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More documentation related to this discussion can be found at:
www.oecd.org/daf/competition/artificial-intelligence-data-and-competition.htm

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Artificial intelligence, data and competition*

Recent developments in generative Artificial Intelligence (AI) have brought it into global prominence. The technology is still developing but has the potential to impact many markets for the better. However, it is important that markets remain competitive to ensure their benefits are widely felt. The lifecycle for generative AI is still in development and is complex. This paper focuses on three stages: training foundation models, fine-tuning and deployment. Costs to enter vary at different stages, but access to sufficient quality data and computing power appear vital.

As a potentially important technology in the future, the stakes are too high not to give competition every chance. It is too early to say how competition will develop in generative AI, but there appear to be some risks to competition that warrant attention. Competition concerns could arise due to linkages across the generative AI value chain, including from existing markets, as well as potential barriers to accessing key inputs. Despite the uncertainty, several competition authorities and policy makers are taking actions to monitor market developments and may need to make use of the various tools at their disposal. Going forward, competition authorities will require sufficient technical capability to perform their roles. International and domestic co-operation could play an important role in allowing authorities to efficiently maintain their knowledge and expertise.

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1. Introduction

1. While Artificial Intelligence (AI) has been around for decades, there has been much discussion in the past 18 months around generative AI and artificial general intelligence (AGI), a controversial concept that can be described as machines with human-level intelligence or greater (OECD, (forthcoming)[1]). Whether this goal is close to being met is hotly debated. Nevertheless, the launch of ChatGPT by OpenAI in November 2022 and subsequent developments of generative AI have demonstrated its potential as a significant technological advancement (Mei et al., 2024[2]).

2. Generative AI relies on advanced computational techniques to train huge models from vast datasets (Lorenz, Perset and Berryhill, 2023[3]). It can not only respond intelligently to prompts in natural languages but do so quickly and competently. The full economic impact of generative AI is uncertain. However, it may revolutionise many aspects of markets and impact productivity and GDP growth. While AI is broader than generative AI, much of this paper focuses on these recent developments in generative AI.

3. AI has already captured the attention of policy makers. It raises concerns across several policy areas including its potential impact on labour markets, threats to privacy and intellectual property rights, its potential to amplify and spread disinformation and undermine democracy, as well as more existential risks.[1] Adapting old or producing new regulations is being considered in relation to AI, with the first comprehensive legislation on AI globally seen with the recent EU Artificial Intelligence Act.[2] Others may follow suit. Box 1 summarises some of the work undertaken within the OECD, including the OECD Council's own Recommendation – recently updated - which includes principles to foster innovation and trust in AI.

Box 1. OECD Recommendation on AI and other OECD work on AI

OECD Recommendation on Artificial Intelligence

Following years of work starting in 2016 across the OECD, the OECD Recommendation on Artificial Intelligence was adopted in May 2019. The Recommendation provides key AI terms and sets out five values-based principles for the responsible stewardship of trustworthy AI by all stakeholders. These principles set out how AI stewardship should seek to foster inclusive growth, sustainable development and well-being, as well as human-centred values and fairness.

The Recommendation also include recommendations to governments on national policies and international co-operation, including investing into AI research and development and building human capacity. The Recommendation has been adopted by OECD members and 8 non-

[1] For example, in March 2023, many notable signatories put their name to an Open Letter calling for an immediate six month pause to training AI systems more powerful than GPT-4. Available here: https://futureoflife.org/open-letter/pause-giant-ai-experiments/

[2] European Parliament, Artificial Intelligence Act, Adopted 13 March 2024, https://www.europarl.europa.eu/doceo/document/TA-9-2024-0138_EN.html

members. It was amended in November 2023 to update the definition of an AI system and in May 2024 to reflect policy and technology developments. The Recommendation also formed the basis for the G20 AI Principles and can be seen reflected in emerging AI laws, regulations, and governance frameworks, such as in the EU AI Act, the Council of Europe Convention Framework on AI, Human Rights, Democracy and Rules of Law, and in standards organisations such as the National Institute of Standards and Technology (NIST) Risk Management Framework in the US.

From AI principles to practice: The OECD.AI Policy Observatory

To help move from principles to practice, the OECD.AI Policy Observatory was created in 2020 as a hub for understanding AI governance around the world, data and trends, and best practices for ensuring trustworthy AI. The Observatory is a large database of national and regional AI policies, which includes over 1 000 AI policies from 70 jurisdictions – the largest government-backed and up-to-date repository of AI policy in the world.

The OECD.AI Policy Observatory includes resources and tools on AI data and trends to support policymakers around the world. For example, the OECD Framework for the Classification of AI Systems provides a tool designed for policymakers and others to help assess the risks and opportunities posed by different types of AI systems. The purpose is to promote a common understanding of AI and assessment of its potential risks.

Through the OECD AI Network of Experts (ONE AI), the OECD also convenes a community of approximately 400 AI experts divided between six expert groups on various topics related to trustworthy AI, namely AI risks and accountability, AI incidents, AI Index, Compute and the environment, AI Futures and AI, data, and privacy. The Expert Groups provide AI-specific policy advice to the OECD, contribute to the development of resources for the OECD AI Observatory and inform the work of the OECD on AI governance.

Beyond the OECD.AI Observatory, many other directorates across the OECD analyse the impact of AI on their respective policy areas, such as education, tax, health, and the environment.

Sources: OECD Recommendation of the Council on Artificial Intelligence, OECD/LEGAL/0449, amended 08/11/2023 and 03/05/2024, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0449 ; OECD AI Policy Observatory, https://oecd.ai/en/; OECD (2022), "OECD Framework for the Classification of AI systems", OECD Digital Economy Papers, No. 323, OECD Publishing, Paris, https://doi.org/10.1787/cb6d9eca-en.

4. Given the potential implications of generative AI, whether it is, and will remain, a competitive industry is an issue that warrants discussion. Several competition authorities are already considering this issue, as are governments.[3] Such interest is not completely new. The OECD Business and Finance Outlook discussed AI and Competition in 2021, noting the potential implications and clear role for competition policy (OECD, 2021[4]). However, AI and competition had been discussed even before, for example in (Himel and Seamans, 2017[5]).

5. Recent developments in AI also take place in the context of an increasingly concentrated digital economy, which may affect how the sector evolves (OECD, 2019[6]), (Calligaris et al., forthcoming[7]). On

[3] The work of competition authorities is discussed in more detail in Chapter 4. For an example of government discussion of AI, see: The White House, "Readout of White House Meeting on Competition Policy and Artificial Intelligence", 20 January 2024, https://www.whitehouse.gov/briefing-room/statements-releases/2024/01/20/readout-of-white-house-meeting-on-competition-policy-and-artificial-intelligence/

the one hand, AI could allow new firms and propositions to emerge.[4] Alternatively, existing digital firms may succeed by being able leverage their existing positions.[5] Adding to these complications, competition authorities may be under pressure to act given recent experience of the difficulties in competition enforcement in digital markets.

6. It is therefore timely to consider the prospects for competition within AI, as the OECD Competition Committee has not directly considered it before. It has however discussed related issues. For example, in 2023 the Committee held a roundtable on Algorithmic Competition, which included consideration of how the use of AI could affect competitive outcomes in markets and competition enforcement. Further, in recent years the Committee has discussed many potentially related issues in Digital markets, such as Theories of Harm in Digital Mergers in 2023 and the 2020 hearing on Competition Economics of Digital Ecosystems.

7. In considering competition and AI, several questions appear relevant to competition authorities. Firstly, what is AI? Second, to what extent are concerns about future competition warranted? Third, if there is some merit to them, what can or should be done about it? Relatedly, does AI raise genuinely novel challenges to competition policy or are current analytical approaches sufficient? The paper considers these questions. It is not however a market study or detailed investigation, and so has not collected information from market participants.

8. The paper starts by introducing relevant concepts in AI in Chapter 2. , including what appear to be the most important current market dynamics. Next, Chapter 3. explores potential competition issues within the supply of AI, while also considering whether there is a case to give it special attention. Chapter 4. then considers the tools that competition authorities and policy makers have at their disposal in response to those issues. Chapter **Error! Reference source not found.** then briefly introduces two additional issues. F irst, how the use of AI could affect competition in other markets. Second, the potential for AI to assist competition authorities in carrying out their functions. The paper finishes with a conclusion.

[4] For example, some wonder if generative AI might revolutionise online search and there appear to be many companies offering generative AI based online search engines. Whether these will be able to make an impression on the market however remains to be seen. Others argue that it will not, for example as seen from a recent article by technology website, The Verge, arguing that this is unlikely: The Verge, Here's Why AI search engines really can't kill Google, 26 March 2024, https://www.theverge.com/24111326/ai-search-perplexity-copilot-you-google-review

[5] For an example of media discussion along these lines, see: Le Monde, " Digital giants' AI domination already raises concerns", 14 November 2023, https://www.lemonde.fr/en/opinion/article/2023/11/14/concerns-arise-as-digital-giants-race-for-ai-domination-heightens_6253253_23.html ;

2. What is AI?

9. This section sets the scene for the rest of the paper, describing key elements of AI as relevant to competition policy. It introduces relevant terminology and describes the supply and value chain, including the key inputs required to produce generative AI. It also considers potential implications. As AI is technical and fast moving, market dynamics are prone to changes over time.

2.1. What is Artificial intelligence?

10. The OECD Recommendation on AI (see Box 1) defines AI systems 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 physical or virtual environments. Different AI systems vary in their levels of autonomy and adaptiveness after deployment."*

11. Interestingly, this definition was updated November 2023 to reflect recent developments. Much recent focus on AI has been driven by developments in one field, generative AI.[6] AI has since attracted media attention and that of the globe; some excited for the future, others fearful of the implications for humanity.[7] Recent achievements have been described as an "inflection point" for technological change, which will only shepherd in an ever-increasing technological frontier.[8]

12. Given the recent nature of AI's prominence in public discourse, one could be forgiven for believing that it is a relatively recent concept. The concept of artificial human-level intelligence however is almost as long lived as the concept of digital technology itself (OECD, 2019[8]). It is perhaps even older, being seen in literature as early as the 19th century and relevant concepts having been around since the Ancient Greeks (Hogg, 2022[9]).[9]

13. Many have long held their breath awaiting an AI breakthrough. When Deep Blue prevailed against then world chess champion Garry Kasparov in 1997, the potential power of machines to exhibit

[6] These developments are perhaps best encapsulated with the release by OpenAI of ChatGPT in November 2022, which for many felt like a watershed moment. OpenAI described the launch of ChatGPT in a blog post, found here: https://openai.com/blog/chatgpt

[7] Much has been written on the popularity of ChatGPT shortly after it was released, having obtained around 100 million users in just two months. There were subsequent increases in the amount of discourse on AI and generative AI across traditional and social media. As an illustration, ChatGPT was named word of the year by the Economist for 2023. https://www.economist.com/culture/2023/12/07/our-word-of-the-year-for-2023

[8] For example, renowned AI researcher Fei-Fei Li has described AI as currently being at an inflection moment, see: Melissa Heikkilä, "AI is at an inflection point, Fei-Fei Li says", HMIT Technology Review, 14 November 2023, https://www.technologyreview.com/2023/11/14/1083352/ai-is-at-an-inflection-point-fei-fei-li-says/

[9] For example, the book "Erewhon" by Samuel Butler, published in 1872, could be described as one of the first pieces of literature to discuss the idea of artificial intelligence.

"intelligence" was showcased to the world.[10] Similar feats continued, such as when an even more complicated game, Go, was mastered when AlphaGo beat Lee Sedol in 2016.[11] Beyond these showcase events however, AI has been present in all of our lives for years; helping us park cars, find information on the internet, or responding to spoken questions.[12] Box 2 provides a very brief overview of some historical developments in AI.

Box 2. A very brief history of Artificial Intelligence (AI)

The concept and principle of AI, or intelligent machines, was perhaps first put into a formal framework by Alan Turing, the British mathematician famed for his role in cracking the Enigma encryption machine during World War Two, when he wrote a paper called "Computing Machinery and Intelligence" in 1950. The opening line of the paper reads "I propose to consider the question. 'Can machines think?'" and proposes the now well-known Turing test for machine sentience. However, the seeds for AI started even earlier, with many relevant works, including from Turing himself, as well as crucial thinking around neural networks and logical activity, such as McCulloch and Pitts (1943). However, when Turing developed his logical framework for AI the field was largely theoretical; computing was simply not advanced enough to put intelligent machines into practice. AI appears to have been coined as a term in 1956.

Over the next decade, more and more scientists (of various backgrounds) began to take an interest in the concept of AI. In 1956, Herbert Simon and Allen Newell designed what many consider to be the first intelligent machine, a programme called the Logic Theorist, which was able to provide proofs for mathematical problems. Research continued in the field, and advancements in computing power unleashed greater and greater possibilities. Government agencies began to take an interest in AI and starting funding research programs. In the 1960's the first "chatbot" appeared called ELIZA, developed by the American-German computer scientist Joseph Weizenbaum, which could mimic some human conversations. This is considered one of the first examples of natural language processing (NLP). Developments kept coming, but there were perhaps many false dawns. In 1970, Marvin Minsky, an American computer scientist responsible for many important breakthroughs in the field told Life Magazine that "In from three to eight years we will have a machine with the general intelligence of an average human being."

That this did not occur should not lead one to underestimate the scale of progress. Over the next decades, much work – too much to mention in a very brief history – continued. This included notable investment by the Japanese government in the 1980s into the Fifth Generation Computer Project, which many credit as indirectly assisting in important progress in the field, even if it may not have met its goals. Perhaps most importantly, as computing power evolved over time this eased constraints and allowed more possibilities.

As noted above, 1997 heralded a watershed moment for AI and showcased it to the world, with IBM's Deep Blue beating world champion Garry Kasparov at chess. Speech recognition software was

[10] Deep Blue had actually beaten him in one game the year before but ended up losing the next three to lose overall. See: https://www.ibm.com/history/deep-blue#:~:text=Deep%20Blue%20won%20the%20first,Deep%20Blue%20for%20a%20rematch.

[11] GoogleDeepMind, "AlphaGo", https://deepmind.google/technologies/alphago/

[12] For example, AI plays an important part in the accuracy of results of online consumer search. Speech recognition is also a form of AI, which requires the ability to recognise and process natural languages into other content. Further, while the fully autonomous self-driving car may not yet be seen traversing the roads, anyone who has used adaptive cruise control, or a smart parking system has benefited from AI's integration into automobiles.

implemented by Microsoft's Windows the same year, having been developed by Dragon Systems. Since then, breakthroughs continued at break-neck speed, even if they are not always seen as such at the time. Work on key concepts, such as deep machine learning and neural networks, have their roots in decades of previous research and reasoning. Machine learning for example, a crucial component for generative AI which allows model training from huge amounts of data, was coined in 1959 in the context of a programme developed to self-learn in order to play the game checkers. GPT-3, the model underlying ChatGPT was developed in 2020 and smaller generative AI models had been released, by OpenAI and others, over the preceding years. Generative AI may have heralded in a new phase of AI attention, but the developments have been long coming.

Sources: OECD (2019), Artificial Intelligence in Society, OECD Publishing, Paris, https://doi.org/10.1787/eedfee77-en., Anyoha, R (2017) The History of Artificial Intelligence, https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/ ; Turing, A. M. (1950), Computing Machinery and Intelligence, Mind 49: 433- 460; Gugerty, L (2006) Newell and Simon's Logic Theorist: Historical Background and Impact on Cognitive Modeling, DOI:10.1177/154193120605000904; Kuipers, B (2019) Progress in AI, https://web.eecs.umich.edu/~kuipers/opinions/AI-progress.html; McCulloch, W and W, Pitts (1942) A Logical Calculus of the Ideas Immanent in Nervous Activity, Bulletin of Mathematical Biophysics, Vol. 5, pp. 115-133 (1943). Toloka Team (2023) History of Generative AI, https://toloka.ai/blog/history-of-generative-ai/ ; NVidia Developer (2021) Using DeepSpeed and Megatron to Train Megatron-Turing NLG 530B, the World's Largest and Most Powerful Generative Language Model, https://developer.nvidia.com/blog/using-deepspeed-and-megatron-to-train-megatron-turing-nlg-530b-the-worlds-largest-and-most-powerful-generative-language-model/

14. AI is a general-purpose technology with broad applications (OECD, 2019[8]). As the most prominent recent development, this paper focusses on generative AI, sometimes using the term interchangeably with AI. Generative AI can produce convincing responses to human prompts, allowing unprecedented consumer interaction. Model outputs have expanded into creating original images, videos and audio.

15. Despite this focus, there are several noteworthy fields within AI, such as computer vision or reactive AI. These have the potential to also produce revolutionary technological progress. How these different fields will evolve is unknown, as is their likely future importance. Some of the characteristics of these other fields may be shared with generative AI, but others may not. Crucially, the dynamics that are most relevant from a competition perspective may change.

2.1.1. Generative AI

16. As described in Box 2, much of the techniques that underpin developments in generative AI have been in development for some time. Like many breakthroughs, these developments have built upon many previous ones, adding tweaks and increasing scale. Such progress continues.

17. Generative AI combines techniques which could be considered within computer science and statistics.[13] At its core, it might be characterised as extremely effective statistical inference, using large models with many parameters derived from even larger datasets. These models predict complex outputs – such as text responses, computer code, detailed essays, or a cartoon image of a cat - from inputs written, or spoken, in a range of human languages. Box 3 provides a rough guide to some of the terminology used in the context of generative AI.

18. Fundamentally, through techniques that allow the processing of large amounts of data, generative AI models learn to identify patterns and can "predict" the best responses to queries based on probabilities. The predictive nature of these AI technologies is an important element of anticipating future uses.

[13] Only in a broad sense as more precisely it uses techniques in the standalone field of artificial intelligence.

Box 3. Rough guide to generative AI terminology

There are many terms associated with generative AI. Some are used interchangeably. Ultimately, those in the competition field do not need to acquire a PhD in Artificial Intelligence, much as they did not need to be an expert in smelting steel or flying a plane to assess competition in those markets. However, understanding the essence of terms will make the field more accessible. This box contains basic explanations of some commonly used terms in relation to generative AI, although we must note that some of these definitions are not always agreed upon by different stakeholders in the AI community.

Machine learning – refers to a set of techniques within artificial intelligence that are an important part of machines self-learning without needing to be directed manually by humans. It refers to the use of statistical algorithms to detect patterns from data and hence learn autonomously.

Algorithm – an algorithm is a list of simple operations applied mechanically and systematically to a set of inputs to produce outputs.

Neural networks (in AI context) – is a type of machine learning modelled on the brain. It refers to a means of structuring learning from data into nodes, or layers, such that connections are built between them.

Deep learning - refers to machine learning using many layers in a neural network.

Specialised software packages – are packages or frameworks that apply the underlying algorithms to conduct machine learning. Examples can be found in libraries such as PyTorch or Tensorflow.

Tokens – represents the unit of data used to train models. A word may be a token, or several.

Parameters – these are the underpinning components of trained models that determine how inputs are turned into outputs. They are comprised of weightings and biases.

Natural Language Processing (NLP) – refers to the ability to process languages developed and spoken by humans, as opposed to computer programming language traditionally required to input instructions to computer software.

Large language models (LLM) – a type of generative AI model trained on written text using deep learning techniques to create very large models.

Synthetic data – is data created from the extrapolation of real data, based on its underlying characteristics and distribution.

Transformer – this is a type of architecture within deep learning, developed by Google, that maps the relationships between different parts of inputs to allow appropriate processing of sequences. It has been used to develop many of the foundation models seen to date and is an important part of being able to process sentences of text, where dependencies between words are key.

Computer Vision – this refers to the ability of computers to process and analyse visual data, such as images.

Multi-modal – describes models that cover more than one from of input or output, for example text, images or audio.

Supervised and unsupervised learning – refers to different training methods for models, depending upon whether they use datasets that are labelled or unlabelled respectively. With labels added to data, this supervises the learning of the model by teaching it to learn relationships between variables. Unsupervised learning derives patterns from unlabelled data.

Reinforcement learning – learning from human feedback, this form of learning allows models to differentiate between outcomes considered good or bad based on human feedback. This feedback then further trains the model.

Application programming interface (API) – is a form of software interface that acts as a conduit for computer programmes to interact and interoperate.

Note: Definitions are aimed to be explanatory rather than technical.
Source: OECD (2023), Algorithmic Competition, OECD Competition Policy Roundtable Background Note, www.oecd.org/daf/competition/algorithmic-competition-2023.pdf; Competition and Markets Authority, AI Foundation Models: Initial Report, September 2023; Larry Hardesty, "Explained: Neural networks", MIT News, 14 April 2017, https://news.mit.edu/2017/explained-neural-networks-deep-learning-0414; OECD (2023), "A blueprint for building national compute capacity for artificial intelligence", OECD Digital Economy Papers, No. Source: OECD (2023), Algorithmic Competition, OECD Competition Policy Roundtable Background Note, www.oecd.org/daf/competition/algorithmic-competition-2023.pdf; Competition and Markets Authority, AI Foundation Models: Initial Report, September 2023; Larry Hardesty, "Explained: Neural networks", MIT News, 14 April 2017, https://news.mit.edu/2017/explained-neural-networks-deep-learning-0414; OECD (2023), "A blueprint for building national compute capacity for artificial intelligence", OECD Digital Economy Papers, No. 350, OECD Publishing, Paris, https://doi.org/10.1787/876367e3-en.

2.2. Potential economic impact of generative AI

19. This section considers the extent to which competition authorities should focus attention on generative AI markets, noting that spec focusing on one area of technology is somewhat unusual for the competition community. To be warranted, the development in question would presumably need to have major implications for global economies. Understanding the importance and overall economic implications of generative AI for society and economies requires predictions on how it will be used, and how much.

20. AI will likely continue to improve. Generative AI combines enhanced predictive capability with an understanding of natural languages. Such a combination has the potential to enhance, or even revolutionise, a long list of tasks. Activities such as categorising data, editing text, investigating problems, generating ideas, and many more besides, could benefit from generative AI. It may not necessarily replace human work but supplement it (Lane, Williams and Broecke, 2023[10]).[14]

21. These uses imply a potential for substantial improvements in productivity, providing enhanced autonomy and enabling workers to use AI to do things faster, and in some cases better (Filippucci et al., 2024[11]). It may change the nature of some tasks all together. Interestingly though, some research suggests that the implications of generative AI for productivity may not be straightforward and could lead to some tasks being performed less well. For example, if businesses seek to use AI beyond its capabilities, it could create a "jagged technological frontier" where different levels of capability exist for tasks that appear otherwise similar (Dell'Acqua et al., 2023[12]).

22. As its use increases, AI has the potential to alter the nature of economic activity across an economy which may impact how competition functions, perhaps as increasing automation changes how parameters of competition are set or prompting the emergence of new supply chains. The potential effect of AI on competition in other markets is explored in the section **Error! Reference source not found.**.

[14] Predicting how AI will change the nature of work is difficult, yet many have tried. Many are analysing the potential usages and impacts, which clearly has the potential for a large impact across a wide range of businesses. For example, see this article by Global Consultancy McKinsey entitled "What every CEO should know about generative AI, May 2023, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/what-every-ceo-should-know-about-generative-ai?stcr=B60B136AD987472CAB40D9BD1EAA4AFF&cid=other-eml-alt-mip-mck&hlkid=611fd194def746a98b31aa7f81d0aa9e&hctky=15336073&hdpid=2f607bec-0a05-4335-a27f-6abf3c9e45b7

23. An obvious, but nonetheless important, point to make is that the impact of a continuingly evolving technology cannot be known for certain. With the development of more powerful AI, the potential applications will increase and may pivot in unexpected ways, or perhaps unexpected bottlenecks are around the corner. The OECD launched an Expert Group on AI Futures in July 2023 to explore those questions. The group provides insights into scenarios about AI's future and associated risks and benefits as well as potential policy measures to mitigate future risks with AI developments.

24. Nonetheless, while perhaps describing it as a consensus would be too strong, there are multiple analytical predictions that forecast AI, and generative AI in particular, having a significant impact across many aspects of human life in the years to come. For example, Goldman Sachs produced research estimating that generative AI tools had the potential to add 7% to GDP over the next 10 years, which equates to around USD 7 trillion, while also raising productivity growth by 1.5 percentage points.[15] Similarly, research by McKinsey in June 2023 estimated that generative AI would add between USD 2.6 trillion to USD 4.4 trillion of value annually even just focussing on 63 specific use cases – an estimate that they consider could double if expanded to other cases.[16]

25. Another potential indicator of the importance of AI is its value, with some estimates suggesting that there has already been substantial value created within the sector. For example, analysis by *The Economist* estimates that firms across the AI value chain have experienced huge increases in market capitalisation between October 2022, shortly before ChatGPT was launched, and mid-March 2024.[17] Further reflecting its expected importance, the generative AI market is projected to grow substantially in value, with research by Bloomberg estimating that the market could grow to be worth USD 1.3 trillion by 2032.[18]

26. Some sectors appear most likely to benefit from AI, at least initially (Filippucci et al., 2024[11]). For example, a report by McKinsey identified customer operations, marketing and sales, software engineering and research and development (R&D) as the four areas most likely to derive benefits from generative AI.[19] Different types of professions may also have different exposure to AI (Cazzaniga et al., 2024[13]). However, there is already evidence that generative AI can lead to significant productivity gains for businesses, for example:

1. access to a generative AI assistant allowed customer support agents to resolve 14% more issues per hour (Brynjolfsson et al., 2023[14]);
2. it can increase productivity in work-based writing tasks and reduce quality differentials between workers (Noy et al., 2023[15]); and
3. assisted software developers to complete programming tasks around 55% faster (Peng et al., 2023[16]).

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[15] Goldman Sachs, "Generative AI could raise global GDP by 7%", 5 April 2023, https://www.goldmansachs.com/intelligence/pages/generative-ai-could-raise-global-gdp-by-7-percent.html

[16] McKinsey, "The economic potential of generative AI: The next productivity frontier", 2023, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#key-insights

[17] The Economist, "Just how rich are businesses getting in the AI gold rush?", 17 March 2024,https://www.economist.com/business/2024/03/17/just-how-rich-are-businesses-getting-in-the-ai-gold-rush

[18] Bloomberg Intelligence (2023) "Generative AI to Become a $1.3 Trillion Market by 2032, Research Finds", https://www.bloomberg.com/company/press/generative-ai-to-become-a-1-3-trillion-market-by-2032-research-finds/

[19] McKinsey, "The economic potential of generative AI: The next productivity frontier", 2023, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier#key-insights

2.3. Generative AI lifecycle and value chain

27. The next sections describe current elements of the generative AI lifecycle and value chains, including the inputs required. This section does not analyse potential risks to competition, leaving this to Chapter 3. .

2.3.1. Generative AI lifecycle and different levels of the value chain

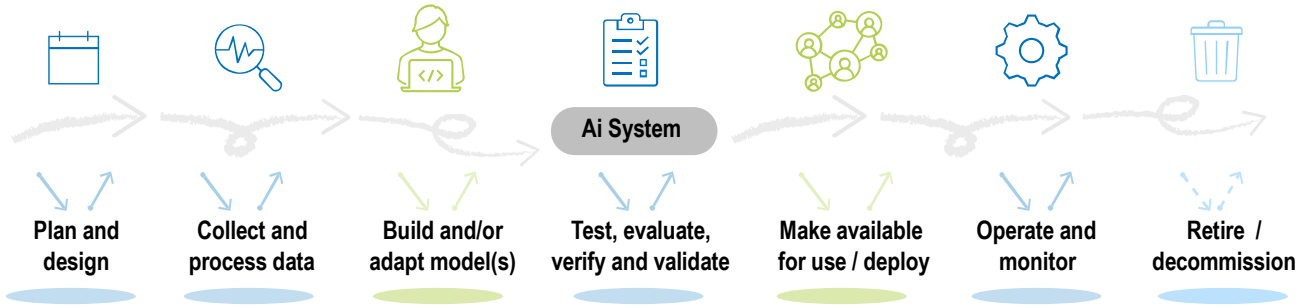
28. Identifying the stages in the lifecycle of a system is valuable to understand what is required to deliver it, an important part of assessing potential competition issues. Value chains for AI are often not linear in the way many traditional markets are. Nonetheless, the AI value chain can be divided into various levels. However, delineating between these too strictly may not only be inappropriate, but could also distort reality.

29. The OECD recommendation defines an AI lifecycle as:

> *"An AI system lifecycle typically involves several phases that include to: plan and design; collect and process data; build model(s) and/or adapt existing model(s) to specific tasks; test, evaluate, verify and validate; make available for use/deploy; operate and monitor; and retire/decommission. These phases often take place in an iterative manner and are not necessarily sequential. The decision to retire an AI system from operation may occur at any point during the operation and monitoring phase."*

30. Figure 1 presents an illustrative representation of the complexities of an AI system.

Figure 1 Illustrative overview of an AI system lifecycle

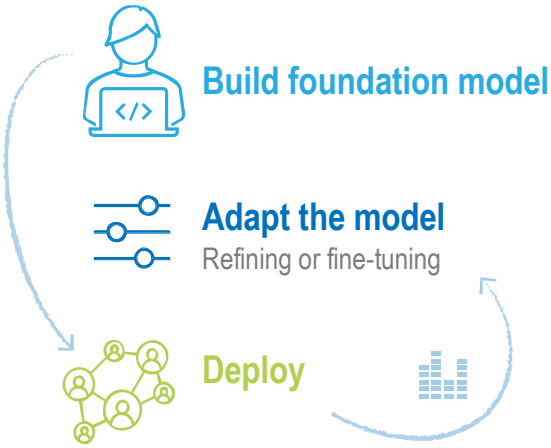


Note: This figure presents only one possible relationship between the development and deployment phases. In many cases, the design and training of the system may continue in downstream uses. For example, deployers of AI systems may fine-tune or continuously train models during operation, which can significantly impact the system's performance and behaviour.
Source: OECD Secretariat

31. This paper loosely focuses on two stages of the AI lifecycle to simplify the analysis relevant to competition assessment: building a foundational model, adapting the model through refining and fine-tuning, and deployment of the foundational model. This is not to say that other aspects of the lifecycle are not important and other parts of the lifecycle are incorporated as necessary in the discussion below.

32. According to the three stages in this paper: building a foundation models provide underlying general capability, which can then be further refined for a specific purpose, before being deployed for use. Data generated from usage after deployment may lead to further refinement. This leads to a simplified key lifecycle as outlined in Figure 2.

Figure 2 Simplified key steps for competition in generative AI lifecycle



Note: This diagram is a significant simplification of the key steps in the generative AI lifecycle which have been identified by this paper as important for competition. The complexities of the system are better represented through the previous figure.

33. The OECD defines the AI system value chain based on the activities of actors involved in the development and use of the AI system (OECD, 2023[17]). This conceptualisation of the AI value chain is being developed specifically for the purposes of applying responsible business conduct and accountability principles to relevant enterprises in the AI value chain [C(2024)53][DAF/INV/RBC(2024)11]. It places actors in three broad categories:

- Group 1: Suppliers of AI knowledge and resources
- Group 2: Actors actively involved in the design, development, deployment, and operation of AI systems.
- Group 3: Users of the AI system

34. Under this understanding, Group 1 includes actors involved in activities pertaining to the provision of AI knowledge, i.e., the information inputs used to develop an AI system, such as data and code; and activities related to the provision of financial, logistical, administrative, and hardware inputs needed to support the development of the AI system such as investors, digital infrastructure providers and semiconductor manufacturers. Group 2 includes businesses, service providers and research institutions involved in the AI system lifecycle. Group 3 are actors using the AI system in their operations, products and services. These include financial institutions and businesses in the 'real economy' (i.e., manufacturers and sellers of goods and services).

35. Unlike value chains for physical commodities, AI value chains are non-linear in nature. They are more akin to a complex web of overlapping services and relationships. These groupings are not rigid and exclusive but rather, intended to inform how actors in these groups should approach human rights and environmental due diligence in the AI value chain. Many actors may be conducting activities which would place them in multiple groups.

36. Other versions of the value chain could separate the stages above, or add additional ones focussed on highly specific areas. While not exhaustive, among the steps that are mentioned above, some of these models also include reference to:

1. Computing power, through Graphics Processing Units (GPUs) or cloud computing.
2. The provision of data, such as data compilation services.
3. The various operational inputs required to manage AI systems, sometimes referred to as Tooling.
4. Distribution platforms for deployment.

5. Services to provide assistance on how best to use and benefit from AI (prompt engineering).

37. Many of these could be thought of as components of Figure 1 or Figure 2. The sections below explain the main inputs required for the three stages outlined in Figure 2. It starts with the first level, foundation models. At the end of this Chapter, Figure 3 attempts to provide a more detailed illustration of the individual inputs required for generative AI, including a number of these steps above.

2.4. Foundation Models

38. Typically developed with enormous amounts of data, foundation models provide the general capabilities that power a generative AI system or application. This provides the ability to process inputs in natural language and generate outputs of various forms. Foundation models are potentially interesting in themselves, for example the UK's Competition and Markets Authority launched a monitoring piece of work specifically to study developments in generative AI foundation models (CMA, 2023[18]).

39. New foundation models are frequently launched, with 149 notable models launched in 2023 and models appear to continue to get larger (Stanford University, 2024[19]). Larger models may allow better performance across a range of metrics, but also the capacity to understand and process a range of inputs. Several firms have launched foundation models, ranging from existing firms active in adjacent digital spaces to start-ups (CMA, 2024[20]).

40. A notable feature of foundation models are the reportedly large development costs they incur. For example, the reported cost of training GPT-4 was over USD 100 million.[20] Training also takes time, with anywhere from 20-90 days being required depending on model size and the hardware used (CMA, 2023[18]).

41. Another interesting dynamic of the development of foundation models is the extent to which they are proprietary or open-source – defined loosely. Open-source models are made available for use, sometimes with licensing conditions.[21] Historically, many AI developments have been open-source.[22] There have been concerns that recently more developments are becoming proprietary, potentially as firms wish to recoup their increasingly large investments.[23] Nonetheless, resources appear to remain available for potential developers. Of the 149 foundation models released in 2023, 98 were open-source, although a higher proportion of notable models are produced by firms rather than in academia (Stanford University, 2024[19]).

42. The following sections describe the most significant inputs for developing foundation models. This includes the two principal inputs, data and computing power, as well as other factors of relevance, such as access to know-how and finance.

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[20] While OpenAI does not appear to have provided specific figures, a cost of $100m has been widely report. For example, see https://www.wired.com/story/openai-ceo-sam-altman-the-age-of-giant-ai-models-is-already-over/

[21] Using the term in this way is potentially inconsistent with traditional definitions of open-source within the academic and technology community. Here it just means models that are available to use rather than necessarily providing full access to source code.

[22] The extent of this phenomena will depend on the costs that can be avoided through the use of open-source material, as well as the level of ingenuity it provides.

[23] On the other hand, there may be financial reasons to make models available open-source, for example if it supports the branding or awareness of a related, larger, commercial model, or encourages the take-up of the model from which associated support services could be provided. It might also be that there are indirect network effects from allowing others to adopt a model, for example if it leads to an improvement in quality from experience (CMA, 2023[18]).

2.4.1. Data requirements

43. Foundation models are derived by applying machine learning techniques to enormous amounts of data. They express patterns that emerge from the data they are trained on. Different types of data can be input into the models, such as text, images, videos, audio. To derive useful models, enough reliable data must be provided to populate its parameters (or layers). Before beginning the process, developers need to clean the data, removing any unwanted elements and turning it into the appropriate format, for example into tokens, and sometimes to add labels or structure (CMA, 2023[18]).

44. The exact amount of data required to train a foundation model is unclear. Some argue data is the single biggest issue for developing them. For example, after building of a model of the value of generative AI, (Hunt et al., 2023[21]) estimates that around 70-75% of model value is from data. However, recent speculation has suggested that the trend towards increased data needs may be over, with for example Sam Altman, CEO of OpenAI, suggesting that the race towards giant models was over.[24]

45. At the cutting edge of advancements however, it seems likely that significant data will continue to be required, although where the focal point of the industry will settle is unclear.[25] Many firms have not detailed which data they used to train their models, beyond noting a mix of public and licensed data.[26] It appears that much of the data used is from the internet and there a number of datasets that are available publicly (CMA, 2023[18]). If public data will continue to be a main input is unclear, and there has been some speculation that stocks of data may be running out, with some suggestions that high-quality language data could be exhausted by 2024, and other forms within a few decades (Stanford University, 2024[19]).

46. Several sources of proprietary data could exist, perhaps being held within internal databases of firms, or collected from users of services they host. As noted, it does not appear to have been a major part of the current development of models. However, this could change if data stocks became low or if major sources of quality proprietary data were available. Interestingly, it appears that developers are beginning to engage in contracts with potential data providers (CMA, 2024[20]), although it is unclear whether this would be used to train foundation models or fine-tune them, as discussed below.

47. Data also needs to be considered in terms of how it affects the competitiveness of generated models. While a minimum amount of data may be required, there are other qualities likely to affect model competitiveness. Some frameworks discuss three dimensions of data, including its quality, scaling and uniqueness (Hunt et al., 2023[21]). Others suggest “four Vs”, volume, velocity, variety and value (OECD, 2016[22]). Quality data is needed to reduce the risk that model outputs are themselves of low quality, for example by exhibiting bias or producing incorrect information that is presented as true, known as “hallucinations”.

48. Variety and volume are likely to affect data quality. Another important aspect of data quality will be its accuracy. Models are, quite literally, what they are made from, so if inaccurate data is used to develop them, their outputs will be inaccurate (Hunt et al., 2023[21]). If, for example, a foundation model was trained on data that contained consistently incorrect facts, it would reliably propose responses that were inaccurate. The more varied the data, the broader the range of responses. Another relevant aspect is the velocity of data, which refers to how quickly it can be collected and may affect how up-to-date it is. The

[24] For description of comment by Sam Altman, see “OpenAI’s Sam Altman says giant A.I. models are over—but going small won’t appease regulators”, Fortune, by David Meyer, 18 April 2023. https://fortune.com/2023/04/18/openai-sam-altman-llm-size-elon-musk-truthgpt-eu/

[25] For example, if a high proportion of functionality that customers demand can be fulfilled more cheaply by smaller models, then the cutting-edge may be of relative less importance to future market dynamics, similar to advancements over time in automobiles.

[26] For example, OpenAI explains that they used a mixture of publicly available data (such as from the internet) and licensed data from third-parties to train GPR-4 (OpenAI et al., 2023[69]).

ability of firms to access up-to-date public data may be limited as they compile what already exists.[27] It is unclear how much of an obstacle this will be for developing foundation models though, which are general by nature.

49. It is possible small amounts of data can be extrapolated to create synthetic data. Whether such synthetic data can replace real, human-created data, is contentious, although it seems unlikely to generate enough valuable data for training foundation models (Hunt et al., 2023[21]). Some have argued that it generates substantial risk and will lead to increasingly lower quality as the training loop progresses, unless there is enough real data (Alemohammad et al., 2023[23]). It therefore appears likely that a reasonable amount of human data will be required to train foundation models for the foreseeable future (Stanford University, 2024[19]).

50. How foundation models are fine-tuned or refined can affect overall data requirements. For example, there may be techniques that allow the production of models with strong performance on less data (Carugati, 2023[24]). There have been increasing developments in techniques that seek to provide strong performance from models but with fewer parameters and hence data requirements (Hu et al., 2021[25]). These developments are discussed further below.

2.4.2. Computing power

51. Substantial swathes of data do not simply become parameters in models. The data must be processed using substantial computer processing resources – often referred to as the compute (OECD, 2023[26]). For technical reasons, most compute is supplied through GPUs.[28] Designed to supplement core processing power to better enable rendering of improved graphical content on screens, GPUs were until recently perhaps best known for their appeal to video gamers. However, with their ability to process large amounts of data at high speeds, and work together in parallel at scale, they appear to be the most in-demand hardware to train foundation models (OECD, 2023[26]). In addition to hardware, firms may also need software and systems which improve the ability of the hardware to work efficiently at scale.

52. Current foundation models have required substantial compute at considerable cost. OpenAI's GPT-4 reportedly used USD 78 million in computing costs alone to train, while Google used USD 191 million in training Gemini Ultra (Stanford University, 2024[19]). Foundation model developers have two broad options for compute: purchase hardware to run their own systems or access it through a service such as cloud computing. In practice there may be variations within these and developers may be able to access a range of options (OECD, 2023[26]).

53. Thousands of GPUs appear necessary to train foundation models, which in turn require energy (OECD, 2023[26]). For example, it is estimated that GPT-3 required over a thousand high-end GPUs, while Meta's LLaMA used over two thousand (CMA, 2023[18]). There may be an element to which speed can be traded off with computing power, but fundamentally training a foundational model requires lots of processing. Demand for GPU units has reached unprecedented levels, further increasing costs.[29]

[27] It is possible that this could be overcome if models are able to feed into search databases when deployed and therefore rely on that information.

[28] Processing power from Central-Processing Units (CPUs) is less suitable for the processing power required for training foundation models (OECD, 2023[26]). Alternative types of hardware, such as Tensor Processing Units (TPUs), which were developed by Google, offer alternatives to GPUs, although which is most appropriate may depend on the types of models being developed.

[29] It can be difficult to identify the cost of these chips, as there are multiple distribution outlets, but they are likely to be in the range of multiple thousands of euros.

54. Many GPUs are reportedly produced by one single supplier, with some estimates that they supply up to 80% of GPUs globally (Myers West and Vipra, 2023[27]).[30] Cloud computing provides access to processing power remotely, paying instead for the infrastructure that they use rather than having to run their own systems.[31] It is worth noting that the cloud operators will themselves tend to use GPUs as part of their servers to process AI related loads.

55. How the costs of computing power for foundation models will change as technology evolves is uncertain.[32] On the one hand, models may keep getting larger and current trends suggest that the computing power demanded by foundation models continues to grow (Stanford University, 2024[19]). On the other, AI techniques continue to evolve and new advancements occur regularly in the hardware space, which may reduce the amount of computing power required, or make it cheaper to obtain.[33] For example, AI chip suppliers are seeking to increase production, as well as potential entrants, including efforts by current cloud computing providers to develop their own processing chips (CMA, 2024[20]). Whether these will be successful given challenges of mass producing such chipsets remains to be seen, although government support has already been launched in some countries to assist in the development of local production, for example in Europe.[34] Nonetheless, computing power appears likely to remain an important requisite and in many ways these developments serve to illustrate the importance of hardware for development and implementation of AI.

2.4.3. Other factors required to develop foundation models

56. Even armed with all the data and computing power in the world, it is unlikely that someone could develop a competitive foundation model without the requisite expertise and talent. Finding innovative ways to produce models with competitive capabilities at lower costs is likely to be one of the main competitions between firms over the coming years. Talent and ingenuity will play a role in this.

57. The expertise required to develop a foundation model includes the necessary AI based techniques, as well as the talent to progress techniques to derive the right outcomes. Innovation often requires ingenuity. Increased demands for workers may lead to shortages of some skills and upwards pressure on wages. However, recent attention in generative AI has increased interest in the sector and will likely expand labour supply over the longer term, and many countries have experienced large increases in the size of their AI workforce (Stanford University, 2024[19]). There are also examples of new firms being started by

[30] The Economist, "Just how rich are businesses getting in the AI gold rush?", 17 March 2024,https://www.economist.com/business/2024/03/17/just-how-rich-are-businesses-getting-in-the-ai-gold-rush

[31] It is likely that large customers will be able to negotiate rates for access to these services. Some media sources offer estimates of the ball-park cost for accessing GPUs on the cloud at around USD 2 – USD 2.5 per hour and developing large foundation models is likely to take at least many hundreds of thousands of GPU hours. See for example: "The economics of trading equity for compute are not great' — Mistral releases its first model", Sifted, Tim Smith, 27 September 2034, https://sifted.eu/articles/mistral-releases-first-ai-model.

[32] Both in terms of the per unit cost of compute or amount demanded given the latest techniques and development methods.

[33] For example, on 18 March 2024, Nvidia announced a new GPU, the B200 GPU, which it claims will reduce cost and energy consumption substantially compared to the previous model, H100.

[34] For example, the European Commission recently approved State Aid between 7 countries to support the development of cloud and high-end technologies. See: European Commission, "Commission approves up to €1.2 billion of State aid by seven Member States for an Important Project of Common European Interest in cloud and edge computing technologies", Press Releases, 5 December 2023, https://ec.europa.eu/commission/presscorner/detail/en/ip_23_6246

previous employees of former large tech firms, suggesting that even if there is a limited ability of new talent to enter, existing talent is not necessarily fixed.

58. Beyond talent, the factors above highlight that capital is required to train foundation models (CMA, 2023[18]). As noted, the development costs of many models are often in the hundreds of millions of US dollars. It is unlikely that a model could be developed without at least some capital, although some argue that the costs may decrease substantially as techniques and hardware evolve (Carugati, 2023[24]).

59. Given the projected growth of AI, it may be difficult to imagine too acute a shortage of capital being willing to invest in the hope to capitalise.[35] Of course, capital will only be willing to invest if there is the potential to earn a return in the long-run.[36] As a new market, and discussed more below, it is unclear how successful the various attempts at monetisation in generative AI will be. There is also the pressing issue of a highly uncertain legal and regulatory environment, further casting doubt on the potential for return.

2.5. Fine-tuning / refining

60. Foundation models can be refined or fine-tuned to improve their performance. This could be additional training on further or tweaking to improve performance, for example to remove unwanted biases or tones contained in the training data (CMA, 2023[18]).

61. This further training stage could be considered part of the production of the foundation model itself (CMA, 2024[20]).[37] However, open-source foundation models and the ability to license proprietary ones may provide access to foundation models for others to fine-tune or refine.[38]

62. In general, fine-tuning and refinement requires many of the same inputs as foundation models, albeit with some key differences. Building on a general model, the volume of data and scale of compute required will likely be lower. However, these could still be significant, especially if models are audited by human observation. If models are fine-tuned less expensively though, this is a potential route to market for smaller producers.[39] Attempts to develop more efficient, and smaller, models that are less data and compute hungry will surely continue.

63. Despite this, data requirements are not necessarily straight-forward for fine-tuning or refining models. Data may need to be highly specialised to train a model for a particular purpose (CMA, 2023[18]). So, while volume may be less critical, data quality and uniqueness may become more important (Schrepel and Pentland, 2023[28]). This may mean that only certain firms have access to the data required to fine-tune a general model for a specific purpose. For example, consider that a hospital may have exclusive access to data to fine-tune models for dealing with hospital admissions.

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[35] For example, many firms appear able to have raised equity investment in the sector, even if the largest investments appear to have come from firms already active within the AI space. Mistral, a French start-up, reportedly secured close to USD 527 million across two funding rounds (Stanford University, 2024[19]).

[36] While a certain profit will always be preferred over an uncertain one, a small chance at a very large profit is not something that all investors would spurn.

[37] Indeed, there are examples of many foundation models that are available, either open source or through third party licensing that have gone through this process (Carugati, 2023[24]).

[38] As noted in (Carugati, 2023[24]), an example of fine-tuning can be seen from Phind-CodeLlama-34B-v2 which reportedly performs well on a number of performance metrics, see: https://www.phind.com/blog/code-llama-beats-gpt4

[39] For example, it has been argued the Koala model is a good example of this, having been trained for a reported time of 6 hours and for less than USD 100 using the LLaMA model and fine-tuning it with Open Source datasets (Carugati, 2023[24]).

64. Relatedly, a potentially important question will be the extent to which fine-tuning and refinement can incorporate feedback data that comes from usage of AI applications. Data from the production of outputs from inputs can be captured to potentially further refine and improve a model. A/B Testing could further this effect, allowing firms to gather data on how a model reacts to different scenarios and then adjust according to the results.

2.6. Deployment of generative AI

65. No matter how impressive a feat it is to train, and possibly fine-tune, a generative AI foundation model, it is its usage that will derive real value for the economy. This paper refers to this as deployment.

66. How deployment evolves will depend on the methods of commercialisation that suppliers pursue and customers demand. Currently different approaches are being taken, such as subscription services, licensing or consultancy style offerings. While the cost and structure of payments for such services varies, a common system appears to be metering, where payment is based on the amount of queried levied to the system. Deployment is also likely to vary according to the purpose intended. For example, a model deployed to provide a chat service to internet users will differ from a call centre assistant model.[40]

67. To deploy a generative AI product, the user must be connected to a system that can access and run the underlying model, and any associated applications and data. When an input, or query, is given to a model, it must infer the output. This requires compute, potentially a significant amount when aggregated across users.[41] This appears to present one differentiating factor with other digital markets, where variable costs are often low or negligible. Whether this will remain the case in the future is unclear. There have been suggestions that improvements in computer hardware technology, as well as advances in developing more efficient models, may reduce this cost in the future.[42] Nonetheless, to provide an AI service a provider will either need to run their own servers and network to meet these demands or use a cloud service provider.

68. While there may be various use types, it may be useful to distinguish between use by organisations and individuals. Organisations may be businesses, governments or research institutions that own some infrastructure and wish to use AI to help fulfil tasks within their systems. Conversely, individuals access AI solutions through software supplied via existing devices, such as personal computers, laptops, smart phones or devices.

69. For organisations, there appear to be two main options to deploy AI solutions. They could license a foundation model, including one that is fine-tuned, and incorporate it into their systems. Alternatively, they could purchase the solution as a service. Further configurations are possible. For example, the solution may be hosted by an AI services provider which grants access through an API, meaning the organisation accesses a terminal to the solution rather than having access to the underlying model. A supplier could even tailor its service to user needs, such as developing fine-tuned models based on their

[40] There are many more examples, such as a law firm wishing to produce legal drafts, or health researchers considering prospective molecules to test (Lane, Williams and Broecke, 2023[10]).

[41] For example, it has been estimated that 40% of all one provider's GPUs used for AI have been used to deal with queries as opposed to training. See: The Economist, "Just how rich are businesses getting in the AI gold rush?", 17 March 2024,https://www.economist.com/business/2024/03/17/just-how-rich-are-businesses-getting-in-the-ai-gold-rush

[42] To illustrate the point, consider that some recently developed models have reported being more efficient than others. For example, Mistral has stated that its model is significantly more efficient than competitors, requiring 50% less computational power than Meta's Llama 2. See: https://sifted.eu/articles/mistral-releases-first-ai-model

data.[43] One challenge going forward for deployment and adoption will be how different sectors are able to access and leverage their own data.

70. AI has the potential to improve technical capabilities along a range of dimensions for industries. AI as a service could be purchased on a stand-alone basis or alongside other IT related services. This could provide some synergies to customers, for example if data storage can then be leveraged to further refine model performance. Such offers appear to exist already, and this is likely to continue developing over the foreseeable future. For example, AI could be offered as part of a package of software as a service or alongside other software applications or packages.

71. Individual users need to be provided with an interface to access AI.[44] Deployment could be standalone or integrated into existing offerings. A standalone offering could be through a website, programme or application that can be accessed or installed via a personal device. Many chatbots can be accessed through the provider's website for example. An AI service could also be offered as part of an existing product or suite of products. For example, it has been noted that several firms are already offering combined solutions to users (CMA, 2024[20]). Standalone and integrated solutions may be offered, with users able to choose which they prefer, depending on the advantages they offer.[45]

72. There appears to be potential for strong interaction between AI applications and other digital services, such as digital platforms. Such ecosystems may provide one route to market for AI, such as through applications on existing operating systems, or even through websites. New routes to market may emerge, such as new platforms or stores for applications that focus on AI.

73. As with deployment to organisations, how solutions are supplied to individuals is still developing. Some services are available free of charge, either standalone or part of broader software packages. Not all services are free, with some suppliers charging either through subscription or on a per use - or metered – basis. A variety of options in between already appear available. Several suppliers offer what is often termed the 'fremium' model, where basic access to the service is provided free of charge, but a better service can be accessed for a fee. What is available free also varies, with limits on the number of queries or the quality of model supplied. There may also be deployment of AI through hardware that consumers purchase directly, such as an AI specific device or gadget. While there does not appear to be widespread usage of such devices yet, there has been increased interest from firms in producing AI specific hardware, which may itself fit within existing digital ecosystems.[46]

2.7. Overview

74. The list of firms operating in some form in the AI space is long, including both specialist startups and pivots from existing ones. Many of the most recent development and advances have been associated with existing firms based in the United States and several are active across the supply chain, developing hardware, models and platforms for software solutions. However, these are not alone, with examples of start-ups and other firms operating at certain parts of the supply chain, even producing foundation models.

[43] Some AI developers may use applications as part of a system to support the provision of other services. In such cases, it could be thought of as an input into that service.

[44] There may also be organisations that prefer to access AI technology in the same way that an individual would.

[45] Such advantages could include seamless operation between different applications, or by allowing improved personalisation due to access to user data.

[46] For exploration and examples of some of the potential developments with regard to AI specific devices, see: Piece, David, "Welcome to the AI gadget era", The Verge, 3 April 2024, https://www.theverge.com/24117865/ai-gadget-era-humane-rabbit-brilliant-meta

Firms more broadly involved in a range of information technology solutions are also developing models and solutions (CMA, 2024[20]).[47]

75. Developments are not limited to North America and Europe. For example, several major companies in Asia, including India, Japan, Korea and China have developed and released generative AIs over recent years (Takamiya, 2024[29]), (Research Prism, 2023[30]). A distinctive feature of these generative AI models being developed and released is their optimisation in local languages, underscoring the region's emphasis on creating highly localised AI solutions (Shin, 2023[31]).

76. A notable feature of the current landscape is the many links between different parts of the value chain, with many operators vertically integrated or operating in adjacent markets. There are also several partnerships between firms with different offerings (CMA, 2024[32]), including Microsoft's investment in OpenAI as discussed in Box 7 further below.

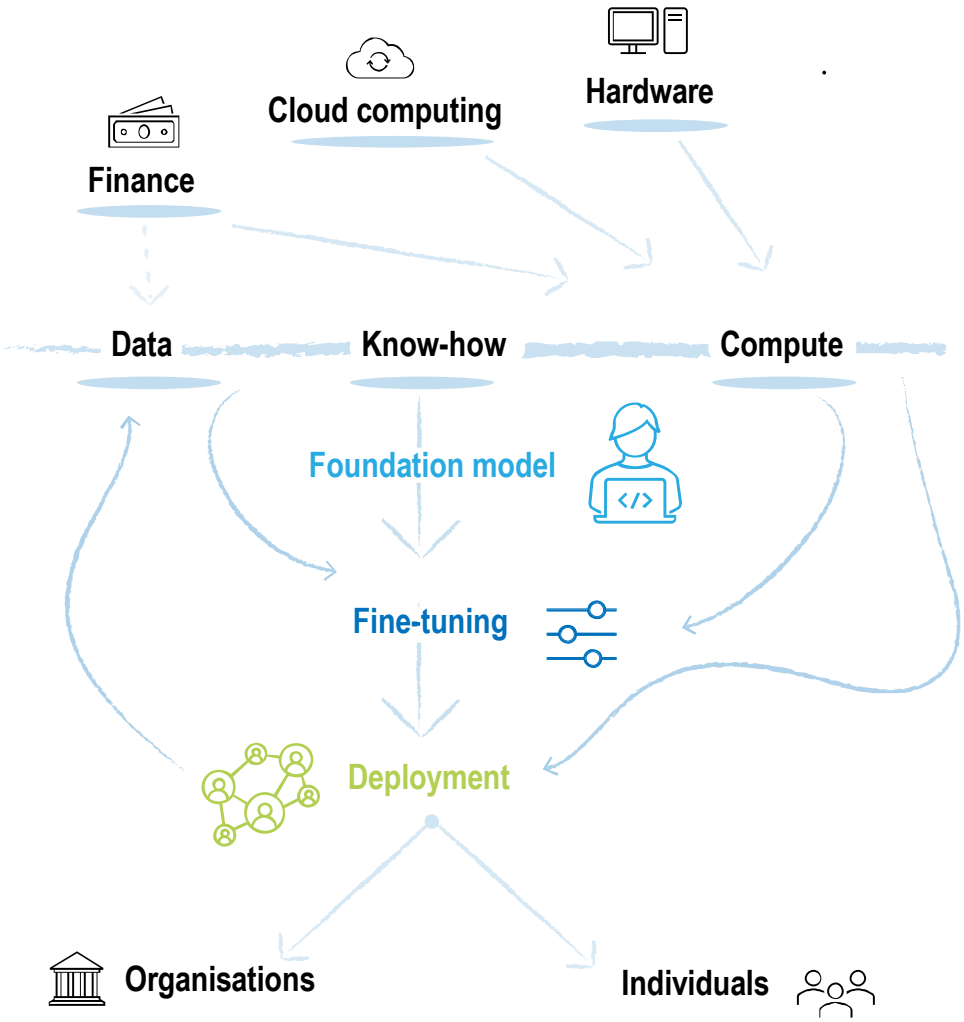
77. Developments in AI may also be affected by the interaction between industrial policy and competition between jurisdictions, as different countries seek to cement their role in "the AI technology race". As noted in Box 2, public sector investment has been a feature of AI for some time, and it remains to be seen how funding and direction from central government's affect AI markets.[48]

78. As discussed, a mix of inputs are required across the supply chain to produce AI. Figure 3 illustrates some of the key inputs required to compete in the generative AI supply chain, as discussed in this paper. It builds on the three stages set out in Figure 2.

[47] As an example, IBM, notable in the pursuit of AI with Deep Blue, operates a platform for businesses that enables them to incorporate AI into a number of different business uses, as well as various data storage and cloud provisions. The service is provided under their Watson branding, and offers access to a number of foundation models, including those that are open source, such as Llama 2, and some models developed internally by IBM.

[48] The geopolitical nature of some issues in AI have been discussed by commentators, for example: Goldman Sachs (2023), "The generative world order: AI, geopolitics, and power", https://www.goldmansachs.com/intelligence/pages/the-generative-world-order-ai-geopolitics-and-power.html#:~:text=The%20most%20profound%20impact%20of,GDP%20by%20nearly%20%247%20trillion.

Figure 3 More detailed illustration of generative AI value chain



Note: This diagram is a significant simplification of the key steps in the generative AI value chain with key inputs for competition identified by this paper.

3. Competition in the supply of AI

79. This Chapter considers potential competition issues in the supply of generative AI. As already explained, this paper is not a formal assessment of competition and is not based on detailed market specific information. The intention is to explore the types of competition issues that authorities and policy makers may wish to consider in more detail. That there are potential risks to competition within generative AI does not preclude it having substantial positive effects on markets, many of which were discussed above.

80. The first part of the Chapter considers some of the reasons why competition authorities, public bodies and even the wider public, may wish to consider competition issues in AI. The next analyses the likely role for competition in the sector, before exploring potential competition issues. The tools that competition authorities may have to tackle these issues are discussed in Chapter 4. .

3.1. Why care about competition in the supply of AI?

81. While many predict wide-sweeping technological change as a result of AI, predictions on the speed and impact of innovations have been wrong before (see Box 2). With such uncertainty, it seems natural to question whether a focus on competition in a nascent sector is warranted.

82. Competition authorities face many competing demands. Some will not be discretionary, for example notified mergers or if obliged to respond to complaints. Nonetheless, there will likely be some discretional resources at an authority's disposal. Within these, there is scope to consider devoting resources to AI balanced against the opportunity cost of employing them elsewhere.

83. Ineffective competition leads to market power and market failure. Effective competition in the provision of AI services is likely to be important in ensuring consumers and economies fully benefit from the technology. As with many fast-paced and innovative markets, the key is effective dynamic competition. The interaction between competition and innovation is not straightforward, but there is broad acknowledgment of the importance of competition to promote innovation (OECD, 2023[33]). Thus, while there may be instances where particular firms are able to gain temporary market power through an insightful breakthrough, it is the expected durability of this position that is of interest.[49] Even if competition for the market is intense, if there is little prospect of competition ever meaningfully occurring within the market, this may not be the best outcomes in the long-run, particularly if the effects of market failure spread into adjacent markets.

84. While competition in the supply of AI is important, to warrant focus, such a focus should have potential to materially improve competition. Two conditions appear relevant. Firstly, that competition issues might emerge if left unchecked and have a substantial impact on markets.[50] Second, intervention could

[49] Crucially, the key issue is the extent to which such durability can be predicted in advance and, ideally, stopped before it develops.

[50] Note that it is not necessarily the case that such issues need to be likely to arise, but that if they did, they would have a material impact.

remedy them. If either is not met it would be difficult for a competition authority to justify committing resources to the sector. However, understanding if this is the case may itself require further analysis.[51]

85. Even if met, the conditions above could hold for large sections of an economy. Additional factors appear to be needed to justify a focus on generative AI. One such factor could be its importance. AI's importance could come from its potential to become widespread and used in many other markets, exhibiting a significant multiplier effect. As discussed above, that potential appears large.

86. Another aspect to consider is timing. If AI presents issues that require a speedy response, for example if markets risked "tipping" as discussed further below, authorities should arguably prepare to act. This involves getting up to speed technically. The risk is that it may be too late if authorities are too slow in developing an understanding of the issues. In this sense, there is a question of whether lessons from digital markets could be learnt, with the speed of action to-date from some authorities suggesting that they are keen to move quickly.[52] Further, even if one believed that there was little reason to worry about AI from a competition perspective, focusing on it to understand the basics may be necessary given its technical nature. Absent this knowledge, authorities may find themselves in the dark about a potentially large segment of their economy.

87. Relatedly, AI could also warrant attention if it raised novel competition issues which required new approaches that might take time to develop. It is unclear if there are any genuinely new challenges for competition policy from AI. Many of the challenges of digital markets appear relevant. However, having already established digital markets may affect how AI develops and raise new issues. There could also be challenges in applying competition law to a sector that diverges further and further from human-made decision making (OECD, 2023[34]), which may also warrant deeper interactions between competition and consumer policy.

88. Finally, beyond a traditional consumer welfare perspective, arguments relating to the balance of public and private economic and political power could present reasons to focus on AI (Amato, 1997[35]). The argument would be that the risks to society if a vital technology were to end up concentrated, even if it was beneficial to consumers warrants attention. Concerns could include the potential ability of large businesses to lobby to shape regulations, either to reduce them or to facilitate their use as barriers to entry. Such a lens could point towards rebalancing the risk of type 1 and type 2 errors towards a more interventionist approach (OECD, 2023[36]).[53]

3.2. What types of competition issues could emerge in the supply of generative AI?

89. At the outset, it is important to be mindful of the distinction between conduct that is potentially unlawful and factors that might affect competition but may not fall foul of competition law. However, it is not always clear when conduct has the potential to break competition law. Further, factors that do not

[51] In this respect there may be a "chicken and egg" scenario for authorities. To determine whether it makes sense to focus on a market they must consider the potential impact of that focus. To do that they need information. To get information they need to give it some focus.

[52] For example, in a recent speech, EU Commissioner for Competition Margaret Vestager noted how time may be running out to act on AI. See coverage of speech: GCR, "Vestager: AI "window of opportunity" is closing", 19 February 2024, https://globalcompetitionreview.com/article/vestager-ai-window-of-opportunity-closing

[53] Type 1 (overenforcement) and type 2 (underenforcement) errors need to be carefully balanced when considering enforcement under uncertainty. In sectors where the costs of type 2 errors are particularly high, there may be a case for rebalancing away from the risks of underenforcement. Such a pivot presents increased risks of overenforcement.

involve potential breaches of competition law may nonetheless significantly impact the effectiveness of competition. Both are therefore considered in this section.

90. That there may be risks to competition in the supply of generative AI has been noted by several competition authorities, such as CMA (2024[32]), Canada Competition Bureau (2024[37]) or the Portuguese Competition Authority (2023[38]). Concerns include access to inputs and users, as well as that the emergence of AI will further strengthen the market positions, and power, of digital firms. Most of the potential concerns appear to fall under categories of more traditional theories of harm, and it is not clear whether entirely novel issues will arise (Hogg and Westrik, 2023[39]). Concerns may also arise around the nature of the market and its structure, including whether it exhibits "winner takes most" dynamics and trends towards concentration (CMA, 2024[32]).

91. Others argue however that the risks appear low, highlighting that the market is competitive, with many active firms and a dynamic state of innovation, such as (Carugati, 2023[24]) or (Copenhagen Economics, 2024[40]). Others argue however that the risks appear low, highlighting that the market is competitive, with many active firms and a dynamic state of innovation, such as (Carugati, 2023[24]) or (Copenhagen Economics, 2024[40]). An issue often raised is the potential risk of reducing innovation by intervening in a nascent market (Curry and Hill, 2024[41]).

92. The following sections consider risks to competition, starting with structural factors such as the nature of the market and relationships between firms. The discussion then turns to potential barriers to entry related to accessing key inputs and users.

3.3. Structural factors

3.3.1. Economies of scale and first-mover advantages

93. Whether AI markets could trend towards concentration independently of anticompetitive conduct could inform the appropriate competition policy response. In particular, if there are "winner takes all/most" characteristics intervention risks being ineffective if too late. With market dynamics still developing, an assessment of these factors is necessarily speculative.

94. Experience from digital markets may be a useful starting point in such an assessment. Factors such as economies of scale or scope, network effects, and ecosystems, have been identified as relevant to the development of digital markets and a tendency to "tip" irrevocably towards certain firms (OECD, 2020[42]). Certain parts of the digital economy have even been likened to natural monopolies, particularly online search and online marketplaces (Ducci, 2020[43]). Aside from natural monopolies, substantial economies of scale can provide first-mover advantages and make it more difficult for new entrants to compete. It is therefore useful to consider the likelihood of such conditions emerging, as well as whether there are likely to be increasing returns to scale within the AI sector (Schrepel and Pentland, 2023[28]).

95. Economies of scale appear likely to vary at different stages of the AI value chain. For foundation models, development costs appear high. If this were to emerge as an independent section of the market, for example if providers were to adopt licensing models, then there may be relatively few running costs, implying substantial economies of scale. In terms of deployment though, marginal costs are non-zero, although it is unclear what structure marginal and average costs will take over the long run.

96. Regarding economies of scope, which are conferred through reductions in costs across business lines, the clearest potential comes from firms operating across adjacent markets, such as cloud computing services or other digital markets. For example, data could be an economy of scope if operating in adjacent markets allows firms to capture data that improves its ability to develop better generative AI models. There may also be synergies if staff that work in related fields can work on AI development. This could have the effect of making it difficult for some firms to compete against digital platforms (Digital Platform Regulators

Forum, 2023[44]). Economies of scale within adjacent markets will also affect the significance of economies of scope, as could the ability (and desire) of consumers to switch between different AI offerings. The latter could become particularly relevant if AI is deployed as part of an existing digital ecosystem.

97. Network and feedback effects can, if sufficiently strong, lead to markets tipping. There may be potential for feedback effects at certain parts of the generative AI value chain. For example, if user data allows the further refinement of models, then the value of a generative AI service may be higher to consumers as that service gets more users. If these effects are strong, it could provide substantial first-mover advantages, as entrants without an existing network of users struggle to compete by refining and improving models. This would generate a cyclical effect, where more users improve product quality, driving more users.

98. Such feedback effects appear most relevant to deployment and fine-tuning of models. The strength of these effects will depend on the ability of firms to offer competitive quality without access to feedback data. To date this appears relatively unimportant but whether this will change is highly uncertain. It could also be that the effect varies by business model and industry. For example, feedback effects could be more significant as deployment becomes more specialised, such as within an industry or narrowly defined task.

99. Access to capital and expertise may also provide first-mover advantages if there is significant uncertainty on returns on investments, perhaps due to potential regulatory changes or other policy interventions. Larger firms may be better placed to deal with this.

3.3.2. Acquisitions and partnerships

100. Firms could also use mergers or partnerships to alter market structures (CMA, 2024[32]). Many acquisitions are pro-competitive and allow businesses to improve their offerings to consumers. This can be particularly true in the context of innovative markets, where the combination of different ideas allows previously unforeseen synergies to be realised. However, acquisitions also have the potential to lessen competition through the elimination of a current or potential competitor. Risks to competition from mergers and acquisitions are not specific to generative AI, but there could be a few areas of specific interest.

101. For example, the risks of "killer" acquisitions, which was an issue discussed prominently in the context of digital markets, may be relevant if firms seek to remove potential competitors before they emerge (OECD, 2020[45]). A true killer acquisition, where the intention is to acquire and kill, is unlikely to have a pro-competitive explanation. Most instances will not be so black and white however, for instance if a particular product is halted but results in synergies.

102. Another interesting aspect to consider in relation to generative AI is how different forms of partnerships between firms may have similar effects to outright acquisitions and raise competition concerns (CMA, 2024[32]). This could involve investment or contracting for services, such as access to data or compute, potentially exclusively in one or more direction. Recently there has also been discussion of the potential of hiring staff *en masse* from a rival firm to mimic some of the effects of a transaction.[54]

103. It is not clear if such transactions are inherently more likely to occur, or more likely to raise competition concerns, within generative AI. However, due to the increasingly complex arrangements between firms operating at different parts of the value chain, there may be a wider range of agreements than in other sectors.[55] This could well also be driven by the expected growth of the sector, or even expectations of closer antitrust scrutiny.

[54] For example, see article from competition media outlet Global Competition Review: GCR, " Microsoft's Inflection tactics may signal a need for new legislation, Mundt says", 12 April 2024, https://globalcompetitionreview.com/article/microsofts-inflection-tactics-may-signal-need-new-legislation-mundt-says

[55] This may be further complicated by firm structure, such as not-for-profit or recently created start-ups.

104. As discussed in Chapter 4. , merger control may face difficulties if some of these transactions raise issues but fall outside current jurisdictional boundaries. Whether such transactions lead to competition concerns depends on the facts of each case.

3.4. Availability of data

105. As discussed in Chapter 2. , if accessing, processing and storing data were to be difficult, this could be a risk to competition. Some factors could make data difficult to obtain irrespective of anticompetitive conduct, although conduct could also exacerbate issues. Potential risks may also vary across the value chain.

3.4.1. Access to data at the foundation level

106. Data volume is likely to be a key requirement for foundation models. Chapter 2. discusses the various sources of data, and notes that much of the data used appears to be publicly available.

107. However, it is some uncertain how much other data sources are also required, as firms that have developed generative AI models are rarely transparent about their sources. Data may also be licensed from data scraping firms (Hunt et al., 2023[21]), and proprietary datasets may also help firms that are developing generative AI. For example, (Schrepel and Pentland, 2023[28]) argue that some large datasets are proprietary and may provide unique insights that others struggle to replicate, noting as an example Google's ownership of YouTube and the potential to control access to its video transcripts.

108. Another factor that could affect the ability of firms to access data, or for some firms to gain advantages in their access to it, could be the extent to which suppliers of generative AI are able to capture and use data from other firms by supplying a service to them. For example, a firm using AI services may give access to data being generated or held by the firm as part of the terms of use. The potential for such conduct to be considered a form of exploitative abuse is also considered in Chapter 4. .

109. Another uncertainty is the extent to which the use of some data, for example data that is publicly available, may give rise to potential risks of copyright infringement. There is uncertainty on the copyright implications for AI, both in terms of legal cases against AI developers and how they used data, as well as the legal status for outputs that firms create using generative AI. The outcomes of legal cases could have implications for the ability of firms to access the data required to train large foundation models, and one might speculate that it could lead to increased importance for proprietary, or exclusively licensed, datasets (Martens, 2024[46]).[56] Further, uncertainty of the legality of some data usages raises risks for prospective developers who may also need to invest in understanding the stance of different jurisdictions.[57]

110. Markets for data are likely to continue to evolve over time, as its importance in the AI value chain becomes clear. The important factor regarding data's effect on competition will be the extent to which the marginal benefit of training models using it can be replicated.

3.4.2. Access to data for fine-tuning and deployment

111. Despite some differences, the issues discussed above for foundation models are likely to be relevant for fine-tuning and deployment. Less data may be required if foundation models are available to licence or via open-source. In such cases, developers may be able to use data to develop specialised

[56] This could be both from the perspective of the legal right to use certain types of data and what this means for the outputs of models.

[57] For example, some jurisdictions have taken more permissive approaches than others in the treatment of copyright in training foundation models (Martens, 2024[46]).

models. Rather than volume, the data's required characteristics may be more demanding and specific. The velocity of data may become more pressing, perhaps needing to be more responsive and closer to real time, as could its uniqueness. Access to such data could provide a competitive advantage if unable to be replicated by rivals, for example if synthetic data is not a sufficiently viable substitute for real data.

112. As deployment becomes more specialised, specific data could become crucial for firms to compete. For example, to provide useful functionality for specific industries may require data held only by that industry. Such firms may wish to use the services of an AI developer, either through a licensing or as-a-service arrangement. Depending upon the uniqueness of the industry data, the ability for other generative AI suppliers to compete could be limited if access were to be exclusively held by one AI developer. The portability of data covered under such arrangements could affect future ability to switch providers. As such, the conditions attached to vertical relationships between users and suppliers of generative AI services, and potentially their adjacent services, could significantly impact the ability of new entrants to compete. As markets develop, further analysis could consider the extent to which data, and more specifically which types, could be considered close to essential services.

113. At the deployment level, as noted above, access to data from users provides a potential feedback effect, which could lead to increased concentration or even market tipping. Data is both an input that is required to train models, but also an output of use that can then be used to refine and retrain. The ability for providers that train models and also deploy them to collect data on user experience may prove invaluable for improving model performance. For competition, this could make entry difficult if new providers are unable to train models of sufficient quality to attract users without having users to collect data from. If such data were to be crucial, access to the data from users could be essential to promote competition.

114. Another potential issue that relating to vertical links between firms could be how firms in different parts of the value chain are able to use data to benefit their operations in other markets. For example, there may be concerns if upstream or downstream market power allowed service providers to gain access to information from rivals that allowed them to gain a competitive advantage at the expense of that rival.

3.5. Access to compute

115. Similarly, and as also discussed in Chapter 2. , access to compute is important at all levels of the generative AI value chain. While compute requirements will be lower for smaller models, for example for fine tuning specific models rather than training foundation models, it is still necessary. Models also require compute to be deployed.

116. High costs of computing power may reduce the ability of firms to develop or train their own models (Myers West and Vipra, 2023[27]). It is unclear how the demands for computing, and their associated costs, will evolve as generative AI and associated markets mature.

117. There may also be potential competition issues due to vertical relationships involving computing power, with suppliers of key computing hardware and cloud service providers also active in the development and deployment of foundation models (CMA, 2024[20]). If a firm were to have market power in one of those upstream markets, it could provide the ability and incentive to foreclose downstream rivals from computing resources. There may also be risks of customer foreclose, for example through the bundling or tying of services. The interoperability and portability of AI solutions may be a key question going forward.

118. It is outside the scope of this paper to consider competition within cloud services in detail, but competition concerns have been raised by some authorities in this sector, such as (Autorité de la Concurrence, 2023[47]) and (Ofcom, 2023[48]). More information on these studies is provided in Box 4. In general, while there are many potential cloud services providers, three firms appear to have large market

shares in several countries (Autorité de la Concurrence, 2023[47]), namely Amazon – through Amazon Web Services (AWD), Microsoft – through Azure – and Google – through Google Cloud. As these firms are also active in AI and other digital markets, the relationship between these services may be an area for future monitoring (CMA, 2023[18]). Indeed, some argue that cloud computing firms are the best placed to benefit from the recent AI boom. For example, *The Economist* argues that their increase in market capitalisation, which far outstrips expectations in direct revenues attributed to AI, suggests investor confidence that there is substantial future value here.[58]

Box 4. Selected market studies into Cloud Services

Autorité de la concurrence market study on competition in the cloud sector

In January 2022, the French competition authority launched a market study on competition conditions in the cloud computing sector. An interim report was released in July 2022, before a final opinion in June 2023. The study focusses on two cloud services supplied to businesses with different levels of outsourcing, infrastructure as a service (IaaS) and platform as a service (PaaS). IaaS includes access to computing infrastructure, such as storage, computing and networking, whereas PaaS includes the addition of software tools to help build and run applications. The report also considered the full cloud value chain where necessary, including software as a service (SaaS), which is the most outsourced model, where users are given direct access to applications that are managed by the supplier.

The Opinion notes that there appear to be risks to competition in the sector, which appears to be concentrated in France and dominated by three "hyperscalers". These risks include the existence of fees to transfer data, known as egress fees, as well as the use of credits to potentially lock-in customers. These factors, amongst others, can make it difficult for customers to switch providers and may lead to barriers to expansion for competitors to the hyperscalers. In its Opinion, the Autorité highlights that it has tools to act swiftly to protect competition if needed, such as abuse of dominance and economic dependency, and also notes the potential relevance of regulations in addressing some concerns. Interestingly for this paper, the study also refers to the potential relevance of competition in cloud services to other sectors of, including LLMs.

Ofcom cloud services market study

In October 2022, the UK's Ofcom also launched a market study into cloud services. The aim of the study was to better understand an important part of the UK's digital economy and to understand if competition was working well. An interim report was published in April 2023 before a final report in October of the same year. The study focused on cloud infrastructure services, which provide the foundation for the development and running of software applications. As with the French study, it mainly considered Iaas and PaaS services.

Despite noting the transformational nature of the sector and positive outcomes for many customers, the study identified several features in the sector that Ofcom considered limited competition. These included several similar concerns to the French study, namely features that made it more difficult for customers to switch suppliers or to multi-home by using multiple suppliers. This egress fees, technical barriers in switching, as well as the structure of credits. As a result of these concerns and the importance of competition working well in the sector, Ofcom referred the matter to the CMA for a market investigation. The CMA will conclude its investigation by April 2025.

[58] The Economist, "Just how rich are businesses getting in the AI gold rush?", 17 March 2024,https://www.economist.com/business/2024/03/17/just-how-rich-are-businesses-getting-in-the-ai-gold-rush

Sources: Ofcom (2023), "Final Report", in Cloud services market study, https://www.ofcom.org.uk/__data/assets/pdf_file/0027/269127/Cloud-services-market-study-final-report.pdf; Autorité de la Concurrence (2023), "Opinion 23-A-08 on Competition in the Cloud Sector", https://www.autoritedelaconcurrence.fr/en/press-release/cloud-computing-autorite-de-la-concurrence-issues-its-market-study-competition-cloud

3.6. Bundles, switching costs and ecosystems in the deployment of generative AI

119. Restrictions on the ability of customers to switch between providers of generative AI services could also provide a barrier to entry for new firms. There appears to be several risks that may occur at the deployment levels, many of them similarly linked to the potential relationships between AI and existing services.

120. It should be noted that there are many be benefits to being able to integrate AI more holistically into existing ecosystems (OECD, 2020[49]). The interaction with existing regulations on the interoperability of systems may also be relevant.

3.6.1. Access to individual consumers

121. Many factors are likely to affect how individual consumers select AI services. Some of these may also be familiar in the context of digital markets, such as fears of a loss of data, ability to operate with other systems, or even consumer inertia (OECD, 2022[50]). The relevance of these factors to generative AI will depend on the services offered and the monetisation strategies of firms.

122. Recent experience with standalone AI applications may suggest that, at least at present, accessing consumers may not present a significant issue. However, over time it remains to be seen whether firms with large existing customer bases in adjacent digital markets can leverage these into AI markets. Barriers to switching across ecosystems are likely to be higher than between individual applications (OECD, 2020[49]). As such, an ecosystem with a large base of active consumers already may provide a firm with a significant advantage compared to firms unable to offer a range of complementary services, unless there was the ability for individual applications to interoperate within an existing ecosystem.

123. The extent to which consumer facing applications will be integrated into existing ecosystems is unclear, and there may not need to be absolute exclusion in order for some frictions on consumer switching to arise. For example, access may be provided on a standalone as well as integrated basis, and the ability of firms to exploit consumer biases, for example with defaults, may be a key factor in which firms are able to grow their consumer bases. The extent to which there are increasing returns to scale at the deployment level could be a key factor in whether this raises competition issues in practice (Schrepel and Pentland, 2023[28]).

124. This is likely to be of particular concern if there are large consumer bases in applications or ecosystems where AI could be deployed, such as operating systems or platforms. If AI applications could be added to these, as outlined above, this may make it difficult for standalone providers – namely those without their own ecosystem or platform – to compete. Combined with potential barriers discussed above around data, this could have reinforcing effects to limit competition. As ecosystems broaden, and as the capability of generative AI improves, the potential to leverage a strong position from currently established platforms may grow as the value of being within a system increases.

3.6.2. Access to organisation customers

125. Organisations may demand a range of services that firms active in the supply of generative AI also provide. This is likely to depend on the industry application and the size of the business customer. There

may be advantages for incumbent IT service providers to offer AI solutions, for example due to easier operability of systems and integration of single solutions. Further, any market power in adjacent markets needs to be considered, particularly if different solutions may be bundled or tied with AI solutions. For example, (Jenny, 2021[51]) highlights in the context of the wider cloud services market that providers of software-as-a-service may have the ability and incentive to effectively bundle or tie prominent software to the purchase of other services, and this can have the effect of reducing competition for those services.

126. There are likely to also be issues around the interoperability of different IT system solutions. For example, consumers may wish to be able to port data produced using an AI solution to another provider.

127. There may also be circumstances where consumers wish to work with more than one AI solution. For example, if a task required more than one capability and two AI providers specialised in different aspects of those tasks, then the ability of those tools to work together could be important. This is particularly the case if one provider were to have market power in a related market. In this scenario, it is straightforward to imagine how interoperability could facilitate the entry of smaller specialised firms that provide specific aspects of tasks well. It should be noted that in interoperability can raise practical challenges however.

3.7. Access to other key factors

128. Depending on how the sector evolves, there may also be concerns that other key factors of production are difficult for some firms to obtain.

3.7.1. Access to foundation models

129. If substantial barriers to training foundation models were to materialise, access to those models for other parts of the value chain could be vital to maintain effective competition there. To maintain competition, access would need to be on reasonable terms, both in terms of prices, quality and data policies. Foundation model suppliers could be in a strong position to dictate such terms and there is a risk that they leverage that position to gain an advantage and reduce competition.[59]

130. The availability of open-source models and materials may well be a key factor in the extent to which new or smaller developers are able to enter the market without needing to rely on access to closed systems. This appears to be an area that shows some promise at present, but as with many aspects of the sector, is hard to predict.

3.7.2. Labour markets and entrepreneur entry

131. Another potential barrier to entry could be access to expertise and talent if these were difficult to obtain. Similarly, the ability for entrepreneurs to launch their own start-ups and innovate could be an important part of the competitive process going forward. There is high demand for the skills required across the AI value chain, which is perhaps not surprising given its potential. How much of a bottleneck staff become is unclear, although one might expect demand and supply to balance over the longer term.[60]

132. Aside from mismatches between supply and demand, any conduct that reduced the ability of workers to switch jobs or launch their own enterprises could have an effect on competition. For example,

[59] For example, this could be of a similar form as the concerns raised by the CMA against Meta regarding its use of data gathered from its advertiser customers, which had little choice but to accept the terms of use offered. See: CMA Investigation into Meta's (formerly Facebook) use of data, https://www.gov.uk/cma-cases/investigation-into-facebooks-use-of-data

[60] Note that if there are significant first-mover advantages, short-term restricted access to skilled labour could still lead to competition issues down the road.

non-compete clauses restrict the ability of workers to move to rivals. They may be justifiable in some circumstances to solve hold-up problems and protect investments in training. However, if used disproportionately they could harm workers by reducing fair compensation and also reduce dynamism in the sector by creating barriers to entry.[61]

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[61] Such concerns led to the US FTC issuing a final rule banning noncompete clauses nationwide in 2024. See: "FTC Announces Rule Banning Noncompetes", 23 April 2024, https://www.ftc.gov/news-events/news/press-releases/2024/04/ftc-announces-rule-banning-noncompetes. Further, it has been speculated that one of the reasons for the success of technology firms in Silicon Valley has been due to Californian court's history of not enforcing non-compete clauses in labour contracts. See, for example, this media article: "A little-known California law is Silicon Valley's secret weapon ", Vox, 13 February 2017, https://www.vox.com/new-money/2017/2/13/14580874/google-self-driving-noncompetes

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138. Aside from mismatches between supply and demand, any conduct that reduced the ability of workers to switch jobs or launch their own enterprises could have an effect on competition. For example, non-compete clauses restrict the ability of workers to move to rivals. They may be justifiable in some circumstances to solve hold-up problems and protect investments in training. However, if used disproportionately they could harm workers by reducing fair compensation and also reduce dynamism in the sector by creating barriers to entry.[64]

139. Beyond effects in AI markets directly, a shortage of skilled labour could provide firms with a greater incentive to reduce pressure on wages or staff turnover. This could make anticompetitive conduct with respect to labour more tempting. Firms, for example, could reduce competition for key talent through no-poach agreements or by wage-fixing (May, 2022[52]), (OECD, 2020[53]).

140. More broadly, there could be other potential issues relating to purchasing power. This could affect suppliers to AI firms, such as those who provide content. Purchasing power could lead to the foreclosure of rival buyers, for example through predatory buying through high salaries to foreclose rival purchasers, who would also likely be downstream competitors.[65] In some circumstances, if there were to be purchasing power, such conduct could reduce dynamism in the sector and raise barriers to entry or expansion, particularly for newer firms. This could have the effect of dampening incentives to enter the field, leading to under provision or lower levels of innovation in the long-run (OECD, 2022[54]).

3.9. Summary and interrelation of factors

141. This section has explored high-level categories of potential risks to competition that could emerge based on current developments. The risks discussed are speculative and there is no evidence that those factors are currently impeding effective competition. Further. Chapter 2. noted the many positive effects of generative AI and, while the section has not sought to weigh those against risks to competition, these should be considered going forward.

142. Many of the factors discussed above have a common cause which is that several firms are operating at different levels of the value chain. In itself, there is nothing inherently anticompetitive about this. Indeed, operating as a vertically integrated firm can allow firms to operate efficiently, reducing transaction costs and informational asymmetries, and allowing them to offer improved services to their customers. However, it may raise competition concerns. One concern that has been voiced by several authors in the context of AI is that concerns in digital markets will spill over into AI, either affecting how it

[63] Note that if there are significant first-mover advantages, short-term restricted access to skilled labour could still lead to competition issues down the road.

[64] Such concerns led to the US FTC issuing a final rule banning noncompete clauses nationwide in 2024. See: "FTC Announces Rule Banning Noncompetes", 23 April 2024, https://www.ftc.gov/news-events/news/press-releases/2024/04/ftc-announces-rule-banning-noncompetes. Further, it has been speculated that one of the reason for the success of technology firms in Silicon Valley has been due to Californian court's history of not enforcing non-compete clauses in labour contracts. See, for example, this media article: "A little-known California law is Silicon Valley's secret weapon ", Vox, 13 February 2017, https://www.vox.com/new-money/2017/2/13/14580874/google-self-driving-noncompetes

[65] There has, for example, been speculation on the strategies to purchase teams within AI start-ups. See for example commentary from the media, for example: The Wall Street Journal, "The Fight for AI Talent: Pay Million-Dollar Packages and Buy Whole Teams", 27 March 2024, https://www.wsj.com/tech/ai/the-fight-for-ai-talent-pay-million-dollar-packages-and-buy-whole-teams-c370de2b

develops or further entrenching market power due to data and compute advantages, for example (Caffara, 2024[55]). Several of the relevant issues have already been discussed above, but it is perhaps the combination of these that needs to be considered. This is particularly true in the context of discussion about the underlying nature of the various generative AI markets and a potential tendency towards "winner takes all/most" characteristics. While this may be a natural result of competition for the market, the potential for durable market power is likely to be of concern to the competition community.

143. If a firm has substantial market power, they may be able to leverage this to foreclose rivals in downstream markets. As AI technologies continue to expand and improve, there may be increasingly expanding limits of adjacent markets where anticompetitive leverage could be applied.[66] A core part of these concerns rest on the premise that a certain part of AI value chain will become concentrated with substantial barriers to entry, allowing a few players to develop and maintain market power (CMA, 2024[32]). If dominance occurs at any level of the value chain, or if there are clear adjacencies between other digital markets, such as customer data or platform access, then interoperability and restrictions on self-preferencing may become important.

144. There is also the potential for AI to integrate within existing digital ecosystems, which could raise difficulties in accessing consumers. These effects could be amplified if access to consumers provide feedback effects in terms of access to data that allow further improvement to models. In addition, there may also be consumer facing issues linked to existing ecosystems.

145. There may be areas of generative AI that deserve more attention than others. For example, some authorities have already focussed their attention on particular segments of the value chain, such as foundation models (CMA, 2023[18]).

[66] For example, imagine the potential impact that a breakthrough in the cost and efficacy of robotics could mean for the implications for AI and widespread use.

4. Tools available to competition authorities

146. This section considers the tools and opportunities that competition authorities, and wider policy makers, have at their disposal in face of recent developments in generative AI and the potential risks to competition. It explores what actions authorities could take now, as well as how they might react should any of the threats to competition discussed above appear imminent.

147. Which tools are most relevant will depend on how markets evolve and what authorities judge to be the main issues. For example, some see the large threat of long-term solidification as the main threat (Coyle, 2023[56]). Others suggest that authorities should focus on short term risks to competition (Carugati, 2023[24]). An alternative approach would be to start with a broader, exploratory brush, from which to identify areas that warrant more focused attention.

148. Many competition authorities have already reacted to developments and launched initiatives considering competition in the sector. These come in a variety of shapes and sizes. For example:

1. the UK's CMA launched a study into AI Foundation Models in 2023 (CMA, 2023[18]), and similarly the Hungarian authority launched a market analysis of the sector in 2024.[67]
2. Also in 2024, the European Commission launched a call for contributions[68], as did the French Authority. [69]
3. Several authorities have also released reports on the topic, including the Portuguese AdC issues paper on Competition and Generative AI (AdC, 2023[38]), a Canadian report considering similar issues (Competition Bureau Canada, 2024[37]), and in Australia, the Digital Platform Regulator's Forum published a joint working paper considering LLMs (Digital Platform Regulators Forum, 2023[44]).
4. There have also been some competition inquiries launched, such as in the US by the FTC into various partnerships, and other investigations by some authorities of specific deals.[70]

[67] Hungarian Competition Authority, "GVH launches market analysis on the impact of artificial intelligence ", Press Release, 4 January 2024, https://www.gvh.hu/en/press_room/press_releases/press-releases-2024/gvh-launches-market-analysis-on-the-impact-of-artificial-intelligence

[68] European Commission, Press Release, "Commission launches calls for contributions on competition in virtual worlds and generative AI", 9 January 2024 https://ec.europa.eu/commission/presscorner/detail/en/IP_24_85),

[69] Autorité de la Concurrence, "Generative artificial intelligence: the Autorité starts inquiries ex officio and launches a public consultation open until Friday, 22 March", 8 February 2024 https://www.autoritedelaconcurrence.fr/en/press-release/generative-artificial-intelligence-autorite-starts-inquiries-ex-officio-and-launches

[70] Federal Trade Commission, "FTC Launches Inquiry into Generative AI Investments and Partnerships", 25 January 2024, https://www.ftc.gov/news-events/news/press-releases/2024/01/ftc-launches-inquiry-generative-ai-investments-partnerships

149. As an emerging technology and sector, any intervention to address potential harm to competition should be balanced against the costs of intervention. In particular, how it might undermine innovation and, ultimately, competition (Curry and Hill, 2024[41]).

150. There may be several costs to intervention. This could include the costs to firms taking part in investigations or market studies, and authorities should consider how best to collect information and burden firms proportionally. This is particularly important in a sector where any small firms operate, and authorities will want to strive to maintain this vibrancy. There may also be uncertainty raised by the prospect or threat of intervention. Such uncertainty could reduce perceived incentives to invest or undertake risks in a sector. Ultimately, intervention could impose monitoring or regulatory costs on businesses that act as a barrier to entry, with smaller firms being less equipped to deal with the regulatory burdens of providing information or complying with obligations. This is something that authorities are likely to consider in any measures that they adopt.

151. The first part of this Chapter considers various tools and instruments that might be relevant, starting with monitoring and advocacy, before considering market studies, merger control and enforcement. Finally, the section discusses the potentially beneficial role of cooperation.

152. The focus of this paper is competition policy and therefore consumer protection is not discussed. However, consumer protection may also have a role in ensuring effective competition, supporting trust and providing protection from undue lock-in, as within broader digital markets (Fletcher et al., 2023[57]).

4.1. Monitoring, advocacy and information gathering

153. Two of the challenges that AI raises for competition authorities is its technical complexity and rate of change. One task for authorities is therefore to understand it better. In this regard, one option is to gather information by monitoring developments. This could take several forms, from devoting small amounts of resources to track developments, through to advocacy and engagement with market operators or even market studies. These latter two developments are discussed further below.

154. Authorities may wonder if there is enough certainty of competition issues arising to justify devoting resources to AI, but also worry about being too slow to act if problems materialise. Monitoring and information gathering could be a relatively light-touch first step in understanding whether the sector requires further attention, or even enforcement investigation. Monitoring could be assisted with access to expertise, which could be provided by specialist staff. Many authorities are already considering the mix of skills that they need for the future (OECD, 2023[58]). For example, the ICN recently released a joint statement on the need to build capacity to deal with digital issues, including AI.[71]

155. There could also be scope for co-operation between authorities to conduct joint monitoring efforts. This could include sharing information on developments that impact international markets, discussing the potential competition issues that may arise, or even sharing knowledge of the sector and emerging trends.

156. Monitoring or information gathering could also lead to advocacy efforts, such as publishing the results. With a new market, enforcement may not be an option or could even be too slow, but there could be a role for authorities to study the sector and to either advocate for change or seek to influence the market behaviour of players.

157. One form of advocacy that authorities could employ would be to release statements that outline their understanding of the sector. Such statements or documents can have multiple purposes, such as

[71] International Competition Network, "Building Digital Capacity to Strengthen and Support Law Enforcement Agencies", 26 March 2024, https://www.internationalcompetitionnetwork.org/working-groups/icn-operations/technologists/technologist-forum-statement-on-building-agency-digital-capacity/

sharing knowledge with stakeholders, as well as to provide a message to firms in the sector of their obligations regarding the law. They could also form the start of consultative periods to enhance understanding of the sector.

158. It can be important to ensure firms are put on notice that authorities will investigate breaches of competition law. This may reduce the risk of breaches occurring in the first place. As well as putting firms on notice, these statements can serve to illustrate, and promote, the benefits of competition. By highlighting the need for competition to a wide set of stakeholders, this could ensure that it remains an objective within broader policy making efforts regarding AI. It could also ensure that parties with information that may help identify anticompetitive conduct are more likely to report it and identify it in the first place.

159. Amongst the several examples of authorities taking this approach is Portugal, where the competition authority released an issues paper in response to advances in AI. As well as informing local discussion, such papers also provide a starting point for international discussion and can help facilitate coordination efforts at a later date. Box 5 provides more information on the issues paper by the Portuguese authority.

160. There may also be a role for authorities to advocate for competition to government. This could include asking for regulations or powers if needed. There is also a risk that regulation reduces competition, and so competition authorities may need to keep an eye on developments to ensure that competition has a “voice in the room”.

161. One dimension of the public policy debate on AI that is of relevance to the field of competition is how it interacts with other aspects of policy concerns, such as ethics, privacy, intellectual property rights (IPR), labour issues, amongst others. There may be interactions with regulations aimed at addressing risks or concerns in those areas. There may be a positive correlation between some of these concerns and concerns about competition (referring to a lack of it). For example, if privacy and data are valued by consumers, then more competition should provide a higher quality service to them, improving outcomes in both aspects. More competition could also reduce concerns around the political effects of increased economic concentration of a potentially important technology.

162. However, concerns in other policy dimensions may not be positively correlated with competition, with increased competition leading to increased risks in other areas. For example, more competition could increase incentives for IPR infringements, or reduce the ability for regulators to monitor the ethics or accuracy of operators. Such tensions raise the risk that regulations are enacted which stifle competition. While the interactions between different policy areas is complex, it is important that competition authorities are well positioned to argue for the importance of competition.

163. For example, there may need to be an emphasis on the role of open-source resources to benefit to competition by lowering barriers to entry. However, open-source could pose risks, especially as models grow in capability, if it could be misused for malicious purposes. In such circumstances, there may be calls to reduce or restrict access to such resources. While balancing other public policies is ultimately for governments, competition authorities should ensure the benefits of promoting competition through are known to reduce restrictions to those necessary (Carugati, 2023[24]).

164. Finally, there may also be issues in relation to competitive neutrality and industrial policy. A lot of governments are trying to invest in their own models, although at this stage do not appear to be major competitive forces (OECD, 2023[59]). In itself this could be pro-competitive, especially in light of concerns about market concentration. However, there is clearly potential for such intervention to distort competition, and there may be a role for authorities to highlight this.

Box 5. Portuguese Competition Authority (AdC) Generative AI issues paper

The AdC published an Issues Paper addressing competition issues in Generative AI in November 2023. In the Issues Paper, the AdC mapped the key determinants that affect the competitive process and anticipates the risks to competition in the Generative AI sector.

The Issues Paper notes that Generative AI models are hungry for data and computing power, entailing strong scale effects and thus these effects may result in accumulated competitive advantages to digital incumbents, as they already have access to large volumes of data and computing power.

These characteristics may make markets prone to high levels of concentration and raise risks to competition, particularly exclusionary strategies, in the markets for cloud computing, hardware, and Generative AI models.

As such, AdC underscores the importance of access to data, access to cloud computing or specialised hardware, and access to foundation models in Generative AI as crucial elements for fostering a competitive environment. This approach aims to ensure innovation and consumer benefits in the rapidly evolving field of Generative AI.

Within the scope of its mandate and in the context of international cooperation, the AdC warns of competition risks in the Generative AI sector and highlights that it will not hesitate to intervene to ensure the promotion of competition and the application of competition law in Portugal, for the benefit of consumers and whenever the identified risks materialise.

Source AdC (2023), Competition and Generative Intelligence, AdC, https://www.concorrencia.pt/en/articles/adc-warns-competition-risks-generative-artificial-intelligence-sector.

4.1.1. Market studies, Market Investigations or sectoral studies

165. While often considered part of advocacy, market studies can provide information gathering as well as the opportunity to advocate for change. This could be useful given potential challenges with enforcement, such as its speed, availability of sufficiently targetable remedial action and, crucially, ability to establish dominance (OECD, 2020[42]). In an increasing number of jurisdictions, market investigations could also provide the power to intervene directly and improve competition.

166. Market studies can help if there are competition issues not caused by breaches of competition law and which may require alternative action such as regulation. Building an evidence base for such changes could be an important first step to significant intervention later on. Market studies may also allow authorities to better understand the sector without needing to find evidence of specific breaches of the law and come in many sizes and need not all look the same.

167. Already, several authorities have launched market study type initiatives in the AI sector. These range from calls to information, in the case of for example France and the EU, [72] to wider studies that have already produced long reports, for example from the UK's CMA. Box 6 describes the CMA's Initial Report in more detail.

[72] Autorité de la Concurrence, "Generative artificial intelligence: the Autorité starts inquiries ex officio and launches a public consultation open until Friday, 22 March", 8 February 2024 https://www.autoritedelaconcurrence.fr/en/press-release/generative-artificial-intelligence-autorite-starts-inquiries-ex-officio-and-launches

Box 6. CMA market study Initial Report

Introduction

In May 2023, the Competition and Markets Authority (CMA) published the report titled "AI Foundation Models", aimed at providing insights into the marketplace for foundational AI models and their potential development scenarios. The report explores the various opportunities and risks associated with these scenarios from the perspectives of competition and consumer protection. Furthermore, it discusses the principles of competition and consumer protection that best guide the future development of these markets.

Potential Benefits and Challenges

The report notes that the advent of AI Foundation Models (FMs) means that consumers and businesses alike can expect the introduction of innovative products and services, easier access to information, and assistance in both creative and administrative tasks. Despite their potential, the Initial report notes that widespread adoption of FMs is not without challenges. Key potential concerns include false information, AI-enabled fraud, and the risk of market monopolisation by a few dominant players. Such outcomes could harm consumers and stifle innovation, underscoring the need for robust competition to ensure the optimal utilisation of FMs.

Regulatory Framework and Guiding Principles

The CMA Initial Report argues that competition is essential for people to see the full benefits that FMs have to offer. It is important to consider the role of effective competition alongside other considerations such as safety, data protection and intellectual property rights, etc. To safeguard against these risks while promoting the beneficial use of FMs, businesses must comply with existing consumer and competition law.

Additionally, the report proposed the principles by which the development and deployment of FMs should be guided; **Access** (ongoing ready access to key inputs), **Diversity** (sustained diversity of business models including both open and closed), **Choice** (sufficient choice for businesses so they can decide how to use FMs), **Flexibility** (flexibility to switch or use multiple FMs according to need), **Fair Dealing** (no anti-competitive conduct, including anti-competitive self-preferencing, tying or bundling), **Transparency** (consumers and businesses are given information about the risks and limitations of FM generated content so they can make informed choices). These principles, developed through collaborative efforts among stakeholders, aim to support the best outcomes for people, businesses and the economy by ensuring that innovation benefits are widely accessible and that the marketplace remains dynamic and competitive.

Future Directions and Collaborative Engagement

The paper outlines an ongoing program of engagement and consultation in the UK, US, and beyond, aimed at refining these guiding principles and adapting them to the evolving landscape of AI technology. By involving diverse stakeholders—including consumer groups, FM developers, deployers of FMs, innovators, academics, and government, regulators—the initiative seeks to update the principles, helping realise the full potential of FMs while addressing the inherent challenges of their deployment.

In April 2024, the CMA released an update, including a detailed technical paper which covers market developments to date. The updated paper highlights three key risks to competition that the CMA will monitor, including access to key inputs, access to consumers and potential for partnerships between firms to worsen this position.

Source: Competition and Markets Authority (2024), AI Foundation Models Update paper; Competition and Markets Authority (2023), AI Foundation Models Initial Report;

168. In many jurisdictions market studies only provide the ability to make recommendations. If enforcement is not an option, this could leave a gap in remedial power, requiring legislative action from government; itself not typically timely. However, market investigation powers are becoming increasingly popular across countries,[73] in part prompted by concerns in digital markets. Such powers provide the ability to intervene in markets and address competition issues, without needing to find breaches of the law. These tools may be of particular interest if, as discussed below, there are concerns that enforcement tools are either too slow or lack the remedial power to deal with issues in fast-paced markets. It remains to be seen whether such powers will be appropriate in the context of AI and such investigations themselves require significant time to complete.

4.2. Merger control

169. In addition to the tools described above, merger control is likely to be one of the main operations for authorities in the emerging stages of the AI market. Indeed, several authorities have publicly noted their intention to monitor acquisitions actively[74] and, in a few cases, have launched investigations.

170. There have even been calls in some quarters to strengthen merger control in light of the emergence of AI. For example, some digital think tanks, including Foxglove and the Mozilla Foundation, suggest that mergers by key "gatekeepers" in the AI industry should be presumed illegal to prevent anti-competitive consolidation.[75] Whether such reform is necessary in unclear at this stage due to the recency of applying merger control to the sector.

171. However, as with digital markets, there are risks that merger control could have gaps that leave risks to competition open (OECD, 2020[45]). One could be filing thresholds, with nascent technology firms often falling below turnover thresholds. Already enacted reforms in some jurisdictions may reduce this risk, but such solutions are not universal. Given these risks, authorities may wish to consider how to use monitoring and information gathering to stay abreast of potential transactions of interest and understand if an issue exists.

172. As noted in Chapter 3. , there may also be challenges regarding whether certain types of transactions are captured within merger control, particularly if they do not correspond to traditional acquisitions or joint ventures, and where it is more difficult to establish changes in control. It is not clear

[73] Powers exist in the UK, Iceland, Greece, Mexico and, more recently, have been introduced in South Africa and Germany. There are also proposals within some other jurisdictions to introduce these powers, such as Czechia (see Office for the Protection of Competition | Press releases - competition | The Office has put forward a number of legislative proposals for greater efficiency in the field of competition (gov.cz) https://uohs.gov.cz/en/information-centre/press-releases/competition/3809-the-office-presented-a-number-of-possibble-legislative-proposals-to-support-efficient-competition.html), Norway and Sweden (see: " https://sweden.dlapiper.com/en/news/emerging-trends-nordic-competition-law-expanded-powers-and-tools-competition-authorities-may#:~:text=New%20competition%20tool%3A%20The%20proposal,no%20breach%20of%20competition%20law.) and Denmark (see: https://www.lexology.com/library/detail.aspx?g=563656e4-0c76-4b06-8c2a-a9153fa3c07c)

[74] See for example media article: GCR, “AI anticompetitive effects to feature in substantive merger assessments, enforcer says”, 20 March 2024, https://globalcompetitionreview.com/article/ai-anticompetitive-effects-feature-in-substantive-merger-assessments-enforcer-says

[75] GCR, “EU merger reform needed to tackle AI concentration, industry groups say”, 12 March 2024, https://globalcompetitionreview.com/article/eu-merger-reform-needed-tackle-ai-concentration-industry-groups-say

whether or not this is a particular risk for generative AI, but there already appear to be some areas of contention emerging.

173. Partnerships and links between firms appear common and likely to be subject to scrutiny by competition authorities (CMA, 2024[20]). The ties between Microsoft and OpenAI, for example, have been subject to initiatives taken by several competition authorities, as described in more detail in Box 7. Other types of transactions may also have the potential to reduce competition, even if they may not traditionally have fallen under merger control. For example, the has been discussion, including from heads of competition agencies[76], that Microsoft's hiring of two of the three co-founders of AI startup Inflection as part of a licensing deal to host its models on Microsoft's cloud service, could have the same effect as an acquisition.[77] Whether such situations are subject to merger control is both situation and jurisdiction specific. However, authorities should be mindful and watchful of the means of collaboration employed in the sector if it could have the effect of lessening competition in practice.

174. An example of such watchfulness outside of tradition merger control can be seen from the US FTC, which launched an inquiry into a range of investments and partnerships in relation to generative AI.[78] This included ordering five companies to provide information in relation to their activities, with the intention of understanding whether such tie ups pose risks to competition.

175. As with other aspects of merger control, given potential geopolitical interests in AI, competition authorities may also have to consider some deals alongside national security review, where a number of issues other than competition may be considered.[79] In such cases, authorities may need to consider their role in advocating for competition if appropriate.

Box 7. Microsoft / Open AI

Microsoft has invested about USD 13 billion in Open AI across 2019, 2021 and 2023 and owned a 49% stake in Open AI in January 2024. This partnership made Microsoft the exclusive provider of cloud services to Open AI and allowed both companies to commercialise Open AI's AI technology. Microsoft's partnership with Open AI has been investigated or monitored by several competition authorities, as discussed below.

On November 2023, Germany's Bundeskartellamt (BKa) stated that it did not have jurisdictions to investigate this partnership given Open AI's lack of substantial operations in Germany in 2019 and 2021, and it does not constitute a notifiable merger even though it gave the tech giant "material competitive influence" over the creator of Chat GPT.

[76] See Global Competition Review: GCR, " Microsoft's Inflection tactics may signal a need for new legislation, Mundt says", 12 April 2024, https://globalcompetitionreview.com/article/microsofts-inflection-tactics-may-signal-need-new-legislation-mundt-says

[77] See for example this article from the Global Competition Review, "Microsoft's AI recruitment strategy raises questions about the scope of antitrust rules", 26 March 2024, https://globalcompetitionreview.com/article/microsofts-ai-recruitment-strategy-raises-questions-about-the-scope-of-antitrust-rules

[78] Federal Trade Commission, "FTC Launches Inquiry into Generative AI Investments and Partnerships", 25 January 2024, https://www.ftc.gov/news-events/news/press-releases/2024/01/ftc-launches-inquiry-generative-ai-investments-partnerships

[79] For an example of this, see media reports. GCR, "CFIUS orders Saudi fund to divest stake in AI company", 4 December 2024, https://globalcompetitionreview.com/gcr-fic/article/cfius-orders-saudi-fund-divest-stake-in-ai-company

However, the BKa said that Open AI obtained substantial operations in Germany 2023, and any further deals might need to be notified.

Meanwhile, the UK's Competition & Markets Authority (CMA) launched an investigation into Microsoft's partnership with Open AI in December 2023. The CMA stated the agency will review whether the partnership has given Microsoft de facto control over Open AI or more than 50% of voting rights to determine whether the "close, multifaceted relationship" constitutes a notifiable merger and thus could harm competition in UK markets.

The European Commission (EC)stated in January 2024 it would check if the investment by Microsoft into Open AI was reviewable under the bloc's merger regulation. In addition, the US Federal Trade Commission (US FTC) issued orders to Microsoft and Open AI requiring them to provide information regarding investments and partnerships based on Section 6(b) of the FTC Act, which authorises the Commission to conduct studies that allow enforcers to gain a deeper understanding of market trends and business practices on 25 January 2024. The information the FTC required includes the practical implications of a specific partnership, analysis of the transactions' competitive impact, and competition for AI inputs and resources.

Up to now, the competition authorities' main concern about Microsoft's partnership with Open AI is whether it may constitute a notifiable merger, but it does not seem to limit the merger's scope. The concerns of competition authorities lie in the overall impact of this partnership on market competition, and it is likely that they are ready to intervene when necessary, as can be seen from the investigation by the FTC.

Source: Bundeskartellamt, "Cooperation between Microsoft and OpenAI currently not subject to merger control", Press release, 15 November 2023, https://www.bundeskartellamt.de/SharedDocs/Meldung/EN/Pressemitteilungen/2023/15_11_2023_Microsoft_OpenAI.html; CMA, Microsoft/ OpenAI partnership merger inquiry, https://www.gov.uk/cma-cases/microsoft-slash-openai-partnership-merger-inquiry; European Commission, "Commission launches calls for contributions on competition in virtual worlds and generative AI", Press Release, 9 January 2024 https://ec.europa.eu/commission/presscorner/detail/en/ip_24_85 ; Federal Trade Commission, "FTC Launches Inquiry into Generative AI Investments and Partnerships", 25 January 2024, https://www.ftc.gov/news-events/news/press-releases/2024/01/ftc-launches-inquiry-generative-ai-investments-partnerships

4.3. Enforcement

176. To date there does not appear have been completed enforcement action in relation to competition in generative AI markets. This is not surprising given its nascent nature. Potential competition issues were raised in Chapter 3. , and many competition authorities are tracking closely, perhaps gathering information or studying the market as a first step. Ultimately, if breaches occur, competition law enforcement will be relevant as with any other market, whether abuse of dominance or in relation to anti-competitive agreements.

177. The most likely avenue if competition concerns materialise would appear to be abuse of dominance provisions.[80] Many factors that are relevant from the experience of abuse of dominance in digital markets may be relevant to generative AI, including needing to understand the nature of potentially abusive conduct and the ability to tackle the underlying issues (OECD, 2020[42]). (Schrepel and Pentland, 2023[28]) suggest that competition enforcement should focus on the parts of the generative AI landscape

[80] It is unclear if there is a particular risk of agreements or cartel conduct in generative AI markets, although these should also be monitored closely.

where abusive conduct could restrict the ability of competitors to benefit from increasing returns to scale, namely those that affect the ability to reduce user growth.

178. Clearly the first port of call for authorities is to establish if there is dominance in a relevant market, next if conduct is an abuse. In a fast moving and relatively new technological sector, abuse of dominance would not ordinarily be considered the most natural tool to employ due to the unlikelihood of determining an entity to hold a dominant position in such a market (Caffara, 2024[55]). However, as noted, potential competition issues could derive from the leveraging of existing positions in adjacent markets. These positions may already have been assessed and held to be dominant in previous investigations.

179. The competition issues raised in Chapter 3. would appear to largely fall under the categories of existing and traditional theories of harm for abuse. There may be some small adjustments needed, but, as there was for digital markets, the underlying conduct appears likely to be broadly comparable (OECD, 2020[42]). Authorities should consider whether this holds in practice as market realities emerge.

180. There are a range of potential types of conduct that could be considered. The interrelated nature of the value chain, where access to one input may affect the ability to access another, means that it is likely sensible to look holistically across the sector rather than to focus purely on one input. For example, due to the likely importance of data across the AI value chain, conduct that restricts the ability of firms to access necessary data to compete may be worth investigating. Dominant firms may refuse to deal and provide access to data to competitors or use contractual terms to restrict access. However, there may also be conduct where firms are able to leverage their existing positions to restrict access to customers. In turn this may reduce their access to data.

181. Authorities should be mindful of conduct from firms that hold dominant positions in upstream or adjacent sectors, for example tying or bundling with existing products that possess market power, foreclosing competitors. As deployment of generative AI continues to evolve, this is likely to be an area that requires regular monitoring.

182. Other practices that might be relevant for enforcement could be if potentially dominant firms restrict the operability of their products with others. Both vertical and horizontal interoperability may be of interest, with upstream firms potentially restricting the ability of downstream firms to operate alongside existing structures, while a lack of operability at the horizontal level may restrict the ability of consumers to multi-home and further enhance any tendency to “winner takes most” outcome. If access fees are used in upstream markets, ensuring that they provide access on fair terms, and do not squeeze margins, is likely to be important. Conduct, such as predatory pricing may also become a concern. At the first phase of the market creation, companies may secure users with fairly generous and open conditions, but change if they became dominant, engaging in exclusionary practices by restricting transaction terms. For instance, after developing various products and services through Open API, dominant firms might abuse their market power by limiting interoperability or restricting transactions with competitors.

183. It is not appropriate to speculate on specific conduct that may be an abuse in the context of generative AI. There may, however, be useful lessons to draw from past experience in the enforcement, particularly from digital markets (OECD, 2020[42]). As this experience has shown, with less linear and clear-cut supply chains, harm to competition may present itself in novel ways and spillover into adjacent markets. For example, leveraging superior bargaining power could result in unfair practices that undermine competition in upstream markets. A recent decision by the French competition authority in relation to sanctions of breach of commitments presents application of existing commitments to generative AI. It imposed a sanction of EUR 250 million against Google for not having respected four of its seven commitments made in June 2022. Among them, with regard to BARD (now rebranded as Gemini) AI service by Google, the Authority noted that it had used content from publishers and press agencies for the purposes of training its foundation model without notifying or providing a technical opt-out to publishers and press agencies, breaching a commitment in how it dealt with third parties (Autorité de la Concurrence, 2024[60]).

4.3.1. Remedial action

184. If enforcement action is taken or settled, commitments or remedies that address competition issues will be crucial. In markets that exhibit tendencies toward concentration, there is a risk that a fine alone may in itself not present a sufficient deterrent if the market power derived from the conduct remains (OECD, 2020[42]). With potential high stakes if competition does not flourish, there may need to be careful consideration that fines are sufficient to ensure deterrence. This could be especially relevant in a market that is still growing and where the potential benefits of anticompetitive conduct in terms of future revenue streams bears little relation to current revenues.

185. Remedies could come in a variety of forms, tailored to the conduct and competition issue. They could seek to provide access to key inputs, such as data or computing power, or to prevent self-preferencing on digital platforms. Measures such as data portability, data sharing, or allowing access to data might offer respite to some concerns.

186. A key issue with competition enforcement and AI is likely to be timing. Abuse of dominance cases can take a long time, even if settled with commitments. There is also the issue of dominance, and the required period of time before this can be established. This may however be less of an issue if the conduct in question concerned leveraging of an existing market into an AI related service, but if the alleged dominance occurred in relation to AI itself, it may be some time before an authority could satisfy the dominance criteria.

4.4. Regulation

187. If competition issues cannot be fully addressed by the tools discussed above, policy makers may wish to consider if regulation could supplement existing instruments. Such discussions on the challenges of implementing remedies or devising effective measures to mitigate market detriment could lead to discussions on ex-ante regulation, as they have in digital markets (OECD, 2021[61]). (Coyle, 2023[56]) argues that some form of regulation could be necessary to ensure the benefits of competition within the generative AI sector.

188. Several jurisdictions have recently enacted, or are proposing, regulations aimed at digital markets.[81] The European Union's Digital Markets Act (DMA) is an example of such regulations. There may also be bargaining codes and codes of conduct in place, that could be extended, or may already cover conduct of potentially relevant firms, such as can be seen for example from the Australian News Bargaining code.

189. Such regulations typically apply asymmetrically. This means that they only target the conduct, or impose obligations, on a select number of firms. In practice, the firms targeted are large digital platforms. Two questions appear relevant in the context of generative AI. Firstly, the extent to which such regulations currently cover competition in generative AI. In this regard, beyond AI specific regulation, a range of other legislative measures may also be relevant, such as regulations around data or privacy.[82] A second question is whether the scope of such regulations should be changed in order to ensure that they do so.

190. How existing regulation applies to generative AI varies by jurisdiction. Most of the legislation designates set operators and applies specific obligations on them. At this stage, none of them appear to directly apply to generative AI itself. However, some of the firms that are active in parts of the generative

[81] See the relevant page on the OECD website for a summary of developments: https://www.oecd.org/competition/digital-economy-innovation-and-competition.htm

[82] For example, the EU has recently implemented the Data Act, see: https://digital-strategy.ec.europa.eu/en/policies/data-act

AI sector are captured through their activities in adjacent markets. Therefore, while unlikely to fully capture all potential concerns, in some jurisdictions existing obligations on firms may reduce the risk of some of the concerns outlined in chapter 3. , specifically if they relate to leveraging from a position covered under an obligation. For example, obligations under the EU's DMA to ensure inter-operability between a gatekeeper's own services may improve the ability of some operators to access users on existing platforms, as may restrictions on self-preferencing.

191. Regarding the second question, there have been calls from some quarters that competition based ex-ante regulations should be expanded to directly cover AI services, or the actions of digital gatekeepers with respect to it, for example by expanding their scope to encompass AI foundation models.[83] As markets develop, and if competition concerns emerge which appear difficult to remedy, there may also be increased called for regulation in the AI space to preserve competition, for example regimes that give access to usage feedback data to rivals (Mayer-Schönberger and Ramge, 2018[62]). The objectives of these regulations will need to balance against the potentially innovation stifling effect of regulation so early in the development of markets (Curry and Hill, 2024[41]). These ex-ante regulations are new and, by definition, not yet proven.

192. Beyond competition focused regulation, it is likely that generative AI, and AI more broadly, will be subject to a range of regulation aiming to tackle a range of potential policy problems. Many of these will not relate to competition problems, but may instead relate to concerns such as ethics, privacy or crime prevention. One example of already enacted specific legislation is the EU AI Act.[84] As noted in the section above discussing advocacy, such regulations may affect competition, for example by raising the costs of compliance to make entry more difficult (Schrepel, 2023[63]). In many instances these restrictions will be justified, but the role of competition to promote benefits to innovation, and ultimately consumers, should also factor into decision making as much as possible.

4.5. Co-operation

193. Much of the issues discussed above will be international by nature, which creates risks of insufficient single authority power to address all issues, as well as divergences in approach, which at worst could create incompatibility between them. This could raise compliance costs for business, as well as the risk of competition issues persisting in some regions. There will also likely be significant costs for authorities to acquire and maintain the relevant expertise. This includes the costs of investing in skilled staff and training, as well as the opportunity costs of what staff could otherwise be doing. Another important consideration is the extent to which national efforts will impact international practice. This could point to some authorities boosting efforts of cooperation with respect to AI.

194. International and domestic coordination provides hope to reduce the risks of divergence, as well as maximising the synergies between authorities and even the ability to share some of the costs of upskilling. Authorities should seek to maintain and expand existing cooperation arrangements. Further, it may be worth considering additional initiatives that may allow all authorities, regardless of their size and experience, to benefit from the fact that they face a common demand for skills and expertise. This could reduce duplication. Such initiatives might take the form of increasingly joined up working groups, that seek to share experiences, through to more radical measures that see pooled costs and shared access to expertise.

[83] For example, see group Article 19's submission to the European Commission on competition and generative AI: Article 19, "EU: Submission to European Commission on competition and generative AI", 25 March 2024, https://www.article19.org/resources/eu-submission-to-european-commission-on-competition-and-generative-ai/

[84] European Commission, AI Act, https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai

195. Co-operation need not exclusively be international, and there are likely to be several domestic bodies with which closer co-operation could reap benefits for authorities (as well as for the broader policy field). Examples of such co-operation can be found in several countries, including Canada, the UK, Australia, to name just a few.[85] These collaborations can be structured in numerous ways, from regular meetings to share information and views, through to collaborative working. On the topic of AI, in Australia, the Digital Platform Regulators Forum (DP-REG), comprised of the Australian competition authority, the Communications Authority, the eSafety Commissioner and the Information Commissioner, produced a working paper on large language models (Digital Platform Regulators Forum, 2023[44]).

196. Relevant international organisations, such as the OECD, but also the ICN and regional partnerships such as the ECN, should continue to play an important role in the development of policies and knowledge sharing. These entities may also be able to support further measures of cooperation as required and demanded. Such endeavours could, for example, take place through workshops, shared resources, or even technological solutions or initiatives, such as at that seen on the OECD Observatory on AI's Incident Monitor.[86]

[85] More information on the Digital Platform Regulators Forum in Australia can be found here: https://dp-reg.gov.au/

[86] OECD AI Incidents Monitor (AIM) https://oecd.ai/en/incidents?search_terms=%5B%5D&and_condition=false&from_date=2014-01-01&to_date=2024-03-28&properties_config=%7B%22principles%22:%5B%5D,%22industries%22:%5B%5D,%22harm_types%22:%5B%5D,%22harm_levels%22:%5B%5D,%22harmed_entities%22:%5B%5D%7D&only_threats=false&order_by=date&num_results=20

5. Future areas of interest for competition policy and AI

197. As a general-purpose technology, AI has the potential to lead to change in many facets of life. This section briefly describes two other impacts of AI that may be of interest to competition policy, seeking only to identify a high-level summary of potential issues for future discussion.

198. Two broad categories of issues are introduced. Firstly, how AI could impact competition in markets outside, either positively or negatively. Secondly, the potential value of AI to assist and empower, competition authorities in carrying out their functions.

5.1. Effects of AI on competition in other markets

199. This paper has focussed on competition within AI markets, and more specifically on generative AI given its recent rise to prominence. As discussed in the section Potential economic impact of generative AI, generative AI could have a substantial impact across economies. It therefore seems plausible that it will affect competition in markets outside of those directly related to its supply.

200. As AI developments change markets, this may change the nature of some markets fundamentally potentially, even making some firms or entire sectors redundant. For example, perhaps AI may fundamentally change the nature of content production, perhaps through data scraping or through a more general change in the consumption of information (Carugati, 2023[24]). In itself, this may not be an issue for competition authorities unless it relates to the imposition of unfair terms.[87]

201. However, these appear to be potential for some effects that could pose additional risks to competition, which competition authorities and policy makers may also wish to discuss. There may also be benefits to competition, which they would likely wish to preserve.

5.1.1. Potential risks to competition across markets

202. Two prominent concerns that arise are the potential role for AI in facilitating collusion if used to generate pricing, as well as the effects it could have on markets if it is used to generate product recommendations to consumers. Both of these issues were discussed in detail at the OECD's Roundtable in June 2023 on Algorithmic Competition (OECD, 2023[34])[88]

[87] For example, see the Australian News Bargaining Code. Australian Government, The Treasury (2022), News Media and Digital Platforms Mandatory Bargaining Code, November 2022

[88] The first worries about how algorithms may reach mutually beneficial, and collusive, outcomes, whereas the second relates to the potential narrowing of demand, and hence ultimately supply, if more targeted recommendations are aimed at consumers. It could also be that technology could distort competition by preferring particular firms aside from their competitive merits. For example, product recommenders could focus demand and create "superstar" products, substantially reducing choice over the longer term.

203. As the capabilities of AI grows, the temptation (and ability) to harness and devolve decisions to programs leveraging those models will likely grow as well. The risks may therefore rise, particularly in sectors that are rich in data and where prices are dynamic. A notable issue for discussion is the extent to which decisions driven by AI can lead to liability for breaches of the law, whether to the business that has used it, or even the supplier of the service if relevant. Further, there may be transparency issues in understanding what AI has done and the reasons it did this. To complicate matters, trade-offs may be necessary between the explainability and effectiveness of models, while understanding where accountability lies for outcomes directed or derived by AI may be complicated by complex supply chains (Cobbe, Veale and Singh, 2023[64]).

204. There may also be risks if generative AI is used by consumers to make a range of product decisions more broadly. This could create risks that firms that deploy AI solutions or develop the underlying models may have incentive to distort the provision of information to self-preference their own products. Whether this is feasible is difficult to assess, although the risk could be heightened if consumers do not fully understand how their services work because it is too complex and technical. The extent to which they rely upon it to make decisions despite any lack of understanding will also be relevant.

205. Beyond those concerns, AI is likely to become embedded in many software solutions across different industries. It may soon touch almost all aspects of a modern economy in some form. How AI affects data use and its function in competition is also an issue of potential interest. There may be two orders of effect. Firstly, as a technology, AI may change the way in which firms are able to use data, for example by being able to process much more, and increase trends towards digitalisation (Mayer-Schönberger and Ramge, 2018[62]). This could make the value of data rise, such that across the economy access to data to compete becomes even more important. Secondly, access to data could further improve the functioning of AI, allowing it to be trained for a specific purpose.

206. Similarly, if first movers in providing AI solutions were to benefit from industry specific network or feedback effects, for example because their models can be refined through user or proprietary data, this could make it more difficult for firms to enter those markets and compete, raising barriers to entry across markets.

207. Finally, there may be a wide range of issues that fall under the bracket of consumer protection but threaten to undermine competitive markets. This note has not considered consumer protection issues but this might be an area that warrants further consideration. Potential issues include if the use of AI were to reduce the cost of making fake reviews, undermining feedback mechanisms to improve product quality, through to making it easier and cheaper to produce realistic fake materials to advertise to, or even scam, consumers (Digital Platform Regulators Forum, 2023[44]), (CMA, 2023[18]). While these issues may be beyond the jurisdiction of competition authorities in many jurisdictions, how these risks materialise can affect overall market confidence, a key component of competition, and is something that should be carefully monitored by the competent authorities.

5.1.2. Potential benefits for competition across markets

208. While it may be natural for authorities to reflect on how they may use their tools to tackle risks to competition, there are many potential avenues through which AI could have a positive effect on competition.

209. As a general-purpose technology, AI has huge potential to increase productivity and improve product quality and innovation in many parts of the economy, see 2.2. This dynamism is both beneficial to, and the result of, competition. It is difficult to foresee all of the ways in which this could occur, but authorities should consider how they could use their advocacy powers to ensure the benefits of pro-competitive technology are felt. Authorities will also want to monitor potential breaches of competition law by incumbents that seek to restrict the ability of rivals to use AI to compete against them, perhaps by lobbying

to have regulations to prevent it, through the use of exclusivity clauses, or even through attempts to agree joint industry approaches.

210. AI could facilitate entry across a range of markets. As noted earlier as an example, there has been some speculation following the widespread rise of generative AI that it could revolutionise online search. Adding AI capabilities to previously low market share competitors, for example through Bing AI, or through entrants leveraging new and improved technology, is a dynamic that could affect the market going forward. Whether this leads to market dynamics altering remains to be seen, not least whether AI can satisfactorily overcome quality issues (such as hallucinations or speed of retrieval) as well as how incumbents respond (Digital Platform Regulators Forum, 2023[44]).

211. As its capabilities grows, the potential for AI to assist consumers in navigating markets, reducing search costs and potentially reducing effects of their biases, also grows. In this respect, AI could be leveraged to act as an agent for consumers, and there is some evidence already to suggest that this is plausible (Liu et al., 2023[65]).

212. Such developments have the potential to bring large benefits across markets through reducing search costs for consumers, leading to increasing competitive tension. The prospects of such technological breakthroughs have been predicted for some time, including before the most recent developments in generative AI, including (Mayer-Schönberger and Ramge, 2018[62]). To become reality, it will rely on models being trustworthy, and in particular in reducing the likelihood of hallucinations, where false information is presented authoratively by chatbots as it either does not have access to correct information or was incorrectly trained to retrieve it.[89] In such circumstances, handing over autonomy for consumer search to such programs could result in worse outcomes for consumers.

5.2. Use of AI for competition authorities

213. AI has wide-ranging applications, and this is likely to continue to expand in the future. An interesting future discussion could therefore be on the extent to which it can aid the work of authorities.

214. While it unlikely to be appropriate for authorities to replace expert lawyers or economists with generative AI, nor to use it to substitute informed reason by human decision makers, there appears to be considerable potential for AI to work alongside experts to increase productivity and generate better outcomes within a wide-range of public policy settings (Ma, 2022[66]).

215. As such, many authorities are likely already considering how AI might help them work better and more productively. AI technology has the potential to make lots of things easier, and there seems no reason to think this could not also apply in managing and investigating competition cases. The ability to understand and interact with a range of language, as well as to process data and predict, has a range of potential applications.

5.2.1. Managing information and assessment

216. Competition authorities deal with lots of information. This information has multiple uses, being necessary as inputs for investigations, for the training of staff and maintenance of corporate knowledge, as well as in selecting priorities. Technology has been used in various ways to help assess documents and save on manual processing time, with authorities using a range of eDiscovery techniques (OECD, 2023[58])

[89] Further, there is some evidence to suggest that humans are generally predisposed to consider text responses from AI chatbots to be convincing, even if it is not based on truthful responses (CMA, 2023[18]).

217. AI could expand these uses, and already several tools are available to illustrate how this could work, and authorities are likely to keep a close eye on these developments. For example, AI can be trained over sector specific content to provide finger-tip access to work related questions from individuals. This could help with research on a legal question, such as offered for example by Casetext[90], or across a range of policy perspectives, for example a tool designed to answer questions about AI policy developments.[91] AI could also provide efficiency in eDiscovery, scanning large amounts of company documents or data, an area where it has been put to use in some circumstances by some authorities for some time. In a data rich world, there is clear potential for AI to assist in finding, and analysing, a range of information that could assist in cases.

218. AI could also change the analytical tools available for assessment. For example, there may be scope to improve tradition analysis through utilising AI techniques by allowing analysis on larger amounts of data, and in particular machine learning. This could lead to changes in the analysis submitted as part of merger control (Bajari, Calanchi and Akati-Udi, 2024[67]).

219. The use of such tools will likely involve at least minor changes in the way that authorities work and may bring challenges. For example, it remains to be seen how courts would react to the integration of AI into investigations if it were to suddenly be used substantially in the collection and analysis of evidence. Unproven uses such as this will undeniably give rise to risks and as such a careful implementation is likely to be necessary. As with other areas of AI, there is likely to be a role for international coordination in establishing standards.

5.2.2. Improving intelligence and case selection

220. Many aspects of competition law are about predictions. As AI reduces the cost of prediction, then it stands to reason that this can be useful to enforcers. Predicting sectors with competition issues or with firms which will breach competition law would clearly be of substantial value to authorities. The launching of ex-officio investigations requires information and intelligence on potential breaches absent leniency or whistleblower information.

221. AI could allow predictions to incorporate wider and deeper sets of data. It could make feasible incorporation of previously incompatible datasets. Consider training a model on all previous cases, giving it access to complaints data and the internet, and asking it where the next five market studies should be. Relying on such an approach blindly would be foolish, but it may suggest idea worth considering.

222. Further, the ability to gather data could improve as AI proficiency in gathering and then analysing relevant data improves. This could have provided increasing visibility for intelligence, but also to inform ongoing investigations.

223. There may also be potential to leverage wider sources of data to generate intelligence. For example, imagine if authorities were able to access and process all of the data on social media networks. This would include potentially priceless intelligence on a wide range of market issues if, it could be processed in an accurate and intelligent way.

224. The legality of using certain types of data, including potential data protection and copyright issues, may need to be considered further by authorities.

[90] https://casetext.com/

[91] https://huggingface.co/spaces/mila-quebec/SAI

6. Conclusion

225. Recent developments in AI have brought it into global prominence. These developments have been most notable in the field of generative AI, which is capable of producing original works of varying kinds, from everyday language. However, AI has been around for some time. Market dynamics are still in a state of flux as are as companies rush to innovate. It is unclear if AI is finally on the brink of substantial AGI as it is hard to predict how far capabilities will advance, and how quickly. Nonetheless, it is clear that current AI technology has the potential to embed itself into many aspects of modern economies and will have a sizeable impact.

226. The AI lifecycle in complex, but there appear to be potentially distinguishable parts even if the lines between them sometimes blur. This paper simplifies the sector to describe three key stages, training foundation models, refining them, and then deploying for use, but it could be possible to cut the market in other ways. Key to developing competitive models is to get access to sufficient data and computing power, the former needing to be of enough quantity and quality, and the latter enough power to process it. While the deployment of generative AI for use continues to unfold, it is clear that it requires significant computing power to run queries on these models, meaning a certain level of access to IT infrastructure is required.

227. There has already been much speculation that AI is destined to repeat the history of digital markets and become concentrated. Competition authorities are facing pressure to act. However, it is too early to assess competition issues in the AI sector with authority, and to know how realistic fears on the future of competition are. There appear to be some reasons to think that generative AI may not possess all of the characteristics as seen in digital markets that led to tipping, such as less clear network effects and more ambiguous economies of scale. This does not mean that there are not some factors that could lead to “winner takes all/most” dynamics.

228. Further, competition authorities and policy makers should not ignore developments in AI. As a potentially revolutionary technology, the stakes are too high not to give competition every chance. Despite being too early to know how competition will develop, there do appear to be several risks that could emerge. These could be difficulties in accessing key inputs, which could be exacerbated through firm conduct over time, including through acquisitions or vertical and adjacent linkages with existing markets. Most notably, links between existing providers of cloud computing infrastructure services or within existing digital ecosystems, may present situations in which competitors struggle to access requisite data, compute or end users. An important factor regarding specific data’s effect on competition within generative AI appears to be the extent to which the marginal benefit of training models using it can be replicated.

229. Several competition authorities are already taking the initiative and studying the generative AI market to gather more information. Investing in monitoring and knowledge building in such ways is likely to be first port of call for many authorities, who may also wish to keep their market study, broader advocacy and merger control tools primed to deal with any issues, whilst also keeping an eye out for potential enforcement investigations. Going forward, policy makers should consider if the speed and remedial effects of abuse of dominance leaves authorities with tools sufficient to tackle complex issues, as well as whether merger control is broad enough to keep a wide variety of transactions under check. The scope and effect of any upcoming or existing ex ante regulation in the digital space could also factor into the equation.

230. Crucially, responding to technological changes will likely require increased capability from competition authorities. This will likely require consideration of acquiring the right skills and expertise internally. However, this is a big ask for many authorities already struggling meet demands with their budgets. Co-operation has an important role to play in allowing authorities to efficiently level-up their knowledge and monitor developments.

231. Finally, it is also worth bearing in mind that AI has the potential to affect markets across the economy, potentially for better if it empowers consumers, but there are also risks. The potential for AI to transform and empower authorities themselves should also not be forgotten and is perhaps a nice synergy to consider from increased knowledge and capacity in the subject. Again, co-operation could play a role in ensuring the full benefits are captured.

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