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Canada

Artificial intelligence and competition

Discussion Paper – March 2024

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Purpose and overview

Artificial intelligence (AI) is affecting many sectors of the economy, in a time of rapid evolution. The importance of governments and policymakers in comprehending and addressing the implications of AI is clear. The Competition Bureau (the “Bureau”) conducts ongoing work to better understand AI, how it might affect competition, and how we can be prepared for addressing potential competitive harm from AI, as well as promoting competition in AI markets. The Bureau engages in cross-governmental collaboration on this front, engaging with the Office of the Privacy Commissioner (OPC) and the Canadian Radio-Television and Telecommunications Commission (CRTC) through the Canadian Digital Regulators Forum to address the implications of emerging technologies, including AI, as they intersect with our respective mandates.

This paper explores several considerations for how AI may affect competition, in the context of Canadian competition law. It is not meant to predict any outcomes or provide any recommendations. Rather, the aim is to foster thoughtful and informed dialogue which can help the Bureau in deepening its understanding of how competition is developing in AI markets, and how the Bureau can enforce and promote competition in these markets.

Section one introduces the concept of AI, exploring proposed definitions for AI and breaking down AI technologies.

Section two discusses markets involved in the production of an AI product or service.

Section three outlines several considerations for how AI may affect competition. Competition impacts are explored in the context of the Bureau’s enforcement areas, in particular Mergers and Monopolistic Practices, Cartels, and Deceptive Marketing Practices. Section three also provides an overview of how the Bureau can work with policy makers to promote competition in AI markets.

Section 1: Introduction to artificial intelligence

1.1 Exploring definitions for artificial intelligence

AI as a theory and empirical reality has been around for quite some time. The field of AI gained momentum in the 1950s and focused on adapting tasks such as problem solving, reasoning, and even game playing to be performed by computers. The term was first coined in 1956 by John McCarthy as "the science and engineering of making intelligent machines".[1] Since then, alternative definitions have been proposed within academia, industry, and government but no common consensus has yet been reached.[2] Despite the advancements and novel technologies that have emerged recently, there is still no universal definition for AI. One difficulty in coming to an agreement on an acceptable common definition for AI is a lack of understanding and consensus on human intelligence.

AI has often been defined and interpreted from different perspectives, which contributes to the lack of consensus in its definitions. There is the academic perspective where AI is seen as a discipline or branch of computer science. The advancement of technology-driven business models and service delivery has seen an industrial perspective of AI as tools and applications. More recently, certain organizations and governments have focused efforts on establishing a definition for an AI system from broader adoption and governance perspectives. [3] For instance, the *Artificial intelligence and Data Act*, a component of Canada's Bill C-27, defines AI as "a technological system that, autonomously or partly autonomously, processes data related to

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[1] John McCarthy is an emeritus Stanford professor and he is considered a pioneer in the field of Artificial intelligence.

[2] For example, the Canadian Centre for Cyber Security defines Artificial intelligence as "a subfield of computer science that develops intelligent computer programs to behave in a way that would be considered intelligent if observed in a human (e.g. solve problems, learn from experience, understand language, interpret visual scenes)". The June 2023 draft of the European Union Artificial intelligence defines Artificial intelligence as a set of techniques and approaches: "(a) Machine learning approaches including supervised, unsupervised, and reinforcement learning, using a wide variety of methods including deep learning; (b) Logic- and knowledge-based approaches including knowledge representation, inductive (logic) programming, knowledge bases, inferences and deductive engines, &symbolic) reasoning and expert systems; and (c) Statistical approaches, Bayesian estimation, search and optimization models."

[3] The June 2023 draft of the European Union Artificial intelligence Act defines an AI system as "software that is developed with [specific] techniques and approaches and can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with. The OECD defines an AI system as "a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions that can influence virtual environments."

human activities through the use of a genetic algorithm, a neural network, machine learning, or another technique in order to generate content or to make decisions, recommendations or predictions". The governance perspective is essential for a working definition to discuss the impacts of AI in competition and marketplace dynamics.

The impact of AI on competition and marketplace dynamics is a complex landscape. On one hand, AI can enhance competition by fostering innovation, lowering barriers to entry, and improving efficiency. On the other hand, there are concerns about the concentration of AI capabilities in a few dominant companies. This could potentially lead to anticompetitive behaviour and increased prices, reduced choice, or lower quality of options for AI users. While there is no commonly accepted definition for AI, we must understand and evaluate its impact on competition. Our ability to do so is crucial for protecting competition and ensuring businesses and consumers in Canada can benefit from competition across all sectors – including AI. We can do this by considering the specific AI technologies and the markets, products, and services where Canadian consumers and businesses come across them.

1.2 Breaking down artificial intelligence

To better understand artificial intelligence, and where it is appearing in Canadian markets, it is helpful to understand the different technologies that make up AI. For consumers, AI can bring benefits such as personalized services, improved customer experience, and access to new and innovative products. The following list provides an overview of some of the technologies which may be a component of an AI product or service. These can affect consumers, businesses, and communities.

Types of AI technologies:

1. Machine learning (ML): techniques that allow machines to learn from data independently, without human instruction. In this sense, machines, such as computers, can learn from data to improve performance without any explicit programming.
    a. Supervised learning: ML trained with labelled data sets and used to classify data or predict outcomes.
    b. Unsupervised learning: ML trained with unlabelled data sets and used to find hidden patterns or data groupings.

        i. Self-supervised learning: a type of unsupervised learning which learns to create labels for unlabelled data.
    c. Semi-supervised learning: ML that aims to label unlabelled data points using information learned from a small number of labelled data points.
    d. Reinforcement: ML where model components, called agents, learn through trial and error with the goal of maximizing a total reward.
2. Deep learning: machine learning using neural networks.
    a. Neural networks: networks modeled on the human brain which consist of interconnected nodes and organized in layers.
3. Natural language processing (NLP): techniques that give machines the ability to understand and generate human language.
    a. Large language models (LLMs): use a combination of NLP and deep learning techniques. LLMs are trained on substantial amounts of data and use learned patterns to identify the next element in a sequence (for example the next word in a sentence) based on a given input (for example a text prompt).
4. Computer vision: techniques which give machines the ability to derive information from digital images, videos, or other visual inputs, making recommendations or taking actions, or both, based on the visual information analyzed.
5. Generative AI: NLP and machine learning techniques used to generate new content, such as text, images, videos, code, music, and synthetic data, using patterns learned from training data.
    a. Foundation models: AI technology trained on substantial amounts of data and can be adapted to a wide range of tasks. Most popular foundation models today use generative AI, and some practitioners use these terms interchangeably. However, some research has pointed to discriminative AI, which may fall under the definition for foundation models.[4]
6. Discriminative AI: ML techniques that distinguish between types of data and used for classification and prediction tasks.

[4] Rishi Bonmmasani et al. "On the opportunities and risks of foundation models." July 2021. Junaid Ali et al. "Evaluating the fairness of discriminative foundation models in computer vision." AAAI/ACM Conference on AI, Ethics, and Society. August 2023.

7. Robotics: the programming of machines to carry out a series of actions independently or semi-independently. Robotics or robots are not AI on their own. AI robots is a robot is controlled by an AI system.
8. Knowledge-based systems: computer systems that use a knowledge base to solve complex problems or make decisions.
    a. Expert systems: computer systems that use a knowledge base of human expertise to solve problems or to make decisions in a particular area of knowledge.

SECTION 1: QUESTIONS FOR DISCUSSION

- Are there any additional technologies, not included in the above list, that the Bureau should consider to advance its understanding of Artificial intelligence?
- Are any of the identified technologies particularly significant to the AI sector in Canada?

Section 2: Markets for artificial intelligence

Production of AI products and services may involve various markets. The creation of an AI product or service may involve participation from:

i. Markets for AI infrastructure: the supply of compute (for instance, processing power, memory, storage and other resources required for the computational success of any program) and data required for the development of AI,
ii. Markets for AI development: the supply of AI technologies such as AI models, algorithms, and architectures, and
iii. Markets for AI deployment: the supply of customer facing AI products or services.

2.1 Vertical relationships

Vertical relationships[5] play a significant role in AI markets. Firms in AI development markets rely on access to expertise, data, and compute[6] to design and train AI technologies. Firms in AI deployment markets rely on access to AI technologies to create new AI products or services or integrate an AI component to an existing product or service. Firms may be vertically integrated, in which a single firm operates in multiple streams of production of an AI product or service. If firms are not vertically integrated, their access to AI inputs will rely on business arrangements with external firms.[7] Access to AI inputs, through vertical integration or other business arrangement, is vital for participation in AI markets.

2.2 AI infrastructure

AI infrastructure provides a foundation for AI development with compute and data.

2.2.1 Compute

A trend in AI development is the requirement for increasing amounts of computational power.[8] This vast computational power is vital input for AI training[9] and inference[10]. Cloud computing infrastructure and specialized computer chips, often referred to as AI chips, are particularly important inputs in AI production.[11]

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[5] Business relationships between buyers and sellers operating at various stages of a production process.

[6] Compute, in the context of AI, refers to the computational resources required to develop AI technologies.

[7] Business arrangements can take many forms including but not limited to a one-time purchase, ongoing purchases (sometimes organized trough contracts), or partnerships.

[8] Dario Amodei et al. "AI and Compute." *OpenAI*. May 2018; Jai Vipra and Sarah Myers West. "Computational Power and AI." *AI Now Institute.* September 2023; Nestor Maslej et al. "The AI Index 2023 Annual Report." *AI Index Steering Committee, Institute for Human-Centered AI, Stanford University*. April 2023.

[9] Training in AI refers to the process of teaching an AI technology or system to learn from data and perform its intended task(s).

[10] Inference in AI refers to the process of an AI system providing an output

[11] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023; Jai Vipra and Sarah Myers West. "Computational Power and AI." *AI Now Institute.* September 2023.

2.2.2 AI chips

AI chips are specialized computer chips[12] used to train and operate AI technologies. Currently, the most popular computing chips for AI development, especially for training, are Graphics Processing Units (GPUs). GPUs offer significantly improved AI-related efficiency compared to traditional computing chips like Central Processing Units (CPUs), notably due to their ability to perform calculations in parallel (i.e., at the same time). Other AI chips include field-programmable gate arrays (FPGAs), which are commonly used for inference, and application-specific integrated circuits (ASICs), which are designed for specific use cases rather than general purpose use.[13]

Production of AI chips involves design and fabrication. AI chip production can involve separate design and fabrication firms or a single vertically integrated firm can conduct operations. Currently, there are a small number of large technology firms which design chips most popularly used for AI development.[14] Several other large technology firms are currently designing, or have plans to design, their own (proprietary) AI chips. Similarly, there are a small number of firms who fabricate (i.e. manufacture) chips popularly used for AI purposes. Costs of operation for chip design and fabrication are high and steeply increasing as the industry continues to advance.[15]

2.2.3 Supercomputers, data centres, and cloud computing

AI supercomputers are networks of connected AI chips, designed to store and process enormous quantities of data and perform complex AI tasks. Supercomputers may be hosted in data centres, which are facilities designed to efficiently host computational hardware at scale. Supercomputers hosted by a data centre can be used by the data centre owner themselves or supplied to third parties through cloud compute. [16] Cloud compute provides third-parties,

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[12] Physical units containing electronic components which process and store information for computers and other electronic devices.

[13] Jai Vipra and Sarah Myers West. "Computational Power and AI." *AI Now Institute.* September 2023; Saif M. Khan and Alexander Mann. "AI Chips: What They are and Why They Matter."; *Center for Security and Emerging Technology, Georgetown University.* April 2020.

[14] Jai Vipra and Sarah Myers West. "Computational Power and AI." AI Now Institute. September 2023; Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[15] Jai Vipra and Sarah Myers West. "Computational Power and AI." *AI Now Institute.* September 2023.

[16] Konstantin Pilz and Lennart Heim. "Compute at scale: a broad investigation into the data center industry." November 2023.

through the internet, on-demand access to hosted computational resources such as supercomputers.

Most commonly, participants in AI development markets access their required compute using either their own data centre, a publicly available supercomputer, or through a cloud compute provider.[17] AI developers who do not already own a data centre are likely to seek required compute through a cloud compute provider. Costs of building and operating data centres, used for the purpose of AI development, are high.[18] There are a small number of large technology firms who are the main suppliers of cloud compute services for AI development.[19]

2.2.4 Data

Data is an important input for AI development markets due to the large data requirements for training, testing, and evaluation of AI technologies. Generative AI has demonstrated an increasing trend in the amount of data used for training. Large language models (LLMs) developed in recent years have been trained using billions to trillions of tokens. [20] A token in the context of LLMs refer to a piece of text, created by segmenting text data into smaller units which the model can process

Generally, AI developers can gather required training data using public or proprietary sources. Developers can access publicly available data via open datasets or web scraping[21] while proprietary data can be bought from the owner. In the case of LLMs, current common practice is to access training data from public sources.[22] However, certain research indicates that publicly available data used for training of LLMs could be fully exhausted in the next few years.[23] This

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[17] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[18] Ibid.; Konstantin Pilz and Lennart Heim. "Compute at scale: a broad investigation into the data center industry." November 2023; Kerry Hawkins and Michael Restivo. "Data centers: expensive to build, but worth every penny." Jones Lang Lasalle (JLL).

[19] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023; Jai Vipra and Sarah Myers West. "Computational Power and AI." *AI Now Institute.* September 2023; Ofcom. "Cloud services market study: interim report." April 2023.

[20] Luv Bansal. "Guide of all open sourced large language models (LLMs). *Medium*." August 2023; Tom B. Brown et al. "Language models are few-shot learners." *In Advances in Neural Information Processing Systems, H. Larochelle, M. Ranzato, R. Hadsell, M. F. Balcan, and H. Lin (Eds.), Vol. 33. Curran Associates, Inc., 1877–1901.* July 2020.

[21] Web scraping is a process that systematically browses the web and gathers data from visited web pages.

[22] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[23] Pablo Villalobos et al. "Will we run out of data? An analysis of the limits of scaling datasets in Machine Learning." October 2022.

may increase AI developers' reliance on access to proprietary data sets. It is unclear to what extent markets exist for the supply of proprietary data. Certain AI developers have begun to seek out partnerships for the purpose of creating public and private datasets for training AI models.[24]

2.3 AI development

AI development pertains to the creation of AI models, algorithms, or architecture, which can be used for or integrated into a final product or service. More broadly, AI development may encompass the creation and innovation of AI technologies outlined in Section 1. While AI development encompasses several types of AI, LLMs have been a particularly active area of development, likely due to recent innovations in model architecture[25] and success of recent consumer facing LLM-based chatbots. The market for AI development is characterized by the presence of large technology companies, start-ups, and academic research groups.[26]

In terms of AI models, the underlying code is distributed and accessible in either “closed source” or “open source” software. Closed source software, also known as proprietary, means that the AI model code is not freely available to the public. The development and distribution are generally controlled by a single entity, or group of partners. Users of closed source AI models only have access to the compiled and available executable version of software. Open source, on the other hand, means the source code is freely available to the public. For these models, anyone may be able to view, change, and (re)distribute the code. This approach is more collaborative in nature, relying on crowd sourcing among a central or distributed community of developers who can contribute to the improvement and customization of the AI model. Each model has advantages and disadvantages. Closed source models may offer proprietary advantages and control, while open-source models may promote transparency, participation, and wider accessibility.

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[24] OpenAI. "OpenAI Data Partnerships". November 2023.

[25] Transformer architecture, first introduced by Google in 2017, offer significant efficiencies for LLMs in comparison to other model architectures. Dale Markowitz. "Transformers, Explained: Understand the Model Behind GPT-3, BERT, and T5. *Dale on AI*. May 2021.

[26] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

2.4 AI deployment

AI deployment refers to markets where final AI products or services are produced. An AI product or service can broadly be thought of as any product or service which applies or integrates technology produced through AI development. In other words, an AI products or service is one that applies or integrates any technology listed in Section 1. Use cases for AI products and services are broad, particularly in the case where generative AI or foundation models are applied. AI products and services are used across many industries including finance, healthcare, education, manufacturing, and law. There are many AI products and services currently available including, but not limited to, AI-powered assistants and chatbots, self-driving vehicles, recommendation systems, speech-to-text software, content generation, and AI-powered search.

Producers of AI products and services can access the required technology inputs, such as an AI model, by either (i) developing the technology themselves in-house or (ii) buying access or ownership of the technology from a supplier, through a partnership, Application Programming Interface (API) access, plug-in purchase, or other business arrangement.[27]

Putting it together: examples of routes to market for AI chatbots and self-driving vehicles		
Supply Chain Level	**Chatbots**	**Self-driving vehicles**
Infrastructure	• Text data input • Specific compute requirements for AI model	• Visual, image, video and audio data input • Specific compute requirements for AI model
Development	• LLMs and various machine learning algorithms	• Various AI technologies including reinforcement learning and computer vision algorithms
Deployment	• Release of chatbots	• Release of self-driving cars

[27] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

SECTION 2: QUESTIONS FOR DISCUSSION

- Does the above description of AI markets align with what is seen in Canadian markets? Are there other markets, or characteristics of the outlined markets, that the Bureau should consider?
- Are there specific considerations for Canadian market participants access to inputs such as compute, data, or AI technologies (such as AI models), that the Bureau should be aware of?

Section 3: AI and competition

3.1 AI and mergers and monopolistic practices

The Competition Bureau investigates and acts when it discovers abuses of market power or mergers that are likely to substantially lessen or prevent competition. Certain characteristics of AI markets could affect the degree to which market concentration and market power may arise and develop.

3.1.1 Barriers to entry

Participation in AI development markets heavily relies on the ability to access data and compute inputs.[28] Difficulty in accessing the required data or compute may be a barrier to entry for new firms seeking to enter AI development markets. Public data suitable for AI purposes (e.g. training an AI model) is highly prevalent and currently comprises a majority of the data used to develop recent high-profile AI technologies.[29] This indicates new entrants may be able to readily access most of their required data inputs for market participation. However, proprietary data currently plays a significant role in certain stages of generative AI development[30] and may

[28] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[29] Ibid.

[30] The UK Competition and Markets Authority's Foundation Model Report found that the data used for alignment in foundation models is often proprietary. Alignment, in the context of AI, can most simply be thought of as the ability of an AI technology to achieve the desired output of the human user.

become increasingly important for AI development more broadly in coming years.[31] If proprietary data becomes a necessary input for participation in AI markets, this may impose certain obstacles on new entrants' ability to compete effectively.

While data access could be a barrier to entry when large quantities of, particularly proprietary, data is needed to compete effectively, innovations in AI technologies and methods could decrease reliance on data for AI development. For example, new methods for training or improvements in models or architectures could create efficiencies, requiring fewer data resources to achieve the same level of performance. Firms may also increasingly use synthetic data for the purpose of AI development. Use of synthetic data may be more easily accessible and less costly compared to collection of public data or buying proprietary data. However, use of synthetic data incurs risks in terms of data contamination and bias propagation, which certain research has shown could result in "model collapse."[32,33]

While there is an emerging market for data providers for AI purposes[34], it is unclear how competition and market power — and consequently costs of access faced by downstream AI development firms — may develop in these markets. Large technology firms may already have access to substantial quantities of proprietary data suitable for AI development, gathered from business activities in other markets they take part in. This may provide a competitive advantage to firms with existing large data stores.

Cloud compute and AI chip markets have both been found to exhibit high concentration, with a few large technology firms dominant in each market.[35] Upfront costs of compute inputs are high, which could impose a barrier to entry for new firms looking to enter either markets for AI infrastructure or AI development. Start-ups would likely be required to access necessary compute inputs from a large technology provider, who may also be their competitors in AI

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[31] See section 2.

[32] Model collapse occurs when a model fails to learn as intended. In the context of synthetic data, certain research has shown that use of this data to train AI models may result in a "feedback loop" that leads to more repetitive, less diverse, and lower quality outcomes

[33] Gonzalo Martinez et al. "Towards understanding the interplay of generative Artificial intelligence and the internet." June 2023; Tshilidzi Marwala, Eleonore Fournier-Tombs, and Serge Stinckwich. "The use of synthetic data to train AI models: opportunites and risks for sustainable development." *United Nations University*. September 2023.

[34] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[35] Jai Vipra and Sarah Myers West. "Computational Power and AI." *AI Now Institute.* September 2023.

development.[36] New entrants in AI development markets may face additional obstacles due to a current shortage of GPUs used for AI purposes.

3.1.2 Product differentiation

Firms may be able to use AI to differentiate their product offerings from competitors, for example through integrating AI functions to existing products or using AI to develop better product offerings. This could benefit competition in the sense that risk of coordinated conduct is mitigated in markets where firms offer differentiated products. Product differentiation may allow firms to achieve market power. Price competition may be less aggressive in differentiated markets, in comparison to markets where numerous firms offer comparable products. However, as new innovations enter the market and compete, market power gained through product differentiation may not be sustainable.

3.1.3 Economies of scope and scale

Substantial upfront costs in AI development markets create economies of scale. Large technology firms may have an advantage in achieving economies of scale in AI markets due to existing in-house resources in human expertise and compute. New market participants, who don't enjoy the same advantages, may have difficulty entering the market or competing effectively.[37]

Firms in AI markets may be able to achieve significant economies of scope due to the wide array of AI applications across various industries and use cases. This effect may be particularly strong in foundation model markets, as foundation models are characterised by their adaptability to a broad range of downstream tasks. This could lead to markets becoming concentrated among firms who can participate across many foundation model applications. [38]

[36] Digital Platform Regulators Forum. "Examination of technology: Large Language Models." October 2023.

[37] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[38] Ibid.

3.1.4 Network effects

Digital markets are commonly characterized by the presence of network effects. AI markets may provide settings where indirect or data network effects could arise.[39] Markets for foundation models or generative AI, where downstream applications are broad, may generate indirect network effects where the value of these technologies increases with the number of downstream applications they are used for or integrated into. Recent research has pointed to the relationship between AI and data network effects, in which as more user data is collected by an AI system the success of these technologies improves,[40] in turn attracting more data-generating users.[41]

3.1.5 Predatory, exclusionary, and discriminatory conduct

A firm engages in predatory conduct when it incurs short-term losses to eliminate a competitor and gain market power. Firms could use AI to better identify opportunities for predatory conduct, as well as for implementing predatory strategies. For example, AI may be able to better identify customers at risk for switching and engage in personalized pricing, targeting below-cost price cuts for “at-risk” group while leaving them unchanged for others. This strategy would minimize losses to the firm employing predatory conduct (by reducing losses incurred on below margin customers), which may increase incentives to engage in such conduct.[42] A firm engages in disciplinary conduct when it tries to punish another firm. Below-cost price cuts could for example be used to discipline competitors in AI markets, rather than to directly eliminate the competitor.

Exclusionary conduct occurs when a firm aims at preventing another firm from operating in the market. The importance of vertical relationships in AI markets may provide an environment where particular exclusionary conduct could arise. Vertically integrated firms could both supply an important input for participation in AI markets, such as data, compute, and AI models, while

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[39] AI markets may also exhibit direct network effects, where the value of an AI technology, product, or service increases with the number of users. However, AI markets do not appear to have any specific characteristics which would lend themselves more towards the development of direct network effects, in comparison to other digital markets.

[40] User data can be leveraged for training and fine-tuning of AI models, potentially resulting in improvements such as reduced bias and hallucinations and improve model alignment.

[41] Robert Wayne Gregory, Ola Henfridsson, Evgeny Kaganer, and Harris Kyriakou. "The role of Artificial intelligence and data network effects for creating user value." *Academy of Management Review, Vol. 46, No. 3.* July 2021.

[42] Thomas K. Cheng and Julian Nowag. "Algorithmic Predation and Exclusion." *U. Pa. J. Bus. L.*, 25:41. 2023; OECD. "Algorithmic Competition." *OECD Competition Policy Roundtable Background Note*. 2023.

also competing in the same downstream markets as the firms they supply to. This would be a concern for competition if these firms were to engage in behaviour to exclude their downstream competitors from the market, for example through refusal to supply or through minimizing the margin between the prices they charge for supplied inputs and prices charged by downstream firms, making it difficult for downstream firms to effectively compete. AI could be leveraged by platforms engaged in self-preferencing, providing advantages to their own products over rivals' products,[43] and may make it more difficult for consumers to recognize sponsored recommendations.[44] AI markets may offer opportunities for exclusionary conduct to arise, given the presence of vertically integrated firms who both supply important compute inputs, such as cloud compute services, as well as competing in AI development markets.

AI markets are characterized by the presence of large technology firms, who compete in various digital markets. These firms may engage in tying and bundling, which are common strategies employed in many industries and can be associated with strong cost efficiencies. However, certain tying and bundling strategies may constitute an abuse of market power. For example, firms with existing dominance in a given market, may leverage tying and bundling strategies to enhance or maintain dominance in other markets they compete in. AI itself could be leveraged to target bundling and tying strategies, for example by targeting customers at risk of switching [45]

There may be specific concerns when AI is employed as a decision-maker, for example determining the pricing strategies of a firm. AI could for example autonomously (absent human instruction) choose to employ predatory, exclusionary, or discriminatory conduct. Firms which use AI for decision-making purposes, may need to ensure proper human oversight to identify and correct any potential anti-competitive decision making of AI.

3.1.6 Considerations for mergers

The Bureau's merger review process involves the assessment of whether the merger would be likely to create, maintain, or enhance market power, or result in meaningful price increases. If

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[43] OECD. "Competition and AI." *OECD Business and Finance Outlook 2021: AI in Business and Finance.* 2021; Competition and Markets Authority. "Algorithms: How they can reduce competition and harm consumers." January 2021; OECD. "Algorithmic Competition." *OECD Competition Policy Roundtable Background Note*. 2023.

[44] Digital Platform Regulators Forum. "Examination of technology: Large Language Models." October 2023.

[45] Thomas K. Cheng and Julian Nowag. "Algorithmic Predation and Exclusion."

U. Pa. J. Bus. L., 25:41. 2023.

the merger places the combined firm in a dominant position, it could result in the ability for the merged firm to engage in predatory, exclusionary, or discriminatory conduct. Horizontal mergers, where merging firms compete in the same market(s), may involve the combination of market shares, or other resources,[46] leading to the combined firm achieving market power.

Vertical mergers combine firms that operate at distinct levels of the supply chain. A vertical merger can result in a firm's suppliers or customers becoming their competitors and could result in enhanced market power in either the upstream or downstream market. A vertical merger would be concerning to the Bureau if it were likely to result in, or increase, the ability and incentive to limit or eliminate competitors' access to inputs or markets.

In the case of a conglomerate merger, where post-merger the combined firm competes in multiple related markets, it may create the ability or incentive of the firm to engage in anti-competitive tying strategies. Mergers, of any form, involving a firm who supplies compute inputs, such as AI chips and cloud services, could warrant additional scrutiny due to the existing high levels of concentration in these markets. Mergers in AI markets may require additional scrutiny as large established firms may seek to acquire emerging competitors as a means of preventing or lessening competition.[47]

A merger may prevent or lessen competition substantially when it facilitates or encourages coordinated behaviour among firms after the merger. Coordinated behaviour occurs when firms engage in accommodating conduct that is profitable for all coordinating firms. Firms may coordinate on various business decisions, such as prices or allocation of markets. Coordination will not always require explicit communication and may be achieved through tacit understandings. AI could help facilitate coordinated conduct, for example through collection of information on and rapid response to competitor conduct.

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[46] While market shares are one of the more traditional indicators used by competition authorities to evaluate market power, characteristics of AI markets, and other digital markets, may create new sources of achieving market power. For example, it has been posited that network effects or exclusive data access could contribute to market power in digital markets. OECD. "The evolving concept of market power in the digital economy." *OECD Competition Policy Roundtable Background Note.* 2022.

[47] Bureau of Competition & Office of Technology, Federal Trade Commission. "Generative AI Raises Competition Concerns." June 2023.

3.2 AI and cartels

Cartels are formed when two or more firms agree to fix prices, allocate markets, or restrict supply. Cartel agreements can result in significant harm to competition and such illegal agreements are criminal offences under the *Competition Act*. While there are several types of illegal agreements covered by the *Competition Act*, one of the most common are price-fixing agreements which occur when two or more competing firms agree to set the same price for goods or services.

3.2.1 AI and cartel agreements

AI could be used to implement or sustain cartel agreements. Firms could, for example, use AI technology to automatically implement agreed upon prices or other business decisions, monitor, and communicate with cartel members, and quickly detect and punish any members who deviate from the agreement. AI can increase market transparency, due to the ability to autonomously and at greater speed and scale intake data on market characteristics and competitors. AI may also lead to increased frequency of interaction between competitors, due to greater ease in detecting competitor price changes and quicker responsive price adjustments.[48] High market transparency and frequent competitor interactions are two market conditions commonly associated with greater ability and incentive for cartels to form and operate.

Concern may arise if multiple competitors purchase or use the same AI technology from a third-party supplier. A supplier of AI may leverage the technology to facilitate a cartel agreement amongst horizontal competitors who it supplies to, known as a “hub-and-spoke” arrangement. While hub-and-spoke arrangements can form without the use of AI, this technology may ease the facilitation of such agreements through greater ease of monitoring or more discreet communication. [49]

3.2.2 AI and tacit collusion

Developments in AI technology, in particular AI-powered pricing algorithms, have led to increased research and discussions around the possibility for AI technologies to achieve tacit algorithmic collusion. This phenomenon has not yet been observed or proven explicitly in real-

[48] OECD. "Competition and AI." *OECD Business and Finance Outlook 2021: AI in Business and Finance.* 2021.

[49] Ibid.

world markets. However, research has shown that, in experimental settings, AI could be leveraged to facilitate a form of tacit collusion[50] in which AI used by horizontal competitors, may autonomously (without human instruction) learn and implement coordinated strategies, similarly to what may be implemented by an explicit cartel.[51]

3.3 AI and deceptive marketing practices

With continuous developments in AI markets, consumers face a vast amount of rapidly involving information about AI, making it challenging to stay informed and make educated decisions on AI product and services. The Bureau seeks to ensure consumers receive truthful information to help them make informed buying decisions. It is against the law for business and individuals to promote goods and services to Canadian consumers using deceptive or misleading methods.

The United States Federal Trade Commission (FTC) outlines a number of ways businesses can avoid making false or misleading representations around their AI products or services. These include exaggerating what an AI product can do, falsely promising that an AI product performs a task better than a non-AI product, not performing risk analysis, and fabricating that a product uses AI (when it may not at all).[52]

The automated nature of AI, and recent developments in generative AI, could be exploited to engage in certain types of deceptive marketing conduct. AI could be leveraged in deceptive marketing practices where AI could be used to automate certain aspects of the conduct, for example in deceptive telemarketing or deceptive prize notices.[53] AI eases the ability to scale such conduct, for example through automating phone calls or other telecommunications. Generative AI could be leveraged to generate content for deceptive marketing conduct, such as

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[50] Tacit collusion occurs when firms make decisions that jointly maximize profits without making an explicit agreement to do so. Tacit AI collusion is the conceptual ability for AI decision making to result in tacitly collusive strategies and outcomes.

[51] OECD. "Competition and AI." *OECD Business and Finance Outlook 2021: AI in Business and Finance.* 2021.

[52] Michael Atleson, Division of Advertising Practices, Federal Trade Commission. "Keep your AI claims in check." February 2023.

[53] When a business fails to make certain disclosures or engages in false or misleading conduct via telecommunications, this may be deceptive telemarketing, which is a criminal offence under the *Competition Act*. When a business sends prize notices which give the recipient an impression they have won a prize, but requires the recipient to pay a fee or incur a cost to collect the prize, this may be a deceptive price notice. It is against the law to engage In these practices, unless the recipient has actually won the prize and the business has made specific disclosures and satisfied certain other requirements.

e-mail or phone scripts. This technology could be leveraged to make deceptive marketing conduct more convincing, using “deepfake” (digitally altered) voices, images, or videos.

3.4 AI and competition promotion

In addition to enforcing the *Competition Act*, the Bureau promotes competition in Canada by advocating for pro-competitive policy development at all levels of government. The way that laws, policies, and regulations (collectively, “policies”) are designed, can promote or hinder competition in Canadian AI markets.

The Bureau generally recommends that regulators rely on market forces to achieve the benefits of competition. These include: innovation, affordability, productivity, and choice. Where market forces are insufficient, the Bureau provides advice on how to achieve policy objectives in a minimally intrusive way. This can take the form of submissions to public consultations, market studies, participation in regulatory proceedings, and working directly with decision-makers to assess the competitive impact of policies and regulations.

One of the tools the Bureau uses when working with policy makers is the Competition Policy Assessment Toolkit. The Toolkit provides a step-by-step guide to assessing how a policy might impact competition and outlines four key indicators of a competitive marketplace. The remainder of this section provides an overview and examples of how the four Toolkit factors might apply to AI markets; followed by discussion questions on other considerations that policymakers should consider in developing pro-competitive policies for AI markets.

Indicator 1: Businesses can easily enter and expand

Why this matters for competition: When a business faces formidable rivals, it must continually innovate, improve efficiency, and keep prices low. Obstacles that make it more difficult for businesses to enter or expand in a market or operate across borders, called barriers to entry, diminish competitive intensity.

In the context of AI, policies should be technology-neutral or device-agnostic to avoid unintentionally prohibiting certain business models.[54] Policies should also be harmonized across

[54] Competition Bureau. "Technology-led innovation in the Canadian financial services sector." December 2017.

geographic boundaries to facilitate businesses operating across Canada and globally.[55] Regular reviews of policies can help ensure that they remain relevant given the rapid advancement and evolution of AI.[56] Policies should also promote entry and expansion. Being careful to limit regulatory burden is a best practice in general but it can be especially important for smaller competitors who may struggle to support the same regulatory overhead as larger rivals. In some cases, it may be an option to tailor regulations to firm size, for example to reflect differential risks. Policies can also promote entry and expansion by improving access to key inputs such as data, compute, expertise, and capital .[57] Policies which support open-source models might also help facilitate entry.[58]

Indicator 2: Businesses can freely set the price, quality, and quantity of their products and services

Why this matters for competition: Policies that require businesses to charge the same price or offer the same quality or quantity of products and services reduces their incentive to find new ways to lower costs, increase productivity or improve quality. This can lead to consumers paying too much for lesser quality products and services.

In the context of AI, policies that unnecessarily inhibit open-source or other business models may needlessly restrict competition.

Indicator 3: Businesses have a strong incentive to compete

Why this matters for competition: Policies that limit the potential gains a business may realize by competing vigorously can reduce the incentive for businesses to compete. These include requirements for businesses to publish information about prices, outputs or sales, self-regulatory arrangements, and profit or market share caps.

In the context of AI, when developing guidelines, policymakers should ensure standards do not result in or facilitate coordination by requiring market participants to share competitively sensitive information. Competitively sensitive information includes, for example, pricing plans or

[55] Ibid.

[56] Ibid.

[57] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[58] Ibid.

costs that would otherwise not be accessible to competitors.[59] In addition, standards for AI market participants should be calibrated so as not to create a marketplace whereby competitors have identical products or services due to compliance with guidelines.

Indicator 4: Consumers can easily switch between competitive alternatives

Why this matters for competition: When consumers can easily switch to a new business, companies will offer better services at lower prices to win or keep customers. This is the essence of competition.

Barriers to switching, such as complicated, time-consuming, and expensive switching processes, are called “switching costs.” Switching costs make it more difficult for new businesses to gain traction in a market because customers are more likely to stay with their current service provider even if a better offer exists. Businesses also have less incentive to discount their prices and innovate when consumers find it difficult to switch.

In the context of AI, policies that promote interoperability generally have a positive impact on competition by facilitating consumer choice.[60] Interoperability[61] and data portability[62] are two specific ways to promote competition by allowing consumers to use multiple models and switch more easily between models.[63]

[59] Competition Bureau. "Bulletin on Amendments to the Abuse of Dominance Provisions." October 2023.

[60] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

[61] Interoperability refers to the ability of a product or system to work with another product or system.

[62] Data portability refers to consumers' ability to port their data from one product or service to another.

[63] Competition and Markets Authority. "AI Foundation Models: Initial Report." September 2023.

SECTION 3: QUESTIONS FOR DISCUSSION

- Are there additional factors that can affect competition in the AI sector?
- Are there additional aspects of the AI sector that are relevant to these competition factors?
- Are any of the possible issues identified above particularly significant to the AI sector in Canada?
- Are there any particularly relevant or informative market study[64] topics, specific to the AI sector or a portion of the AI sector, which the Bureau should consider?

Conclusion

This paper has provided a high-level overview of considerations for AI and competition, as well as an overview of technologies which may be integrated into AI products and services. The paper provides a description of the markets involved in Artificial intelligence production, from computational and data inputs, development of AI technologies themselves, and the production of AI products and services. Finally, it explores how AI could shape how competition develops and is promoted within markets, and how it could be leveraged for anti-competitive conduct. This paper can broadly be viewed as the current set of considerations for AI and competition that the Bureau is monitoring. It is intended to encourage informed feedback from stakeholders regarding (i) the extent to which they may see any of the explored competition impacts playing out in Canadian markets, and (ii) any additional considerations that should be brought to the Bureau's attention.

[64] Market studies allow the Bureau to conduct an in-depth examination of a market or sector to better understand its competitive dynamics and provide informed, evidence-based advice to decision-makers.

Glossary

Algorithm: A set of instructions or steps used to solve tasks. Computer algorithms include instructions and specifications for data processing, calculations, decision making, and automated reasoning.

Architecture: model architecture entails the structure of the components, layers, connections, and processes that (i) make up a machine learning model and (ii) control how data flows through a model. Common model architectures include decision trees, deep neural networks, convolutional networks, and transformers.

Automation: the creation and use of technology to perform tasks, make decisions, and produce goods with minimal human intervention.

Barriers to entry: Factors which make it challenging for a new firm to enter a given market.

Classification: a supervised learning technique involving grouping data into pre-set categories. Classification algorithms use learned patterns from training data to categorize new observations.

Computer network: the interconnected relationship between two or more computers that are linked together to exchange data with each other.

Data labelling: the identification and labelling of data in order to provide context for a machine learning algorithm to train from.

Economies of scope: factors which decrease of a firm's total cost of production when multiple products are produced together, rather than separately.

Economies of scale: the decrease of a firm's per-unit fixed cost due to increased production of a good, as fixed costs become spread over a higher number of units.

Labelled data: data points that have informative labels or identifiers which allow for computations and learning by machine learning algorithms.

Market concentration: the distribution of a given economic market among participating firms.

Market power: the ability of a firm to influence the price of its product or service.

Model: in the context of AI, a model is a program that uses training data to recognize patterns and make decisions without human intervention.

Network effects: occur when the value of a product increases with the number of product users.

Node: a physical endpoint device in a network that creates, receives, and sends information.

Prediction: in the context of machine learning, prediction refers to the output from a machine learning algorithm after it has been trained on historical data and applied to new data.

Product differentiation: the introduction or communication of distinctive characteristics of a product or service by firms to distinguish themselves from competitors.

Synthetic data: data that is artificially manufactured, often via algorithm. Synthetic data is often used to train and improve machine learning models.

Training data: large datasets which are used to teach a machine learning model to process information and learn to perform tasks at a highly accurate level.

Unlabelled data: data points that do not have distinct identifiers or label.