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ANTITRUST & AI SUPPLY CHAINS

Maurice E. Stucke & Ariel Ezrachi***

INTRODUCTION

The buzz in 2024 is AI. In February, AI chipmaker Nvidia joined the multi-trillion-dollar market valuation club, joining existing members Microsoft, which has partnered with OpenAI and is incorporating OpenAI's foundation model across its ecosystem, Google, which is developing its own foundation model, and Apple, which in 2024 shifted resources from driverless cars to AI. As Nvidia's CFO noted, "Building and deploying AI solutions has reached virtually every industry."¹ In a 2023 KPMG survey, 72% of 400 US CEOs identified generative AI as a top investment priority.²

AI's foundation models, trained on vast amounts of data, rely on deep learning to create new content, and can be adapted to execute a wide range of operations.³ Prominent, among the foundation models, are "large language models" and "image generation models" that enable creative text, video, and

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¹ Isabelle Bousquette & Steven Rosenbush, Nvidia Benefits from Surge in Corporate AI Spending, Wall St. J., Feb. 28, 2024, at B4.

² Ibid.

³ "Generative AI uses a type of deep learning called generative adversarial networks (GANs) to create new content. A GAN consists of two neural networks: a generator that creates new data and a discriminator that evaluates the data. The generator and discriminator work together, with the generator improving its outputs based on the feedback it receives from the discriminator until it generates content that is indistinguishable from real data." Nick Routley, 'What is generative AI? An AI explains' (*World Economic Forum*, 6 February 2023) <www.weforum.org/agenda/2023/02/generative-ai-explain-algorithms-work/> accessed 12 January 2024; CMA, 'AI Foundation Models: Initial Report' (18 September 2023)

<https://assets.publishing.service.gov.uk/media/65081d3aa41cc300145612c0/Full_report_.pdf> accessed 23 January 2024; OECD, 'AI language models - Technological, socio-economic and policy considerations' (13 April 2023) OECD digital economy paper No 352 <<https://doi.org/10.1787/13d38f92-en>> accessed 19 January 2024; also see: OECD, 'Algorithmic competition, Competition Policy Roundtable Background Note' (2023) 10 <www.oecd.org/daf/competition/algorithmic-competition-2023.pdf> accessed 19 January 2024.

audio, and as such differ from other technologies used to analyze existing data. The performance of AI models is constantly improving, and key players are now racing toward the ultimate goal, developing Artificial General Intelligence (AGI) - an AI system with human level of cognition and self-teaching capacity to undertake a variety of general range of tasks autonomously.⁴

Foundation models have already been integrated into many facets of our lives and businesses, to facilitate search, improve software, communications, text completion, text-to-speech conversion, content creation, entertainment, financial services, legal services, healthcare, education, pharma, fashion, marketing, insurance, and more.⁵ These technologies promise to shake up the status quo in many industries, as they drive new business ventures, creativity, efficiency, and innovation. Not surprisingly, the market has reacted with excitement resulting in high valuations of the leading players and expectations for exponential growth in the coming years.⁶

Alongside the expected benefits from AI, concerns have been raised as to its potency, limitations, development, and deployment. In 2023, Americans and AI experts were surveyed on the likely impact of AI on their lives in 2040. Overall, the mood was negative on many parameters, with the AI experts surprisingly more concerned:

- 79% of the polled AI experts expect AI to harm personal privacy

⁴ <https://www.investopedia.com/artificial-general-intelligence-7563858>

⁵ FTC, 'Generative AI Raises Competition Concerns' (*Federal Trade Commission Technology Blog*, 29 June 2023) <<https://www.ftc.gov/policy/advocacy-research/tech-at-ftc/2023/06/generative-ai-raises-competition-concerns>> accessed 12 January 2024; Philippe Lorenz, Karine Perset and Jamie Berryhill, 'Initial policy considerations for generative artificial intelligence' (2023) OECD Artificial Intelligence Papers No 1 <<https://doi.org/10.1787/fae2d1e6-en>> accessed 19 January 2024; OECD, 'OECD Digital Education Outlook 2023: Towards an Effective Digital Education Ecosystem' (2023) ch 10 <<https://doi.org/10.1787/c74f03de-en>> accessed 19 January 2024.

⁶ For projections see for example: Fortune Business Insights that estimates the global generative AI market will reach \$667.96 billion by 2030, see Fortune Business Insights, 'Generative AI Markets (2023)' <www.fortunebusinessinsights.com/generative-ai-market-107837> accessed 19 January 2024; Boston Consulting Group, estimates the industry will rise to \$120 billion by 2027, see BCG, 'The CEO's Roadmap to Generative AI' (*BGC Executive Perspective*, March 2023) <<https://media-publications.bcg.com/BCG-Executive-Perspectives-CEOs-Roadmap-on-Generative-AI.pdf>> accessed 19 January 2024.

(which has higher than the two-thirds of polled Americans who expressed that);

- 54% of AI experts expect AI to harm basic human rights (versus 41% of the polled Americans);
- 67% of AI experts expect AI to harm politics and elections (versus 51% of the polled Americans); and
- 52% of AI experts expect AI to actually worsen the level of civility in society (versus 40% of the polled Americans).⁷

One area where the AI experts were slightly less concerned was AI's harm to employment opportunities: 43 percent of the polled AI experts expect AI to harm employment opportunities versus 55 percent of Americans.⁸

While the experts and public were polled on many areas of AI's impact, one critical area was absent: namely, AI's impact on competition and innovation. But assessing that impact, as this paper explores, is nuanced. There might be more innovation, but the *type* of innovation (sustaining versus disruptive) and its *value* (positive, extractive, or negative) might vary. In some ecosystems, we might see many more sustaining innovations that primarily extract value from consumers or other producers. We may see more toxic innovations that reduce our and our children's well-being.

The importance of identifying the trajectory of AI markets and ensuring their contestability cannot be overstated. As many competition officials have candidly admitted to us, their agencies missed or underappreciated the digital market dynamics that lead to "a winner-take-most-or-all" that have led to the present Big Tech Barons, namely Google, Apple, Meta, Amazon, and Microsoft. Currently, enforcers around the globe are scrutinizing these dominant ecosystems, which are heavily investing in AI. But there is no consensus over how to prevent, among other things, the distortion of competition and innovation. The concern is that feeble or delayed action will miss the potential tipping of these emerging AI markets. As the experience with the Big Tech Barons reflects, antitrust enforcement, if too little (e.g.,

⁷ <https://imaginingthefuture.org/wp-content/uploads/2024/02/AI2040-Report-public-opinion-poll-white-paper-1.pdf>; <https://imaginingthefuture.org/wp-content/uploads/2024/02/AI2040-FINAL-White-Paper-2-2.29.24.pdf>

⁸ Ibid

primarily monetary fines) or too late (cases that take years to develop and litigate), will not restore competition and innovation levels. It is far easier to keep markets contestable, rather than trying to restore contestability.

The AI landscape is nuanced, and any intervention needs to appreciate the complexity of the technology stack, and the powers and competition dynamics at stake. But ultimately, two fundamental inquiries emerge: First, the digital economy has several factors and characteristics that can lead toward concentrated markets. Are there similar factors in the emerging AI foundation model supply chain that will lead to “winner-take-most-or-all”? Second, could AI herald significant disruption that will challenge current powerhouses? Could new business models disrupt the dominant ecosystems? Or will the current ecosystems dominate these AI-driven models and applications?

The enforcement challenges raised by generative AI are further amplified by a race to the bottom that emerges between companies. In their attempts to dominate the new space, deep-pocketed companies are racing to release new technologies and disregard many of the emerging risks and concerns. Calls for regulation, or slowing down of some developments, are met with warnings about the competitive disadvantages to Western countries who regulate and the risk that other less regulated jurisdictions may take the technological lead.

It is within this context that this paper considers whether the AI technology forms a disruptive force that could destabilize the current powerhouses, foster competition and ensure future disruptive innovation that improves our well-being, or might the technology herald the next step in the ongoing entrenchment of key ecosystems? This inquiry requires careful consideration of the emerging foundation model supply chain and the extent to which current strategies, market characteristics, and technologies could entrench a few powerful firms.

To explore this issue, Part I outlines the current digital market dynamics that lead to a winner-take-most-or-all. Part II next examines the emerging AI foundation model supply chain. Part III considers several potential antitrust risks that emerge should certain layers become concentrated and firms extend

their power across layers. Part IV raises several countervailing factors that might lessen or prevent these antitrust risks. This Article concludes with suggestions for the policy agenda to promote both healthy competition and innovation in the AI supply chain.

I. THE DIGITAL MARKET DYNAMICS THAT LED TO THE BIG TECH BARONS

The digital economy generally exhibits several characteristics that tend to support a winner-take-most-or-all, with a few companies dominating markets. In the western world, despite the billions invested by Microsoft in its search engine Bing, Google, as of 2024, still dominates search engines and search advertising. Despite the rise of TikTok, Meta still dominates personal social networks and digital display advertising. Amazon remains the leading dominant online shopping platform. Google and Apple remain the leading operating systems for smartphones. Amazon, Microsoft, and Google control the leading cloud computing platforms.

What then has enabled these monopolies to endure? Noteworthy elements include: Scale economies, big data, network effects, big analytics, the ability to channel digital innovation, and an array of anticompetitive measures, including acquire-copy-or-kill. As we, among many others, have explored these themes elsewhere,⁹ let us just summarize here a few:

Big data, which drives much of the innovation and offering in the digital economy, has risen to become a key asset in many digital markets. Data may be structured or unstructured, gathered voluntarily, through observations, or by inferring new information using existing data.¹⁰ When considering the role data plays in the digital platform economy, it is helpful to take note of the

⁹ Maurice E. Stucke and Allen Grunes *Big Data and Competition Law* (2016, OUP); Ariel Ezrachi and Maurice E. Stucke, *Virtual Competition - The Promise and Perils of the Algorithm-Driven Economy* (2016, HUP); Ariel Ezrachi and Maurice E. Stucke, *How Big-Tech Barons Smash Innovation—and How to Strike Back* (2022, HarperCollins); Maurice E. Stucke, *Breaking Away - How to Regain Control Over Our Data, Privacy, and Autonomy* (2023, OUP).

¹⁰ Autorité de la concurrence and Bundeskartellamt, 'Competition Law and Data' (10 May 2016)

<www.bundeskartellamt.de/SharedDocs/Publikation/DE/Berichte/Big%20Data%20Papier.pdf?__blob=publicationFile&v=2> accessed 19 January 2024.

“four Vs of Big Data” – Volume, Variety, Velocity, and Value.¹¹ Alongside the many improvements it offers, noteworthy is the fact that limited access to relevant and timely data may inhibit entry, expansion, and innovation.¹² Data has been referred to (somewhat controversially) as the “new oil” which powers our modern society.¹³ While data is often “non-rivalrous” in the sense that it may be duplicated and used by multiple parties, without depleting its value (and as such differs from oil or traditional assets),¹⁴ its control, especially where the four Vs are present, offers a distinct advantage in the digital economy. A data advantage over rivals can enable leading players to achieve critical economies of scale, which could tilt the data—and competitive balance—in their favor. A positive feedback loop helps the strong become stronger, as the weak get weaker.¹⁵

Network effects occur when a good or service becomes more valuable as others use it.¹⁶ Each of the dominant ecosystems exhibits multiple network

¹¹ For more details on each V, see Maurice E Stucke and Allen P Grunes, *Big Data and Competition Policy* (OUP 2016) 2.04–2.29; OECD, ‘Big Data: Bringing Competition Policy to the Digital Era’, DAF/COMP (2016)14 5 <www.oecd.org/competition/big-data-bringing-competition-policy-to-the-digital-era.htm> accessed 19 January 2024.

¹² The key themes below are discussed in greater detail in Ariel Ezrachi and Maurice E Stucke, *Virtual Competition – The Promise and Perils of the Algorithm Driven Economy* (HUP 2016); Ariel Ezrachi and Maurice E Stucke, ‘Digitalisation and Its Impact on Innovation’, R&I Paper Series Working Paper 2020/07 (2020) <https://wbc-rti.info/object/document/20829/attach/KIBD20003ENN_en.pdf> accessed 19 January 2024.

¹³ The Economist, ‘The world’s most valuable resource is no longer oil, but data’ (6 May 2017) <www.economist.com/leaders/2017/05/06/the-worlds-most-valuable-resource-is-no-longer-oil-but-data> accessed 22 January 2024; Clive Humby and Michael Palmer, ‘Data is the New Oil’ (ANA Marketing Maestros, 3 November 2006) <https://ana.blogs.com/maestros/2006/11/data_is_the_new.html> accessed 22 January 2024; Bernard Marr ‘Here's Why Data Is Not The New Oil’ (5 March 2018) Forbes <https://www.forbes.com/sites/bernardmarr/2018/03/05/heres-why-data-is-not-the-new-oil/> accessed 23 January 2024

¹⁴ EU Commission Case No COMP/M.6314 – *Telefonica UK/Vodafone UK/Everything Everywhere* (joint venture) [2012] OJ - “Customers generally tend to give their personal data to many market players, which gather and market it. Therefore, this type of data is generally understood to be a commodity” (para 543).

¹⁵ OECD, ‘Data-Driven Innovation for Growth and Well-being: Interim Synthesis Report’ (October 2014) <<https://web-archieve.oecd.org/2014-10-01/320106-data-driven-innovation-interim-synthesis.pdf>> accessed 19 January 2024; reference within quotation is to Carl Shapiro and Hal R Varian, *Information Rules: A Strategic Guide to the Network Economy* (HBSP 1999).

¹⁶ Michael L Katz and Carl Shapiro, ‘Network externalities, competition, and compatibility’ (1985) AER 75(3) 424; European Commission, Decision No M.8124 (Microsoft/LinkedIn) 341 (6 December 2016); see also United States v Microsoft Corp [2001] 253 F 3d 34, 49

effects. They include *direct*, *indirect*, and *data-driven* effects that create a feedback loop that attracts users, sellers, service providers, developers, and advertisers to a network. Alongside the unparalleled efficiencies and economies of scale offered by network effects,¹⁷ they may support the rise of significant barriers to entry and limit the competitive pressure on the incumbent.¹⁸ Indeed, the combination of network effects, access to data and analytics may tip the market in favor of a leading provider, which may become inefficiently entrenched.¹⁹ Data-driven indirect network effects, may, in particular, reinforce the feedback loop and lead markets to tip in favor of the leading platform.

Big Analytics offer the power to optimize the use of data, identify patterns, improve the understanding of market dynamics, and open the door to accelerated innovation. Advanced analytics have also been central in the ability to identify consumers' needs and wants. Recent advancements in analytics and AI may enable further optimization even with relatively limited or unstructured data.²⁰ Here as well, alongside the clear benefits, one can identify worrying trends. Data mining, data trade, online marketing, pattern recognition, demand estimation, and price optimization, have been used to approximate reservation prices, identify biases, and power exploitative practices. Big Data and Big Analytics often reinforce each other.²¹

(DC Cir.).

¹⁷ OECD, 'Big Data: Bringing Competition Policy to the Digital Era' (n 5) 11.

¹⁸ Germany, in 2017, for example, amended its competition law to specify that direct and indirect network effects be taken into account in assessing a firm's market position. § 18 (3(a)) of the Act against Restraints of Competition (Competition Act – GWB) - Last amended by Article 10(9) of the Act of 30 October 2017, <www.bundeskartellamt.de/SharedDocs/Publikation/EN/Others/GWB.pdf?__blob=publicationFile&v=6> accessed 22 January 2024.

¹⁹ See Heike Schweitzer et al., 'Modernising the law on abuse of market power: Report for the Federal Ministry for Economic Affairs and Energy (Germany)' (2018) <<http://dx.doi.org/10.2139/ssrn.3250742>> accessed 19 January 2024.

²⁰ Kamal Choudhary et al., 'Recent advances and applications of deep learning methods in materials science' *npj Comput Mater* 8 59 (2022); Tiago Pereira et al., 'Diversity oriented Deep Reinforcement Learning for targeted molecule generation' *J Cheminform* 13 21 (2021); Chonghang Zhao and Hanfei Yan, 'Deep learning enables nanoscale X-ray 3D imaging with limited data' (2023) *Light Sci Appl* 12 159.

²¹ April Glaser, 'Facebook's Face-ID Database Could Be the Biggest in the World. Yes, It Should Worry Us' (Slate, 9 July 2019) <<https://slate.com/technology/2019/07/facebook-facial-recognition-ice-bad.html>> accessed 19 January 2024.

Ability to channel digital innovation. On the one hand, leading digital players such as Google, Apple, Meta, Amazon, and Microsoft, invest heavily in research and development.²² Their investments are often associated with new technologies and disruptions of third parties' value chains.²³ However, their control over their respective ecosystems also enables them to affect the nature and composition of innovation that reaches the market. Key here is how powerful ecosystems can distort the supply and demand for innovation, suppress disruption that threatens their value chains, and promote sustaining innovation that supports their business models.²⁴

What is noteworthy is that despite the pending antitrust litigation, heightened scrutiny in Europe under its new regulatory schemes such as the Digital Services Act (DSA) and Digital Markets Act (DMA), and the threat of further regulations in the EU and elsewhere, these digital ecosystems still dominate. In fact, despite ongoing enforcement and increased regulation, they expand and entrench their power.

Consider Meta. It faces greater scrutiny in Europe under the DMA and DSA. In the US, the FTC is challenging Meta's acquisitions of Instagram and WhatsApp. A bipartisan coalition of states is challenging Meta's exploitation of teenagers.

New Mexico's state attorney general also carried out an undercover investigation of Meta's platforms, creating decoy accounts of children 14-years and younger. The state AG gathered evidence that Meta's platforms:

²² In looking through their financial statements over the past decade, Google, Apple, Meta (Facebook), and Microsoft spent billions of dollars annually on research and development. (Amazon does not break out R&D separately in its annual reports, combining it with content.) These Tech Barons collectively spent over \$451.6 billion on R&D over eleven years.

²³ On disruptive innovation, see: Clayton M Christensen, *The Innovator's Dilemma – When New Technologies Cause Great Firms to Fail* Boston (Harvard Business Review Press 1997); Christian Hopp et al., 'Disruptive Innovation: Conceptual Foundations, Empirical Evidence, and Research Opportunities in the Digital Age' (2018) *Journal of Product Innovation Management* 35(3) 446–457 (surveying literature); Kawamoto, Carlos Tadao, and Renata Giovinazzo Spers, 'A Systematic Review of the Debate and the Researchers of Disruptive Innovation' (2019) *Journal of Technology Management and Innovation* 14(1) 73–82.

²⁴ Ariel Ezrachi and Maurice E Stucke, *How Big-Tech Barons Smash Innovation — and How to Strike Back* (HarperCollins 2022).

- *Proactively served and directed the underage users a stream of egregious, sexually explicit images — even when the child has expressed no interest in this content.*
- *Enabled dozens of adults to find, contact, and press children into providing sexually explicit pictures of themselves or participate in pornographic videos.*
- *Recommended that the children join unmoderated Facebook groups devoted to facilitating commercial sex.*
- *Allowed Facebook and Instagram users to find, share, and sell an enormous volume of child pornography.*
- *Allowed a fictitious mother to offer her 13-year-old daughter for sale to sex traffickers and to create a professional page to allow her daughter to share revenue from advertising.*²⁵

Things got even worse after New Mexico sued Meta for putting “profits ahead of children’s safety” in having its platforms becoming “prime locations for predators to trade child pornography and solicit minors for sex.”²⁶ The U.S. Senate Judiciary Committee excoriated Meta’s CEO (as well as TikTok’s), promising in January 2024 further regulations.²⁷ But the day after the Senate hearings, Meta’s stock jumped over 20%.²⁸ While such a price increase might be seen with a penny stock, one had never before seen a nearly \$200 billion increase in market capitalization in one day: Meta set a new stock market record.²⁹

Wall Street clearly does not see Meta’s dominance under threat. Why? Meta controls an ecosystem, not markets, which provides greater power than a dominant platform.³⁰ Google, Apple, Meta, Amazon, and Microsoft each dominate several interlocking, multi-sided markets, which connect individuals, service and product providers, and advertisers. With positive

²⁵ <https://nmag.gov/attorney-general-raul-torrez-files-lawsuit-against-meta-platforms-and-mark-zuckerberg-to-protect-children-from-sexual-abuse-and-human-trafficking/>

²⁶ Ibid

²⁷ <https://www.nytimes.com/live/2024/01/31/technology/child-safety-senate-hearing>

²⁸ <https://finance.yahoo.com/news/meta-stock-jumps-20-after-earnings-in-biggest-market-cap-jump-in-stock-market-history-212511451.html>.

²⁹ Ibid.

³⁰ Ezrachi & Stucke, Big Tech Barons.

feedback loops and ongoing expansion, their digital ecosystems benefit from unparalleled access to data and other critical inputs of the digital economy that can then be used to improve the products, services, technology, and algorithms and give them a significant advantage over others.

As our most recent book explores, ecosystems can be viewed as autonomies that control the dynamics of competition within them, the entry conditions, fees, and the flow of data within their respective frameworks. Positive feedback loops increase the power asymmetry on the market resulting in key players influencing competition parameters, barriers to entry and expansion, the nature and flow of innovation, and user behavior and choice.³¹

To assess whether AI will disrupt or protect these ecosystems, we will turn to the emerging foundation model supply chain.

II. THE FOUNDATION MODEL SUPPLY CHAIN

First, what is a foundation model? Typically, this AI technology, a deep learning model, undertakes a “wide range of tasks and operations.”³² Foundation models are

*AI models designed to produce a wide and general variety of outputs. They are capable of a range of possible tasks and applications, such as text, image or audio generation. They can be standalone systems or can be used as a ‘base’ for many other applications.*³³

Moreover, the types of foundation models vary, including “generative adversarial networks (GANs), variational auto-encoders (VAEs), transformer-based large language models (LLMs), and multimodal models.”³⁴ As the latter reflects, foundation models can be single or multi-modal, meaning the type of data used to train the model. Google’s Gemini model, for example, is multi-modal, in that the foundation model is trained

³¹ Ezrachi & Stucke, Big Tech Barons.

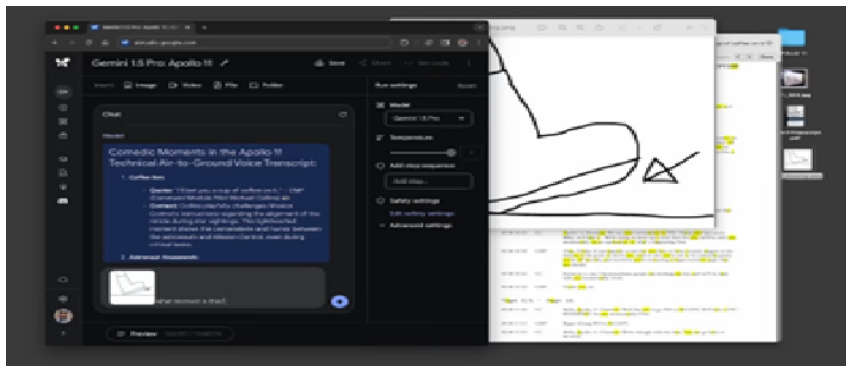
³² CMA Report at 8.

³³ <https://www.adalovelaceinstitute.org/resource/foundation-models-explainer/>

³⁴ <https://encord.com/blog/foundation-models/>

using different types of data, including words, images, videos, and audio.³⁵

The above may feel somewhat abstract to some readers. An example may help situate the technology and its significance. Google, for example, uploaded the 402-page transcript from Apollo 11's historic mission to the moon onto its Gemini 1.5 Pro foundation model. Google then asked its AI model to identify from the text three comedic moments. Arguably, a large enough language model trained purely on text could identify some moments of levity on the moon landing. Google then tested its AI model's multi-modal capacity. It uploaded the following basic drawing of a foot stepping on the ground:



This simple drawing tested the foundation model's multi-modal capacity, namely its capacity to identify what moment of the space trip this picture reflects, without Google telling its model what the picture was or what was happening in the picture. Google's foundation model correctly identified this picture, related it to Neil Armstrong's landing on the moon, and identified when that occurred in the transcript. Here is a combination of text and image, and the model could identify from a few abstract visual details something that happened in the text.

AI-driven technology is advancing at a significant pace. Earlier versions of generative AI have now given way to more advanced performances. Consider Bill Gates. In June 2023, Microsoft's founder was unimpressed with ChatGBT's performance: "I was like, 'Yeah, it's kind of an idiot savant. I

³⁵ <https://blog.google/technology/ai/google-gemini-next-generation-model-february-2024/#context-window>.

don't think it's practical.”³⁶ So, he told OpenAI CEO to get back to him when the foundation model could achieve the highest score on the college advance placement test for Biology. Gates thought, “OK, that'll give me three years to work on HIV and malaria.” Two months later, OpenAI's developers returned, and Gates watched ChatGPT achieve a 5 on the AP Biology test. “I'm still, personally, in a state of shock at ‘Wow, it is so good,’” Gates said. (Only 14.3% of high school students who took the exam in 2023 obtained that top score.³⁷)

Its GPT-4 model, according to OpenAI, has done even better, exhibiting “human-level performance on various professional and academic benchmarks.”³⁸ This includes racking the highest scores on many other AP subjects (including history, statistics, psychology, and micro- and macro-economics), scoring in the 90th percentile on the Uniform Bar Exam for lawyers (the GPT-3.5 model scored only in the 10th percentile), in the 99th percentile on the graduate school GRE Verbal Assessment, and even a 77% on the Advanced Sommelier examination.³⁹ Looking forward, the industry is striving toward the ideal of Artificial General Intelligence, which achieves complex human intelligence across fields.

With better insights into the technology, we can now move to consider its supply chain. The Ada Lovelace Institute, an independent UK research institute with a mission to ensure that data and AI work for people and society, illustrates the emerging AI foundation model supply chain⁴⁰:

³⁶ <https://www.cnn.com/2023/08/11/bill-gates-went-in-a-state-of-shock-after-chatgpt-aced-ap-bio-exam.html>

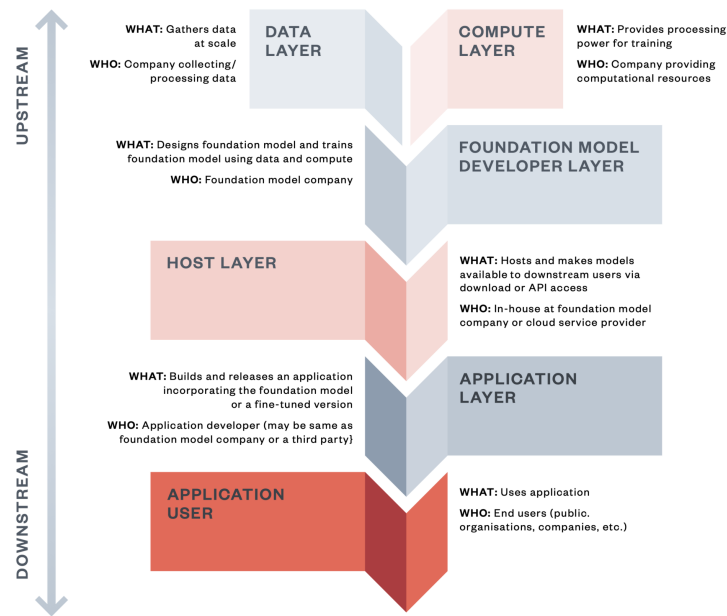
³⁷ <https://apstudents.collegeboard.org/about-ap-scores/score-distributions>.
<https://apstudents.collegeboard.org/about-ap-scores/score-distributions> Moreover, most students who take biology do not take the AP Biology test. The AP course is intended to replicate a “two-semester college introductory biology course for biology majors,” and is recommended for high school students who already took courses in biology and chemistry.
<https://apstudents.collegeboard.org/courses/ap-biology>

³⁸ <https://cdn.openai.com/papers/gpt-4.pdf>; Musk Compl. ¶ 86.

³⁹ <https://cdn.openai.com/papers/gpt-4.pdf>; Musk Compl. ¶ 86.

⁴⁰ https://www.adalovelaceinstitute.org/wp-content/uploads/2023/07/ALI-Foundation-model-supply-chain_.png

Foundation model supply chain



Note: This is one possible model (there will not always be a separate or single company at each layer)

In a competitive market, each layer in the foundation model supply chain might have multiple rivals, and no rival operates on multiple layers. For example, many semiconductor firms provide the accelerator computer chips needed to train the foundation model. Another set of companies provides the data to train the foundation model. A third set of companies provides the computational power. A fourth set develops the AI foundational models. Next are the hosts who make these models available to all the different developers who use the foundation model for their apps, products, or services. As the next parts explore, once we relax these assumptions, antitrust risks emerge when these stacks become concentrated, and powerful firms vertically integrate along the supply chain.

III. POTENTIAL ANTITRUST RISKS IN THE FOUNDATION MODEL SUPPLY CHAIN

Due to economies of scale and scope, feedback loops, high entry barriers, and the need for significant investments, key segments of the supply chain can become highly concentrated. And while the foundation model supply chain has multiple levels, its evolution has already led to significant vertical integration, which raises multiple concerns, including self-preferencing.⁴¹

As the G7 noted, “[a]n inability to access these key inputs may inhibit competition to develop AI and AI applications, reducing innovation and harming consumers.”⁴² As the FTC similarly observed,

*If a single company or a handful of firms control one or several of these essential inputs, they may be able to leverage their control to dampen or distort competition in generative AI markets. And if generative AI itself becomes an increasingly critical tool, then those who control its essential inputs could wield outsized influence over a significant swath of economic activity.*⁴³

Let us consider these antitrust risks, by exploring several key layers in the stack.

A. Concentration of Computational Power

Let us begin in assessing computational power. The development and deployment of foundation models “generally requires dedicated hardware, such as computers with specialized chips like graphical processing units (GPUs) that can be expensive to operate and maintain.”⁴⁴

⁴¹ See Amba Kak and Sarah Myers West, “AI Now 2023 Landscape: Confronting Tech Power”, AI Now Institute, April 11, 2023, <https://ainowinstitute.org/2023-landscape>; Open Markets Institute, AI in the Public Interest: Confronting the Monopoly Threat (November 2023).

⁴² G7 Competition Authorities and Policymakers’ Summit, Digital Competition Communiqué, Tokyo, Japan, 8 November 2023.

⁴³ FTC Report (n 5)

⁴⁴ FTC Report (n 5); CMA Report at 12-13.

While we are only at the onset of the AI revolution, the dominant player, as of early 2024, is the firm supplying the picks and shovels, namely Nvidia. That is to be expected in AI's infrastructure stage, when multiple entities are competing to acquire the resources to develop foundation models.

So one problem, as of early 2024, is in acquiring these specialized accelerator chips, which Nvidia largely produces (with an estimated 80 percent market share).⁴⁵ Given that demand for these chips in early 2024 exceeds the available supply,⁴⁶ not every firm today has an equal shot at acquiring these chips.⁴⁷ As Elon Musk quipped, "GPUs at this point are considerably harder to get than drugs."⁴⁸ These accelerator chips have become prized, so much so that on occasion they have been transported in armored cars.⁴⁹

Another problem, as the *Wall Street Journal* observed, is that "[h]ow Nvidia allocates its limited supplies could influence who wins or loses in the AI race."⁵⁰ Amazon, Google, Meta, OpenAI, and Microsoft have all been huge buyers of Nvidia's AI-training chips.⁵¹ OpenAI, for example, trained its foundation model ChatGBT with tens of thousands of Nvidia's GPU

⁴⁵ Asa Fitch, Nvidia's Assent Makes It a Target, *Wall St. J.*, Feb 27, 2024, at A8.

⁴⁶ *Ibid*

⁴⁷ For illustration, note for example: Duncan Stewart et al., 'Gen AI chip demand fans a semi tailwind ... for now' (Deloitte Insights, 2023) <www2.deloitte.com/uk/en/insights/industry/technology/technology-media-and-telecom-predictions/2024/generative-ai-chip-market-to-reach-40-billion-in-2024.html> accessed 13 January 2024; Kif Leswing, 'Nvidia's top A.I. chips are selling for more than \$40,000 on eBay' (*CNBC*, 14 April 2023) <www.cnn.com/2023/04/14/nvidias-h100-ai-chips-selling-for-more-than-40000-on-ebay.html> accessed 13 January 2024; Anissa Gardizy and Wayne Ma, 'Microsoft Readies AI Chip as Machine Learning Costs Surge' (*The Information*, 18 April 2023) <www.theinformation.com/articles/microsoft-readies-ai-chip-as-machine-learning-costs-surge> accessed 12 January 2024; Hugo Huang, 'What CEOs Need to Know About the Costs of Adopting GenAI' (*Harvard Business Review*, 15 November 2023) <<https://hbr.org/2023/11/what-ceos-need-to-know-about-the-costs-of-adopting-genai>> accessed 13 January 2024; Alberto Romero, '200 Million People Use ChatGPT Daily. OpenAI Can't Afford It Much Longer' (*Medium*, 28 August 2023) <<https://albertoromgar.medium.com/200-million-people-use-chatgpt-daily-openai-cant-afford-it-much-longer-55bf2373d01c>> accessed 13 January 2024.

⁴⁸ Asa Fitch, (n 45).

⁴⁹ <https://www.msn.com/en-us/money/other/nvidia-hits-2-trillion-valuation-on-insatiable-ai-chip-demand/ar-BB1iK6eW>.

⁵⁰ Asa Fitch, (n 45).

⁵¹ Asa Fitch, (n 45).

chips.⁵²

Alternatively, entrants seeking to develop a foundation model can turn to cloud computing services to provide these high-performance computational resources.⁵³ But three firms dominate the IaaS cloud computing service market: Amazon with an estimated 39% share (in 2021), Microsoft with a 21% share, and Google with a 7% share. (Two Chinese firms, Alibaba and Huawei, had a 10 and 5 percent share.⁵⁴) As the U.S. Treasury reported, while there is competition among the three IaaS cloud service providers, “even the largest financial institutions reported difficulties in drafting contracts.”⁵⁵ Moreover, given the demand for the use of the cloud service providers’ server chips used to train these AI models, AI developers have had to wait for months for time on these servers.⁵⁶

This bottle neck has gravitated more power to the already powerful. Rather than wait in line, some foundation model developers are partnering with the Big Tech Barons: the Barons invest in the model developer, which in turn purchase access to the Tech Barons’ cloud server.⁵⁷ Some have described these partnerships “as necessary or ‘critically important’ for the development” of these foundation models.⁵⁸ So, one sees Google’s investment in Anthropic circulating back to the Tech Baron, who now gets greater control over the development of the foundation model.⁵⁹ Consider Microsoft’s partnership with OpenAI. Microsoft has the upper hand in this relationship. As Microsoft’s CEO observed, its partnership is not hands off:

⁵² Asa Fitch, (n 45)

⁵³ FTC Report (n 5)

⁵⁴ Treasury Cloud Report at 16.

⁵⁵ *Ibid* at 59.

⁵⁶ https://www.theinformation.com/articles/ai-developers-stymied-by-server-shortage-at-aws-microsoft-google?irclid=y6sQYbVi0xyPWHP2wd1eHXCuUkH3hcWdyUumxU0&irgwc=1&utm_source=affiliate&utm_medium=cpa&utm_campaign=2334778-Linkbux&utm_term=https%3A%2F%2Foptimhub.com%2F

⁵⁷ CMA Report at 18, 34-35; see also Dave Michaels, *FTC Launches Probe of Big Tech’s AI Investments: Agency says it will look into how roles of Microsoft, OpenAI, Amazon.com, Anthropic and Alphabet affect competition in red-hot field*, Wall St. J., Jan. 25, 2024.

⁵⁸ CMA Report at 35.

⁵⁹ CMA Report at 18, 35-36; Belle Lin, *Companies Weigh Growing Power of Cloud Providers Amid AI Boom, A wave of partnerships between AI model makers and cloud providers is leading tech chiefs to assess the benefits of convenience versus becoming too reliant on any one vendor*, Wall St. J., Aug. 2, 2023.

*We [Microsoft] are in there. We are below them, above them, around them. We do the kernel optimizations, we build tools, we build the infrastructure. So that's why I think a lot of the industrial analysts are saying, "Oh wow, it's really a joint project between Microsoft and OpenAI." The reality is we are, as I said, very self-sufficient in all of this.*⁶⁰

Thus, should OpenAI cease to exist, Microsoft's CEO was confident in his company's ability to continue to provide AI services:

*But the point is, we were very confident in our own ability. We have all the IP rights and all the capability. If OpenAI disappeared tomorrow, I don't want any customer of ours to be worried about it quite honestly, because we have all of the rights to continue the innovation. Not just to serve the product, but we can go and just do what we were doing in partnership ourselves. We have the people, we have the compute, we have the data, we have everything.*⁶¹

Moreover, the concern is that if Microsoft "withheld its cloud computing system on which OpenAI was reliant, [OpenAI] would be incapacitated."⁶² Nvidia, however, is supplying some of its chips to CoreWeave, a cloud-computing firm in which it has invested,⁶³ and is offering its own full-stack of services. And other computational alternatives like Dell are emerging. Nonetheless, an entrant will likely incur significant costs -- either in developing this computational power internally for its foundation model or outsourcing the compute function to a handful of cloud computing service providers, who may be a potential competitor in that AI foundation model market and who can raise their rivals' costs.

While Nvidia is the clear current winner at the chips level, the concern is that the Big Tech Barons -- through their access to data, preferential access

⁶⁰ <https://nymag.com/intelligencer/2023/11/on-with-kara-swisher-satya-nadella-on-hiring-sam-altman.html>.

⁶¹ Ibid.

⁶² Musk Compl. ¶ 108.

⁶³ Asa Fitch, (n 45).

to the Nvidia accelerator chips, development of their own accelerator chips, and their ownership interests in other foundation model developers -- will eventually dominate this layer as well, as they integrate through the various levels of the technology stack.

B. Concentration of Foundation Models

Training AI foundation models, as of 2024, generally requires the following inputs:

- Significant volume and variety of data to train the generative AI foundation model, fine-tune it, and provide up-to-date responses,⁶⁴
- Significant large scale computational resources, including cloud computing resources, with specialized chips,⁶⁵
- Significant amounts of energy, and
- Human capital, including “a skilled engineering and research work force with expertise in areas such as machine learning and natural language processing.”⁶⁶

⁶⁴ <https://www.ftc.gov/policy/advocacy-research/tech-at-ftc/2023/06/generative-ai-raises-competition-concerns> (“Developing generative AI typically requires exceptionally large datasets, especially in the pre-training step. The data used in this step forms the foundation of the model in the chosen domain, such as language or images.”); CMA Report at 10; <https://www.adalovelaceinstitute.org/resource/foundation-models-explainer/> (“A defining characteristic of foundation models is the scale of data and computational resources involved in building them. They require datasets featuring billions of words or hundreds of millions of images scraped from the internet. Foundation models also rely on ‘transfer learning’ – that is, applying learned patterns from one task to another.”)

⁶⁵ <https://www.ftc.gov/policy/advocacy-research/tech-at-ftc/2023/06/generative-ai-raises-competition-concerns>; CMA Report at 10.

⁶⁶ G7 Competition Authorities and Policymakers’ Summit, Digital Competition Communiqué, Tokyo, Japan, 8 November 2023; see also <https://www.ftc.gov/policy/advocacy-research/tech-at-ftc/2023/06/generative-ai-raises-competition-concerns>:

Another essential input for generative AI is labor expertise. Developing a generative model requires a significant engineering and research workforce with particular—and relatively rare—skillssets, as well as a deep understanding of machine learning, natural language processing, and computer vision. It can be difficult to find, hire, and retain the talent required to develop generative AI.

Additionally, the speed and velocity at which generative AI is evolving means that models may quickly become outdated or obsolete. The talent companies can acquire and maintain may play a key role in not only the path, but also the rate, of generative AI’s evolution.

Firms hoping to compete in the generative AI space need expertise, not only on how to develop generative AI but also on how to deploy the fine-tuned AI products. Companies that

Thus, the early advantage in developing foundation models will go to firms that already have a significant volume and variety of data (e.g., hundreds or thousands of gigabytes of data⁶⁷ across different modes) to train these models, have the large-scale computational resources (either internally or committed cloud computing resources), and have the human capital, including the human feedback needed to fine-tune the model's output (such as preventing biased, false or harmful outputs).⁶⁸

Overall, while there are approximately 160 foundation models, the Tech Barons control multiple models: Google has 38 models (28 of which are closed); OpenAI has 18 models; Microsoft has an additional 10 models (6 of which are closed); and Meta has 10 models (2 of which are closed).⁶⁹ Currently, the highest performing models are closed-source.⁷⁰ The significant investment needed to develop the technology supports ongoing concentration.⁷¹ This underscores the risk of further entrenchment of the Big Tech Barons. We are already seeing OpenAI (through its partnership with Microsoft), Google, and Meta develop their own foundation models, from which other firms may fine-tune their AI applications, products, and services. Google's Gemini foundation model, as the company reports, was the first "to outperform human experts on MMLU (Massive Multitask Language Understanding), one of the most popular methods to test the knowledge and problem-solving abilities of AI models."⁷² Gemini also powers Google

can acquire both the engineering experience and professional talent necessary to build and package the final generative AI product or service will be better positioned to gain market share.

Since requisite engineering talent is scarce, powerful companies may be incentivized to lock-in workers and thereby stifle competition from actual or would-be rivals. To ensure a competitive and innovative marketplace, it is critical that talented individuals with innovative ideas be permitted to move freely, and, crucially, not be hindered by non-competes.

⁶⁷ CMA Report at 11.

⁶⁸ CMA Report at 12 & 44.

⁶⁹ CMA Report at 22-23.

⁷⁰ CMA Report at 47.

⁷¹ Rapid AI development over the last decade has been facilitated due to concentration of data and computer resources. See: Ian Brown, 'Allocating accountability in AI supply chains: a UK-centred regulatory perspective' (Ada Lovelace Institute, 29 June 2023) <www.adalovelaceinstitute.org/resource/ai-supply-chains/> accessed 19 January 2024.

⁷² <https://deepmind.google/technologies/gemini/#gemini-1.0>

Bard.⁷³ Microsoft has a partnership with OpenAI's ChatGPT⁷⁴ and DALL-E⁷⁵ and is coordinating with Meta on its Llama-2 foundation model.⁷⁶

At present, the Big Tech Barons are spending hundreds of millions of dollars in datacenter infrastructure and in developing their foundation models. Their activities are felt across the industry with a marked increase in strategic collaboration.⁷⁷ And while other companies occupy this space, the Big Tech Barons currently appear the best positioned to increase investments and collaborations.

Most significantly is the Barons' vertical integration across the supply chain, which enables them to control the data, the cloud servers, the development of the foundation models and the conditions under which they are released to the market. Many also control the consumer and business interfaces.

This privileged position is unique to the Big Tech Barons. It distinguishes them from other companies, even successful ones, that while competing with their models, also heavily rely on Tech Barons for financial support, computing power, or data. Here a *frenemy relationship* may evolve,⁷⁸ where the Tech Barons both cooperate with, and compete against, smaller operators that develop foundation models. These dynamics may ultimately entrench the Tech Barons' power, widening the moat that insulates them from future disruption.

C. Increasing Downstream Dependency

The foundation model supply system can have mixed competitive effects

⁷³ Google, Bard (powered by Large Language Model (LLM) Gemini) (2023) <<https://bard.google.com/>> accessed 23 January 2024.

⁷⁴ OpenAI, ChatGPT (powered by LLM GPT-4) (2023) <<https://chat.openai.com/>> accessed 23 January 2024.

⁷⁵ OpenAI, DALL-E (2023) <<https://openai.com/dall-e-3>> accessed 23 January 2024.

⁷⁶ Meta, Llama-2 developed by Meta in partnership with Microsoft (2023) <<https://www.llama2.ai/>> accessed 23 January 2024.

⁷⁷ Note for example Microsoft's recent expansion of its AI portfolio, through a new partnership with French artificial intelligence developer Mistral AI.

⁷⁸ Ezrachi, Stucke, *Virtual Competition: The Promise and Perils of the Algorithm-Driven Economy* (HUP, 2016) Part IV

downstream. On the one hand, in lowering the cost to access a foundation model, the current supply chain can increase dynamism in secondary application markets. Firms can use the publicly available foundation models to disrupt many traditional markets, lower costs, increase efficiencies, and spur innovation. There can be significant advances in many industries, from health to education and commerce.

On the other hand, the developers in the downstream application layer can become increasingly dependent on the Tech Baron's foundations models. The way the technology is used and licensed turns this into a structural dependency that cuts across the application layer. The more developers who rely on the model, the better the model can become, and the harder it might be for the developers to switch to other foundation models or develop their own. They become dependent on the foundation model, and all their innovations will complement (rather than potentially disrupt) the Big Tech Barn's services, AI technology, and ecosystem. The asymmetry in power between the upstream foundation model and downstream operators increases.

1. How Open Is Open

Currently, the Tech Barons note how "open" the technology is. They emphasize how they operate to democratize the AI environment and empower others to disrupt and evolve.

Consider OpenAI. As its name implies and its Founding Agreement reflects, the non-profit was created to "compete with, and serve as a vital counterbalance to, Google/DeepMind in the race for AGI, but would do so to benefit humanity, not the shareholders of a private, for-profit company (much less one of the largest technology companies in the world)."⁷⁹ OpenAI also partnered with Microsoft to help the world's largest company (in terms of market capitalization) develop its own apps, products, and services, including Microsoft's search engine Bing. Its Copilot function is powered by OpenAI's foundation model. So, we ask Bing's Copilot about Microsoft's investment in OpenAI. The foundation model generated the following response:

⁷⁹ Musk Compl. ¶ 24.

Microsoft has a significant interest in OpenAI, and their partnership has evolved over time. Here are the key points:

1. *Investment and Collaboration:*

- In 2019, Microsoft invested \$1 billion in OpenAI to support the development of artificial general intelligence (AGI) with widespread economic benefits³.
- This investment aimed to create a hardware and software platform within Microsoft Azure that would scale to AGI.
- The collaboration focused on advancing cutting-edge AI research and democratizing AI as a technology platform.

2. *Ongoing Partnership:*

- In 2021, Microsoft and OpenAI extended their partnership through a multiyear, multibillion-dollar investment.
- This third phase of collaboration aims to accelerate AI breakthroughs and ensure these benefits are broadly shared with the world¹.
- It includes commitments from OpenAI to make Microsoft its "preferred partner for commercializing new AI technologies"².

3. *Areas of Focus:*

- *Supercomputing:* Microsoft is investing in specialized supercomputing systems to accelerate OpenAI's groundbreaking independent AI research.
- *AI-powered Experiences:* OpenAI's models are being deployed across Microsoft's consumer and enterprise products, introducing new digital experiences.
- *Azure Cloud:* Azure is the exclusive cloud provider for OpenAI, powering all their workloads across research, products, and API services.

4. *Shared Vision:*

- Both companies share a commitment to advancing AI responsibly and creating transformative impact.
- Their collaboration has led to innovations like GitHub Copilot, DALL·E 2, and ChatGPT.

In summary, Microsoft's interest in OpenAI lies in advancing AI research, democratizing AI technologies, and building powerful AI infrastructure on Azure^{1,2}.

Consider the above claim that Microsoft's interest in OpenAI was in part for "democratizing AI technologies." According to Elon Musk's complaint, Microsoft's investment has had the opposite effect: OpenAI has become "closed, for profit AI."⁸⁰ OpenAI's more advanced model GPT-4 "is now a *de facto* Microsoft proprietary algorithm, which is integrated into its Office software suite."⁸¹ OpenAI has also been accused of offering limited

⁸⁰ Musk Compl. ¶¶ 113, 115.

⁸¹ Musk Compl. ¶ 30.

information on the data used to train its GPT-4 foundation model, or the methods used to create it.⁸² Rather than using its GPT-4 model to benefit humanity, OpenAI, as Musk alleges in his complaint, is using its most advanced foundation model to maximize profits of the world's largest company.

Other Tech Barons have also touted the openness of their AI systems and how their technology benefits others. Yet, several researchers have questioned the true openness of their foundation models and labeled these claims as “open-washing” of closed systems. According to these claims, behind the misleading façade of openness, aimed at influencing public perception as to the availability of the technology, many of the technologies are, in fact, closed systems that support concentrated power.⁸³ For example, in a critique on the release of Llama 2 by Meta, several computer scientists pointed that despite it being described as open source, the technology is “considerably closed off” since Meta did not share the model's training data or code used to train it.⁸⁴ Other commercial systems, as well, offer limited transparency and openness with restricted insights to the codes and data used, the way models are tuned, the nature of RLHF input, and limited peer review.⁸⁵ Doubts have also been raised about related claims from the industry, according to which the gap between closed and open AI models is

⁸² Musk Compl. ¶ 90; see also James Vincent, ‘OpenAI co-founder on company's past approach to openly sharing research: ‘We were wrong’ (The Verge, 15 March 2023) <www.theverge.com/2023/3/15/23640180/openai-gpt-4-launch-closed-research-ilya-sutskever-interview> accessed 19 January 2024.

⁸³ David Gray Widder, Meredith Whittaker and Sarah Myers West, ‘Open (for business): Big tech, concentrated power, and the political economy of open AI’ (17 August 2023) <<https://ssrn.com/abstract=4543807>> accessed 12 January 2024; Andreas Liesenfeld, Alianda Lopez and Mark Dingemanse, ‘Opening up ChatGPT: Tracking Openness, Transparency, and Accountability in Instruction-Tuned Text Generators’ CUI '23: Proceedings of the 5th International Conference on Conversational User Interfaces, 19-21 July 2023, Eindhoven; Will Henshall, ‘The Heated Debate Over Who Should Control Access to AI’ (TIME Magazine, 25 August 2023) <<https://time.com/6308604/meta-ai-access-open-source/>> accessed 12 January 2024.

⁸⁴ David Gray Widder, Meredith Whittaker and Sarah Myers West (n 84); Andreas Liesenfeld, Alianda Lopez and Mark Dingemanse (n 84); Will Henshall (n 84); Steven J Vaughan-Nichols, ‘Meta can call Llama 2 open source as much as it likes, but that doesn't mean it is’ (The Register, 21 July 2023) <www.theregister.com/2023/07/21/llama_is_not_open_source/> accessed 12 January 2024.

⁸⁵ David Gray Widder, Sarah West and Meredith Whittaker (n 84).

“closing astonishingly quickly.”⁸⁶

It is important to nuance the discussion on openness, as democratization of data and technology dictates trade-offs. Openness could increase the susceptibility to distortions, manipulation, or illicit use.⁸⁷ Fears over safety, and legal liability, as well as concerns of competitors using the data and information for their own operations, may justify an approach that fosters limited transparency with respect to numerous building blocks of the technology, including codes, model architecture, data, fine-tuning processes, weights and biases.⁸⁸ Indeed, OpenAI’s chief scientist and co-founder, Ilya Sutskever, noted in an interview how the company changed its approach to openness and considers it now overly risky: “These models are very potent and they’re becoming more and more potent. At some point it will be quite easy, if one wanted, to cause a great deal of harm with those models. And as the capabilities get higher it makes sense that you don’t want to disclose them.”⁸⁹

While these concerns may justify closing certain aspects of the systems, the key concern regarding limited democratization remains. As UK’s competition authority noted, “many firms have kept their highest-performing pre-trained [foundation models] closed-source, keeping the model weights (the internal ‘knowledge’ of the model) a trade secret, and providing access via an API or through user-facing applications.”⁹⁰ Moreover, the alternative open-source foundation models currently are “generally smaller and perform less well than the highest-performing closed-source models.”⁹¹ Thus, the closed, or semi-closed systems, support the Barons’ amalgamation of power, and enhance their control over the foundation models and any third-party apps, products or services that rely on these models.

⁸⁶ Ian Brown at 44.

⁸⁷ Agreements and restrictive licenses may be used to limit liability but can be bypassed and cannot exclude possible misuse and distortion of the technology. See Ian Brown (n 41) 53.

⁸⁸ Elizabeth Seger et al., ‘Open-Sourcing Highly Capable Foundation Models’ (AI Centre for the Governance of AI, 2023) <https://cdn.governance.ai/Open-Sourcing_Highly_Capable_Foundation_Models_2023_GovAI.pdf> accessed 12 January 2024.

⁸⁹ James Vincent.

⁹⁰ CMA Report at 40.

⁹¹ CMA Report at 40.

2. The Venus Flytrap Strategy

In colonizing their ecosystems, the Tech Barons often deploy a Venus Flytrap Strategy. The Venus Flytrap (*Dionaea muscipula*) is a well-known carnivorous plant native to the Carolinas. To attract insects, the herb secretes a sweet sap. Once the plant's leaves snap shut, the entrapped insects have little chance to escape. So too, the data-opolies opened their newly colonized platforms with inducements to attract advertisers, app developers, users, and smart device manufacturers. After dominating that ecosystem, the data-opoly snapped the once open-source environment shut: the data-opoly then imposed upon the entrapped sellers, developers, advertisers, and users anticompetitive terms and fees.

To dominate its Android mobile phone ecosystem, Google, as the United States alleged, deployed the Venus Flytrap Strategy. Once Android became dominant, running on approximately 75% of the world's mobile devices, Google closed its ecosystem and collected monopoly rents and personal data from the entrapped developers and smartphone manufacturers. If smartphone manufacturers wanted interoperability with Google's apps and wanted Google's app store loaded on their phones (a must for any smartphone to be commercially viable), they had to use Google's version of Android (not a competing version). They also had to preload and feature Google's search engine, browser, and other apps (and not competitors'). Google also imposed an app tax on developers (ranging between 15 and 30%) and was alleged to require apps to hand over their users' personal data.

So where does this leave downstream players who rely on commercial foundation models? A startup, for example, can use OpenAI's application programming interfaces ("APIs") to integrate GPT's services into the startup's own applications, products, or services.⁹² Under the API access business model, the developer sends its or its users' prompts to the foundation model. But the developer lacks access to the foundation model's code, training data, or model weights and biases.⁹³ Instead the developer shares data with the foundation model and receives the model's output.

⁹² <https://openai.com/policies/business-terms>.

⁹³ CMA Report at 15.

Here a positive feedback loop can emerge under the API access model: as more developers rely on a few foundation models, the more data and the greater the variety of the data (audio, visual, text, depth, movement, thermal, etc.) that flows from the developers and their customers to these multi-modal foundation models. The increasing inflow of data can help train and further improve these AI foundation models, which, as a result, can attract even more developers.⁹⁴ Accordingly, it might be harder for another company to develop a foundation model that competes against these dominant AI foundation models.

Moreover, both the app developers and their end-users can become locked-in to the foundation model, and thus increase their costs in switching to another model. For example, the foundation model can learn how to customize responses to particular app developers or even their end-users (such as the person's writing style, personal preferences, etc.).⁹⁵ OpenAI heard from end-users "about the friction of starting each ChatGPT conversation afresh."⁹⁶ So OpenAI allows end-users to customize instructions for its foundation model to provide customized, unique responses for each individual user:

Custom instructions allow you to add preferences or requirements that you'd like ChatGPT to consider when generating its responses. . . .

ChatGPT will consider your custom instructions for every conversation going forward. The model will consider the instructions every time it responds, so you won't have to repeat your preferences or information in every conversation.

For example, a teacher crafting a lesson plan no longer has to repeat that they're teaching 3rd grade science. A developer preferring efficient code in a language that's not Python – they can say it once, and it's understood. Grocery shopping for a big family becomes easier, with the model accounting for 6 servings in the grocery list. Set your preferences, and ChatGPT will keep them in mind for all

⁹⁴ CMA Report at 69.

⁹⁵ CMA Report at 68.

⁹⁶ <https://openai.com/blog/custom-instructions-for-chatgpt>

*future conversations.*⁹⁷

We already see such network effects for search engines, especially for unusual (tail) inquiries. The more one googles, the more opportunities for the search engine to learn about relevant responses, and the better its performance relative to other search engines. Now we can have network effects on multiple levels: from improving the model's capabilities across many services and products to improving customized responses for each end-user.

Thus, even when the current foundation model is relatively open, it can close gradually later.⁹⁸ It is therefore important to distinguish the ability of downstream operators to use functions of the AI foundation models and integrate them into their product and service offering, and their inability to control, replicate, develop, or influence its input and output.

There are other risks as well that emerge from the developers' increased dependency on a foundation model. As more developers rely on a particular foundation model, any risks, biases, or flaws in that model will cascade to millions, if not billions, of users.⁹⁹ The foundation model providers will largely, if not entirely, control the safety of the AI technology, the risks of hallucinations, biased, hateful, discriminatory or misleading outputs, and may externalize many of the risks to downstream corporations.¹⁰⁰

D. Narrowing Innovation Paths

The concentration of the foundation model layer and the increased dependency of the application layer are only part of the potential anticompetitive effects. As the foundation model's technology is weaved into more apps, services, and products, the control of key inputs offers the

⁹⁷ <https://openai.com/blog/custom-instructions-for-chatgpt>

⁹⁸ FTC (n 5) (discussing how the "open-first, closed later" tactics may form part of this strategy).

⁹⁹ <https://www.adalovelaceinstitute.org/resource/foundation-models-explainer/>

¹⁰⁰ Elizabeth Seger et al., 'Democratising AI: Multiple Meanings, Goals, and Methods' (2023) AIES '23: Proceedings of the 2023 AAAI/ACM Conference on AI, Ethics, and Society 715, 719 <<https://doi.org/10.1145/3600211.3604693>> accessed 22 January 2024; Kelsey Piper, 'Are we racing toward AI catastrophe?' (*Vox*, 9 February 2023) <www.vox.com/future-perfect/23591534/chatgpt-artificial-intelligencegoogle-baidu-microsoft-openai> accessed 13 January 2024.

dominant players a unique bargaining position and the ability to influence the evolution of technologies and innovation in secondary markets.

For example, a startup can use OpenAI's APIs to integrate ChatGBT services into the startup's applications, products, or services.¹⁰¹ But let us consider Copilot's statement (excerpted above) that OpenAI is committed "to make Microsoft its 'preferred partner for commercializing new AI technologies.'"¹⁰² So, if a developer and Microsoft are both seeking to commercialize a specific AI technology, OpenAI would advantage Microsoft. Thus, it is unlikely that OpenAI would support a developer seeking to use its foundation model to compete against Microsoft or disrupt Microsoft's expanding ecosystem, especially when OpenAI's foundation models rely on Microsoft's cloud servers to compute.

Nor can the startup develop AI systems that disrupt OpenAI. Consider OpenAI's terms of service for its ChatGBT, which expressly limit competing AI development:

We own all right, title, and interest in and to the Services. You only receive rights to use the Services as explicitly granted in this Agreement. You will not, and will not permit End Users to:

. . . (e) use Output (as defined below) to develop any artificial intelligence models that compete with our products and services. However, you can use Output to (i) develop artificial intelligence models primarily intended to categorize, classify, or organize data (e.g., embeddings or classifiers), as long as such models are not distributed or made commercially available to third parties and (ii) fine tune models provided as part of our Services.¹⁰³

Thus, the developer cannot disrupt OpenAI, nor can it allow its users to disrupt OpenAI's products and services. As IBM warns,

A company specializing in voice recognition technology plans to enhance

¹⁰¹ <https://openai.com/policies/business-terms>.

¹⁰² <https://www.zdnet.com/article/microsoft-invests-1-billion-in-openai-which-is-going-all-in-on-azure/>.

¹⁰³ <https://openai.com/policies/business-terms>.

*their existing system by integrating ChatGPT's natural language processing capabilities. However, the terms of service for ChatGPT explicitly state that it cannot be used in the development of other AI systems.*¹⁰⁴

Now let us consider some of the other popular foundation models. Google imposes a similar restriction for licensees for its AI foundation models: “You may not use the Services to develop machine learning models or related technology.”¹⁰⁵

Other foundation model providers, like Meta, offer model access (not just API access). Under this business model, the developer can download the foundation model and incorporate it in the developer’s apps, products, and services. Unlike the API access model, the developer does not send data to the foundation model’s owner through an API.¹⁰⁶ But Meta’s originally model could only be used for research purposes, and excluded commercial applications.¹⁰⁷ Currently its license with commercial and individual users restricts them from “using any part of the Llama 2 models, including the response outputs to train another AI model (LLM or otherwise).”¹⁰⁸ Moreover, users can only “use the outputs to further train the Llama 2 family of models,”¹⁰⁹ which can increase the developers’ dependency on Meta’s foundation model. (They can’t use the outputs to help train a competing foundation model.)

Consequently, companies can use the Big Tech Barons’ foundation models to develop apps, products, and services that disrupt traditional industries; but they cannot disrupt the Big Tech Baron’s foundation model. Nor can they develop models that compete with the Big Tech Baron’s

¹⁰⁴ <https://www.ibm.com/blog/exploring-the-risks-and-alternatives-of-chatgpt-paving-a-path-to-trustworthy-ai/>

¹⁰⁵ Google, GENERATIVE AI ADDITIONAL TERMS OF SERVICE Last Modified: August 9, 2023, <https://policies.google.com/terms/generative-ai>; <https://ai.google.dev/terms> (“You may not use the Services to develop models that compete with Gemini API or Google AI Studio. You also may not attempt to extract or replicate the underlying models (e.g., parameter weights).”).

¹⁰⁶ CMA Report at 15.

¹⁰⁷ CMA Report at 51.

¹⁰⁸ <https://llama.meta.com/faq>.

¹⁰⁹ [Ibid.](#)

products and services. So as more people use the start-ups' AI apps, which rely on the Big Tech Barons' foundation model, it may become harder to develop a foundation model that disrupts the Big Tech Barons' models and AI-related products and services.

As a result, we may see something like an AI app store. As with Google's and Apple's app stores, there will be many AI apps from which to choose. But one cannot develop an application that disrupts the app store itself or the Big Tech Barons' AI foundation models. The AI developers' innovations can *complement*, but not *disrupt*, the Big Tech Barons' AI foundation models, further entrenching the Big Tech Barons' power. As our recent book explores, this shift is key: first, it reduces the number and viability of Tech Pirates who can disrupt this hegemony. Second, in controlling the underlying foundation models, the Big Tech Barons can shape the innovation paths – from disruptive to complementary.¹¹⁰ This asymmetry in the market will intensify, as those in control of the infrastructure and inputs can influence competition and innovation in the downstream markets.¹¹¹

Furthermore, the Big Tech Barons' foundation models exist within their sprawling ecosystems. In controlling the ecosystem, the Barons have many weapons to affect the supply and demand of AI innovations, including multiple weapons to marginalize or exclude potential disruptive threats: this includes downgrading or denying services to potential competitors, bundling products (for example, cloud services and generative AI), excluding the developers from their app stores and ecosystems, making it harder for end users to find the innovation, and self-preferencing.¹¹²

As noted above, concerns about misuse of AI may justify closing certain aspects of the systems. But the restrictions here go beyond safety concerns. They are aimed at ensuring that any downstream disruption will not destabilize the upstream levels of the AI stack. Quite the contrary, to ensure their app gets out quicker than rivals' apps, developers will likely rely on one of the leading foundation models and in doing so, trade-off the risk of

¹¹⁰ Ariel Ezrachi and Maurice E. Stucke, *How Big-Tech Barons Smash Innovation* (n 9).

¹¹¹ FTC (n 5).

¹¹² On the available levers to distort competition and innovation, see: Ariel Ezrachi and Maurice E. Stucke, *How Big-Tech Barons Smash Innovation* (n 9).

increased dependency with speed to the market. Moreover, the developer recognizes that if they try to disrupt the Big Tech Baron's products and services, they would likely be cut off from the foundation model. Nor could the developer likely use the Big Tech Baron's cloud computing service to develop their own foundation model.

Thus, the emerging foundation model supply chain can advantage those who control these models and hinder the innovations of downstream developers. Under the API interface, the developers have limited insights as to the foundation models' operations, safety limitations, and risks. Moreover, they are like sharecroppers. The data they generate flows to improve the foundation model, which they do not own or control. This asymmetry increases their dependency on the model and reduces their power relative to the foundation model provider.

The antitrust risks are clear: a few firms would control all aspects of a technology that can cause "a great deal of harm."¹¹³ Thus, the foundation model supply chain can lead to "winner-take-all-or-most," where a few powerful firms can distort the innovation paths, chill innovations that disrupt their ecosystems, and promote innovations that complement their technologies and reinforce their power.

E. Tech Barons' Expansion

As we have seen with the current dominant ecosystems, the Tech Barons do not sit still. Instead, they expand their ecosystems to other products and services, and when they do they acquire, copy, or kill off rivals in that space. Consider the complaints about Apple displacing popular apps in its app store with its own apps.

The foundation models can improve to the point that they can handle more tasks without significant customization.¹¹⁴ So the foundation layer merges with that particular application layer. Thus, the Tech Barons will likely expand their presence over time in the application layer, adding other

¹¹³ Ilya Sutskever, OpenAI's chief scientist and co-founder's comments in interview, see James Vincent (n 47).

¹¹⁴ CMA Report at 46.

services and products to their ecosystem. In doing so, the Barons' incentives change: now instead of supplying AI technology to an app (say Duolingo) they might compete with their own language app.

Suppose Apple and Google develop their own AI app stores, where the app developers rely on Apple's or Google's foundation model. The Tech Baron here would not only control the AI App Store but the underlying foundation model. Thus, the Baron can deliver many more powerful punches:

- it can kick the third-party app out of its app store (or make it harder for consumers to find it);
- it can cut the offending app off from its model (or degrade its performance by not allowing the API to access the proprietary, more advanced foundation models);
- it can deprive the developer access to critical inputs, such as its own cloud computing service or data sets (to prevent the developer from building its own foundation model); or
- it can otherwise degrade the performance of the third-party app (such as greater latency in responding to end-users' requests).

Suppose Google kicked an AI app out of its ecosystem. The app developer could turn to a rival ecosystem, such as Apple or perhaps Microsoft. But the AI app developer could not disrupt those two ecosystems or their value chain. Moreover, the rival ecosystems may want to expand into that product or service (say develop their own language app) and similarly refuse the developer access to their foundation model and app store.

Thus, as Elon Musk's complaint against OpenAI recounts, the non-profit was created as an alternative to Google in the race for AGI:

In 2014, it was already difficult enough to compete with Google in its core businesses. Google had collected a uniquely large set of data from our searches, our emails, and nearly every book in our libraries. Nevertheless, up to this point, everyone had the potential to compete with Google through superior human intelligence and hard work. AGI would

*make competition nearly impossible.*¹¹⁵

Consequently, as is the case today, there will likely be little, if any, space for AI developers seeking to disrupt the Tech Barons' hegemony with innovations that threaten the Barons' power or their ecosystems' underlying value chain. Instead, they must avoid the elephant's path, and seek to disrupt products and services far afield from the Tech Barons.

IV. COUNTERVAILING FACTORS

The anticompetitive effects addressed above are not preordained. First, the foundation model supply chain, while emerging, may evolve into something else. Second, even if the foundation model supply chain takes hold, there can be several checks on the accretion of power.

One factor will be the continued importance of the inputs for the foundation model. Research by OpenAI, among others, have found, power scaling laws that “increasing model parameters, dataset size and compute with transformers and cross-entropy loss increases the model performance.”¹¹⁶ But to reach optimal scaling in the future, one might not require, for example, the breadth and volume of data.¹¹⁷ Moreover, the availability of computational resources may increase, while computing costs may decline. With some predicting open-source models to continue and improve,¹¹⁸ the cost of computing and the cost of doing business will likely decrease. This openness can lower costs and barriers to expansion and entry, and in doing so level the playing field.¹¹⁹

¹¹⁵ Compl. ¶ 22, filed in Musk v. Altman, Civ. Act. No. CGC-24-612746 (Sup. Ct. Cal. filed Feb. 29, 2024).

¹¹⁶ <https://medium.com/mllearning-ai/everything-you-need-to-know-about-scaling-laws-in-deep-learning-f4e1e559208e>.

¹¹⁷ CMA Report at 11 & 32 (noting several publicly available data sets and the use of synthetic data to pre-train, fine-tune, and test models). The CMA also heard that there may be diminishing returns from the publicly available datasets and “[p]roprietary data may become increasingly important” in developing foundational models. CMA Report at 28-29.

¹¹⁸ Jon Victor, ‘Open-Source AI Is Gaining on Google and ChatGPT’ (*The Information*, 15 May 2023) <www.theinformation.com/articles/open-source-ai-is-gaining-on-google-and-chatgpt> accessed 19 January 2023.

¹¹⁹ International Finance Corporation, World Bank Group, ‘The Role of Artificial Intelligence in Supporting Development in Emerging Markets’ (2019) <<https://openknowledge.worldbank.org/server/api/core/bitstreams/1a1fb8aa-3f48-5d75->

Another factor will be the proliferation and scale of other foundation models advanced around the world. Notable in the West¹²⁰ will be other key AI platforms, such as Stable Diffusion, which describes itself as the “world’s leading open source generative AI company” that delivers “breakthrough, open-access AI models with minimal resource requirements in imaging, language, code and audio.”¹²¹ Europe’s Mistral AI (which includes Microsoft as an investor) is seeking to develop a quasi-open-source foundation model.¹²² According to the company, its foundation model costed about \$22 million to train, and performs similarly to OpenAI’s and Google’s models, which cost far more to train (between \$50 and \$100 million for OpenAI).¹²³ The extent to which developers can easily switch among foundation model platforms can potentially dampen the anticompetitive effects.

Third, and related to the proliferation of foundation models, is the unprecedented level of corporate investment in the technology. Billions of dollars have been invested by venture capitalists and leading corporations in developing a range of foundation models. The battle to win the AI race incentivizes unprecedented investments, including Microsoft’s reported investment of over \$13 billion in OpenAI,¹²⁴ Google’s investment of over \$2 billion, and Amazon’s investment of \$4 billion in Anthropic,¹²⁵ Microsoft,

96da-4e2f6d77638e/content> accessed 11 January 2024.

¹²⁰ Several other key players also operate in the East. Note, for example, the prominent: Baidu, Ernie Bot (2023) <https://yiyian.baidu.com/> accessed 23 January 2023.

¹²¹ StabilityAI, StableDiffusion (2023) <<https://stability.ai/>> accessed 23 January 2024.

¹²² Sam Schechner, Microsoft-Backed AI Startup Challenges Technology Giants, Wall St. J., Feb. 27, 2024, at B1, B4 (noting that Mistral’s most advanced foundation models were not available as open source).

¹²³ Ibid.

¹²⁴ Jordan Novet, ‘Microsoft’s \$13 billion bet on OpenAI carries huge potential along with plenty of uncertainty’ (CNBC, 8 April 2023) <<https://www.cnbc.com/2023/04/08/microsofts-complex-bet-on-openai-brings-potential-and-uncertainty.html>> accessed 11 January 2024.

¹²⁵ Q.ai Contributor Group, ‘Google Invests In Anthropic For \$2 Billion As AI Race Heats Up’ (Forbes, 31 October 2023) <www.forbes.com/sites/qai/2023/10/31/google-invests-in-anthropic-for-2-billion-as-ai-race-heats-up/> accessed 19 January 2024; The Associated Press, ‘Amazon is investing up to \$4 billion in AI startup Anthropic in growing tech battle’ (Associated Press News, 25 September 2023) <<https://apnews.com/article/artificial-intelligence-amazon-anthropic-investment-72d21e6c663d506dbf968f50628e7ded>> accessed 19 January 2024.

Nvidia, and others' investment of over \$1.3 billion in Inflection AI,¹²⁶ and Elon Musk's race to raise \$1 billion in investment in the startup "xAI."¹²⁷ The growth in investments in foundation models is all the more impressive in light of the slowdown experienced by other sectors.¹²⁸

Fourth is the openness (even if limited at times) and accessibility of the foundation models and the ability to use these models to disrupt both *within* and outside the foundation model's ecosystem. A notable aspect of several commercial providers of generative AI has been their effort to make the technology accessible to others. AI systems, cloud computing, and open-source repositories have offered opportunities for growth for those who would otherwise have no, or limited, access to the technology.

Fifth is the potential commoditization of foundation models. As of early 2024 the emphasis is in building and training the foundation models. Thereafter, developers using their data can *fine-tune* the foundation model for their particular applications, and for *inferences*, when the model is asked to process new information and respond.¹²⁹ In 2023 to early 2024, 40% of Nvidia's data center business was for the deployment of AI systems, and not training.¹³⁰ But going forward, in the fine-tuning stage, developers may not require Nvidia's accelerator chips, and might be able to rely on less powerful

¹²⁶ Govind Choudhary, 'Startup Inflection AI secures \$1.3 billion funding from Nvidia and others' (Mint, 30 June 2023) <www.livemint.com/companies/startup-inflection-ai-secures-1-3-billion-funding-from-nvidia-and-others-11688100672381.html#:~:text=AI%20startup%20Inflection%20AI%2C%20co.investors%20including%20Microsoft%20and%20Nvidia> accessed 19 January 2024.

¹²⁷ Mark Sweney, 'Elon Musk's AI startup seeks to raise \$1bn in equity' (*The Guardian*, 6 December 2023), <<https://www.theguardian.com/technology/2023/dec/06/elon-musk-xai-startup-seeks-to-raise-1bn-in-equity>> accessed 11 January 2024.

¹²⁸ Gené Teare, 'Global Startup Funding In 2023 Clocks In At Lowest Level In 5 Years' (*Crunchbase News*, 4 January 2024) <<https://news.crunchbase.com/venture/global-funding-data-analysis-ai-coy-2023/#AI%20leads>> accessed 19 January 2024; CB Insights, 'Funding of artificial intelligence (AI) startup companies worldwide from 2020 to 2023, by quarter (in billion U.S. dollars)' (*Statista*, 15 November 2023) <www.statista.com/statistics/1344128/worldwide-artificial-intelligence-startup-company-funding-by-quarter/> accessed 12 January 2024; Nestor Maslej et al., 'The AI Index 2023 Annual Report', AI Index Steering Committee, Institute for Human-Centered AI (2023) 11 <<https://aiindex.stanford.edu/report/>> accessed 19 January 2024.

¹²⁹ Asa Fitch, Nvidia's Rivals See Shifting AI Market as a Boon, *Wall St. J.*, Feb. 26, 2024, at A1.

¹³⁰ *Ibid.*

and expensive chips.¹³¹ Microsoft, Meta, Google and Amazon have also been developing their own inference chips.¹³² So, one issue will be the relative importance of the foundation model versus the fine-tuning and inference stages.

Sixth, and related to the above, is the democratization effect of the technology. Foundation models and generative AI can lower barriers to entry and enable new entities to enter markets and provide services where they could not have done so before. The technology promises to reduce costs associated with generating and editing content. It can enable reliance on less data to execute tasks, lower data collection costs, lower investment costs, reduce the need for human input, and support further automation.¹³³ It can also assist in faster and more efficient software development, by improving code quality and generating new codes, and in doing so opening the software development market to new players.¹³⁴

These competition and innovation dynamics have been used by some to argue against antitrust intervention and call for limited regulations on AI systems.¹³⁵ After all, in a fast-moving innovation market, intervention could easily miss the mark and chill, rather than promote competition. Competition dynamics, it is argued, could offer a superior outcome and ensure the effective evolution of the technology and markets.

¹³¹ Ibid.

¹³² Ibid.

¹³³ Annie Brown, 'Utilizing AI And Big Data To Reduce Costs And Increase Profits In Departments Across An Organization' (*Forbes*, 13 April 2021) <www.forbes.com/sites/anniebrown/2021/04/13/utilizing-ai-and-big-data-to-reduce-costs-and-increase-profits-in-departments-across-an-organization/> accessed 12 January 2024.

¹³⁴ Kevin Pocock, 'Chat GPT can write code in Java, HTML, Python, and more!' (*PC Guide*, 18 December 2023) www.pcguides.com/apps/chat-gpt-can-write-code/ accessed 22 January 2024.

¹³⁵ See for example: Billy Perrigo, 'Exclusive: OpenAI Lobbied the E.U. to Water Down AI Regulation' (*TIME Magazine*, 20 June 2023) <<https://time.com/6288245/openai-eu-lobbying-ai-act/>> accessed 12 January 2024.; Also note lobbying directed at limiting regulation of 'general purpose' AI systems in the upstream market, and focus on regulation of companies deploying the technology, rather the originators of the technology. See: Natasha Lomas, 'Report details how Big Tech is leaning on EU not to regulate general purpose AIs' (*Tech Crunch*, 23 February 2023) <<https://techcrunch.com/2023/02/23/eu-ai-act-lobbying-report/?guccounter=1>> accessed 19 January 2024.

CONCLUSION

We have seen over the past two decades many digital markets tip to one or two powerful firms. We have also seen how these powerful firms expanded their ecosystems. Positive feedback loops, the control over a wide user base, extraction of personal data, and anti-competitive practices have enabled a few corporations to entrench their power and affect the dynamics of competition and innovation. Digital markets, while dynamic in many ways, have proven to not easily self-correct once markets tip in favor of these Tech Barons. Overall, experience shows that the digital economy gravitates toward concentrated economic power, which often translates to political power.

The emerging AI foundation model supply chain can disrupt these dominant ecosystems. But, as with the digital economy generally, a few firms could use the positive feedback loops, to ensure that more developers rely on their foundation models thereby strengthening their ecosystems. Indeed, in controlling the leading foundation models, the next wave of Tech Barons can have even more power: not only will they control the leading AI app stores, but they will also control the underlying AI technology, data inputs, data storage, and hardware design. The risks are immensely greater: biases, flaws, and vulnerabilities in these foundation models can ripple across society.

So, while the Biden administration has stepped up antitrust enforcement considerably against the Big Tech Barons, the antitrust enforcement has not appreciably increased contestability in many digital markets. Antitrust enforcement in the U.S. remains unwieldy, with costly, time-consuming litigation under the Supreme Court's rule of reason legal standard. To put it bluntly, antitrust failed to curb the excesses of the Big Tech Barons, and we are paying the result.

Now, we are at another critical juncture: the AI foundation model supply chain can potentially tip to where a few powerful firms can again chill competition and innovation. But that is not preordained. Again, the issue is whether antitrust enforcement can prevent this result.

In recent years, several jurisdictions have upgraded their antitrust and regulatory tools for the digital economy. Notable is the European Union with

its Digital Market Act, Digital Services Act, Data Act, and forthcoming AI Act.

So, what needs to be done? We, along with many others, are exploring avenues that would enhance the effectiveness of competition law and related regulation and align the market participants' incentives with wider societal goals. Broadly speaking:

- (i) Multiple tools are necessary to ensure a healthy trajectory of markets (including competition, privacy, consumer protection, and IP laws).
- (ii) At the *competition law* level, for antitrust to be more effective, the agencies and courts must better understand the power of ecosystems (as opposed to the power of particular platforms), including their power to distort innovation paths. Ecosystem power differs from traditional notions of market power. Consequently, agencies and courts must focus on possible abuse of ecosystem power aimed at entrenchment, through leveraging, tying and exclusionary practices (even when the market is not yet concentrated). Structural separation may need to be explored more often in the current state of AI supply chains.
- (iii) Consideration of the scope of competition law,¹³⁶ as well as the use of external regulatory benchmarks to inform competition decision making, would be of value.¹³⁷ This is particularly so since intervention will undoubtedly dictate trade-offs between efficiency and economies of scale and scope, and the need to safeguard the evolution of AI markets and ensure their contestability.
- (iv) At the *regulatory level*, the current design and scope of the EU's Digital Markets Act and Digital Services Act offer some, yet incomplete relief, to the concerns raised by foundation models. The forthcoming AI Act could supplement the regulatory structure when dealing with risk associated with foundation models but does not directly address the problem of entrenchment and increased concentration. Changes may be required to increase the relevance

¹³⁶ European Commission, 'A Dynamic and Workable Effects-Based Approach to Abuse of Dominance' *Competition Policy Brief* (March 2023).

¹³⁷ Case C-252/21 Meta Platforms v Bundeskartellamt ECLI:EU:C:2023:537.

of regulatory tools to address the AI supply chain. In that respect, ex-ante regulation could play an important role in aligning private corporate behavior with public interests, albeit any intervention is likely to be challenged by entrenched interests. When considering the dense EU regulatory landscape, it is important to note that the wider EU regulatory framework, concerning data, privacy, and political stability, may generate inconsistent effects with respect to the AI supply chain.¹³⁸

- (v) Possible changes to regulatory tools would need to take account of the overall burden on undertakings, the possible externalities between jurisdictions, the interconnections between trade policies and competition law, and the possible impact on foreign direct investments.
- (vi) *Enforcement capacity* – at both regulatory and competition levels need to increase to match the level of business activity. Global cooperation and alignment are integral and necessary to ensure effective outcomes. No jurisdiction can shoulder the regulatory framework.
- (vii) *Support policies* should be used to instill growth and innovation in AI. The EU has a role to play in creating the conditions and infrastructure for EU innovation and disruption. Financial grants, tax breaks, loans, guarantees, and capital investments can play an important role in increasing the competitiveness of AI supply chain. Policies should facilitate technology transfers, commercialize innovations, facilitate access to input, and strengthen available human capital. These efforts should be guided by the “Value, Incentives, and Diversity” principles which we explored elsewhere.¹³⁹
- (viii) Finally, competition is not an elixir. We have already seen companies racing to release foundation models, even though the models suffer from biases, hallucinations, and other quality

¹³⁸ See Proposal for a Regulation of the European Parliament and of the Council on the transparency and targeting of political advertising - Offer letter sent to the Chair of the European Parliament’s Committee on Internal Market and Consumer Protection, Interinstitutional File 2021/0381(COD), 17037/23 [in the following: RTPA (agreed text)] (20 December 2023).

¹³⁹ Ariel Ezrachi and Maurice E. Stucke *How Big-Tech Barons Smash Innovation—and How to Strike Back* (2022, HarperCollins) Chapter 11

problems. Competition can pressure firms to release faster foundation models that can undertake even more services without mitigating the models' potential risks. Encouraging this toxic competition can cause even greater harm to society. Enforcement, through competition law or regulation, should be mindful of the nature and quality of rivalry and innovation it fosters: namely, we want to promote a race to the top and not to a potentially horrific bottom.

Failure to move swiftly at the substantive and enforcement levels may leave us with a repeat of past policy shortcomings. AI will only magnify the current legislative and policy deficits. And the results, as the AI experts and public predict, can harm our well-being, autonomy, and democracy.