurrencen på markeder med digitale platforme](#)

Article: Booking platforms, hotels and consumers (Feb. 2019, forthcoming 2023) (In Danish)

[Bookingplatforme, hoteller og forbrugere](#)

Software bid rigging screening tool BidViewer (Apr. 2022)

[Collusion detection in public procurement using computational methods](#)