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Competition Policy Brief

Competition in Generative AI and Virtual Worlds

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Introduction

Generative artificial intelligence (AI) refers to neural networks that can generate high-quality text, images, and other forms of content based on the data they were trained on. Differently from traditional AI, generative AI models can process inputs to produce new content by predicting the likelihood of data typically appearing together.[1]

Virtual worlds are persistent, immersive environments, based on technologies including 3D and extended reality (XR), which make it possible to blend physical and digital worlds in real-time, for a variety of purposes such as designing, making simulations, collaborating, learning, socialising, carrying out transactions or providing entertainment.[2]

These technologies are redefining the way we all interact, work and consume content and are widely presumed to enhance automation and improve productivity. It is also expected that together, generative AI and virtual worlds will create immersive and intelligent interactions, which will have an impact on many sectors, among others manufacturing, retail, finance, education, energy and healthcare. The unprecedented and fast transformation these technologies are likely to bring raises many questions, including in relation to competition policy and enforcement.

DG Competition is deeply committed to understanding how these transformative technologies will reshape the EU´s economy and potentially improve productivity and competitiveness and is keen to ensure that citizens, small and large businesses can enjoy the benefits that competitive generative AI and virtual worlds markets can bring, in terms of price, choice, innovation and quality. With that goal in mind, the Commission launched two calls for contributions on competition in virtual worlds and generative AI, open from

In a nutshell

Generative AI and virtual worlds technologies are set to have a profound impact on many industries. While they will bring many positive changes, they could also give rise to competition concerns.

Some of these concerns may arise in connection with key inputs to these technologies, such as data, AI accelerator chips, computing infrastructure, cloud capacity and technical expertise. Others may relate to the deployment and distribution of these technologies.

The European Commission remains alert to potential anticompetitive practices and is committed to keeping these sectors competitive and contestable via antitrust, merger control and the DMA.

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[1] See Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending (Artificial Intelligence Act) OJ L, 2024/1689, 12 July 2024, recitals 99 and 105; European Commission's Living Guidelines on the Responsible Use of Generative AI in Research, ERA Forum Stakeholders' document, available at https://research-and-innovation.ec.europa.eu/document/download/2b6cf7e5-36ac-41cb-aab5-0d32050143dc_en?filename=ec_rtd_ai-guidelines.pdf, p. 3. See also G7 Competition Authorities and Policymakers' Summit Digital Competition Communiqué, 8 November 2023, available at https://www.bundeskartellamt.de/SharedDocs/Publikation/EN/Others/G7_2023_Communique.pdf?__blob=publicationFile&v=2.

[2] See Commission Staff Working Document, An EU initiative on Web 4.0 and virtual worlds: a head start in the next technological transition, available at https://digital-strategy.ec.europa.eu/en/library/staff-working-document-information-insights-and-market-trends-web-40-and-virtual-worlds, pp. 3 and 87.

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9 January to 11 March 2024.[3] Interested stakeholders were invited to share their experience and provide feedback on competition in these sectors and their insights on how competition law can help ensure that these sectors remain competitive. DG Competition received around 120 contributions on generative AI. Most of the contributions came from companies or business representatives. The remaining contributions were submitted by academics, policy groups, competition authorities and regulators, civil society, other government representatives and law firms. On virtual worlds, DG Competition received just over 50 submissions from businesses, academia, national competition authorities, regulatory bodies, associations, and citizens.

As a follow-up to the calls for contributions, DG Competition organised a workshop on 28 June 2024, which brought together different perspectives emerging from the contributions and facilitated exchanges and the sharing of insights on the complexities of competition dynamics within virtual worlds and generative AI as well as the challenges, opportunities, and regulatory implications arising from the evolving landscape of these digital innovations.[4] The workshop featured three panel discussions, each addressing key themes and issues pertinent to competition in virtual worlds and generative AI. The panel discussions are available on the YouTube channel of DG Competition.

As regards generative AI, DG Competition has also engaged in a thorough analysis of several investments and partnerships between large digital players and generative AI developers, both from the merger control and the antitrust viewpoint, including by sending requests for information to relevant players.[5] It also sent requests for information to better understand whether agreements between large digital players and original equipment manufacturers (OEMs) for the pre-installation of AI foundation models on new devices may raise anticompetitive concerns.

This policy brief is based on the responses to the calls for contributions on competition in virtual worlds and generative AI, the follow-up workshop, and, in relation to generative AI, also on interviews with key stakeholders and parallel market investigations. It has benefitted from fruitful collaboration and exchange with other competition authorities engaged in the analysis of these issues around the world, including the French, Hungarian, Portuguese, and the UK competition authorities, as well as the US Federal Trade Commission.

While the role of competition enforcement in preserving competitive generative AI and virtual worlds markets is clearly important, it should be noted that the way in which market dynamics and competition will unfold in relation to these technologies is susceptible to be affected by many other factors, including regulation on policy aspects different from competition, such as, for instance, AI safety, data and copyright law. Some of these aspects are discussed below in the section on *Other factors promoting competition in generative AI related markets*.

Generative AI

Market dynamics and potential barriers to entry and expansion

This policy brief focuses on competition dynamics and potential concerns in generative AI related markets. It does not discuss AI as an enforcement tool or AI as a possible tool to facilitate anticompetitive conduct in other markets, as in the context, for instance, of algorithmic collusion.

The generative AI sector, which encompasses several markets at the upstream and downstream levels of the provision of generative AI models,[6] is currently described by players and stakeholders as very dynamic, with a rich R&D activity and many players of different sizes along the supply chain of AI foundation model development and deployment.

The responses to the call for contributions and the on-going market investigations identified some market tendencies, which will shape generative AI related markets in the future, as well as several potential bottlenecks, i.e. parts of the generative AI production or supply chain that can be more vulnerable to anticompetitive practices and negatively affect the overall well-functioning, performance, and efficiency of generative AI related markets. These bottlenecks may be due to resource constraints, technological barriers (such as a lack of interoperability) or market access issues, which may reduce the presence of active competitors. Depending on the context, some of these bottlenecks may qualify as barriers to entry and expansion or lead to an anticompetitive practice.

[3] See DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI, 9 January 2024, available at https://competition-policy.ec.europa.eu/about/europes-digital-future_en and https://competition-policy.ec.europa.eu/system/files/2024-01/20240109_call-for-contributions_virtual-worlds_and_generative-AI.pdf.

[4] See DG COMP's Workshop on Competition in Virtual Worlds and Generative AI, 28 June 2024, available at https://competition-policy.ec.europa.eu/about/reaching-out/virtual-worlds-and-generative-ai_en.

[5] See DG COMP's Press Release of 9 January 2024, IP/24/85, Commission launches calls for contributions on competition in virtual worlds and generative AI, available at https://ec.europa.eu/commission/presscorner/detail/en/IP_24_85.

[6] Based on the feedback from the call for contributions and other information collected, for the purpose of this policy paper, the generative AI sector should be understood as the value chain of generative AI models, which may indicatively include, among others, and without prejudice to the market definition assessment performed in concrete cases, the following markets: chips manufacturing, provision of cloud infrastructure, data licensing, supply of specific types of AI workforce, the supply of productivity software, supply of specific chatbot services, supply of specific mobile phone digital assistant services, etc.

Market tendencies

There are several emerging tendencies characterising generative AI related markets that seem to be prevailing at the time of writing and may be relevant from a competition perspective:[7]

Tendency towards vertical integration or establishing partnerships to access input resources

The first noticeable tendency in this sector is linked to the presence of established vertically integrated players, typically offering, in addition to proprietary AI foundation models, also cloud or data centre services at the upstream level, and AI systems and applications to customers and final consumers at the downstream level. This is the case, for example, of Google, Amazon and Microsoft. These players combine large financial resources with access to inputs that are key for offering AI services and the direct knowledge of ongoing customers' needs, for example, in terms of IT services, privacy needs, data storage requirements or fine-tuning demands.[8]

Innovative small AI foundation model developers also often choose to secure privileged access to cloud computing power by establishing partnerships with existing digital players.[9] These partnerships are aimed at providing them with access to these important inputs. From the competition viewpoint, this may be beneficial when it allows smaller and more innovative players to enter and grow in the market by securing access to important inputs. It may, however, also raise concerns in relation to risks of concentration of key inputs in the hands of few players and creation of dependencies between players, which may lead to foreclosure issues and have negative impacts on competition for consumers.

Tendency towards vertical integration or establishing partnerships to access distribution channels

Linked to the above, often, partnerships also offer AI foundation model developers a more direct access to customers and consumers via, for example, integration of the AI foundation model functionality into an established product of a larger digital player, or more targeted access to customers or consumers. From the competition viewpoint, this may be efficient if it gives smaller players wider outreach and direct access to the distribution network of the larger players. It may also, however, raise concerns in relation to the risks of abuse of dominance by established large players aiming at foreclosing competitors, for instance, through control over distribution channels for generative AI applications or services. A similar approach may also be the rationale for mergers and acquisitions leading to the integration of players into an ecosystem.[10]

Tendency towards more efficient, smaller models

Another important tendency that is likely to shape the generative AI sector in the coming years is the race to produce smaller AI foundation models that can efficiently run on mobile devices such as tablets and smartphones, locally and without internet connection (i.e. offline). This tendency promises to be transformative for the industry because, if confirmed, it would mark the beginning of a parallel tendency to the so far strongly predominant principle of 'scaling laws' which characterises the industry, according to which the performance of an AI foundation model is a function of the model size (which depends on the number of parameters or "weights" of the model) and pre-training dataset. Due to the importance of economies of scale and scope in this sector, it has been considered until recently that only AI foundation model developers with a critical mass can effectively recoup initial investments and be competitive in the market.[11]

Running smaller and more efficient AI foundation models on mobile devices is becoming a commercial reality,[12] with varying levels of performance and integration depending on the

[7] See responses to Questions 9 and 10 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI, 9 January 2024, available at https://competition-policy.ec.europa.eu/about/europes-digital-future_en.

[8] See on this point also French competition authority, Opinion 24-A-05 on the competitive functioning of the generative artificial intelligence sector, 28 June 2024, available at https://www.autoritedelaconcurrence.fr/en/opinion/competitive-functioning-generative-artificial-intelligence-sector, para. 220; the Portuguese competition authority, Issues Paper on competition and generative AI, 6 November 2023, available at https://www.concorrencia.pt/sites/default/files/documentos/Issues%20Paper%20-%20Competition%20and%20Generative%20Artificial%20Intelligence.pdf, pp. 16 and 25; and the UK CMA's Update Report on AI Foundation Models, 11 April 2024, available at https://assets.publishing.service.gov.uk/media/6617ef792b2963dfa2d1ea6d/Update_Paper.pdf, p. 8.

[9] Examples include, for instance, OpenAI exclusive computing partnership with Microsoft to build new Azure AI supercomputing technologies, https://news.microsoft.com/2019/07/22/openai-forms-exclusive-computing-partnership-with-microsoft-to-build-new-azure-ai-supercomputing-technologies/; Amazon and Anthropic strategic collaboration to advance generative AI, https://www.aboutamazon.com/news/company-news/amazon-aws-anthropic-ai; Microsoft and Mistral AI partnership to accelerate AI innovation and introduce Mistral Large first on Azure, https://azure.microsoft.com/en-us/blog/microsoft-and-mistral-ai-announce-new-partnership-to-accelerate-ai-innovation-and-introduce-mistral-large-first-on-azure/.

[10] According to the European Commission's Notice on the definition of the relevant market for the purposes of Union competition law, 8 February 2024, C(2023) 6789 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=PI_COM:C(2023)6789&qid=1726475579651, p. 40, "*(Digital) ecosystems can, in certain circumstances, be thought of as consisting of a primary core product and several secondary (digital) products whose consumption is connected to the core product, for instance, by technological links or interoperability*".

[11] See also the French Opinion 24-A-05, fn. 8, p. 63; the Portuguese Issues Paper, fn. 8, pp. 16 and 25; and the UK CMA's Update Report, fn. 8, p. 8. See also Azeem Azhar, Substack, AI's USD 100 billion question: the scaling ceiling, 13 July 2024, available at https://www.exponentialview.co/p/can-scaling-scale?utm_source=substack&utm_medium=email.

[12] See, for instance, the agreement between Samsung Galaxy and Google Cloud to deploy Google's Gemini Pro and Imagen 2 on Vertex AI via the cloud to the Samsung Galaxy S24 Series, Press Release, Samsung, 18 January 2024, Samsung and Google Cloud Join Forces to Bring Generative AI to Samsung Galaxy S24 Series, https://news.samsung.com/global/samsung-and-google-cloud-join-forces-to-bring-generative-ai-to-samsung-galaxy-s24-series.

characteristics of the hardware. Such development may bring significant improvements in terms of speed, privacy and data protection, but may also raise concerns linked to exclusivity agreements and default pre-installation of specific foundation models on popular device brands.

Tendency towards the parallel development of open source and proprietary models

A further tendency that is emerging is the development of AI foundation models that present varying degrees of openness. This includes (i) fully open models (where access to the source code and training weights and data is provided); (ii) partially open models (where access to model-trained weights is provided but not to the source code); (iii) closed source models (accessible via APIs, i.e. access is given to the output but not to the source code); and (iv) fully closed (where no access to source code, weights or output is provided).

Some players focus on open-source models (such as Meta with Llama), while others (such as Mistral AI, Open AI or Google) develop both an open-source and a proprietary version of their models. This has a significant impact on the market dynamics, potentially reducing the barriers to entry in some of the generative AI related markets and promoting innovation and choice.

Potential barriers to entry in generative AI related markets

The consultation and the on-going market investigations revealed that the key components for the development and deployment of generative AI systems include data, AI accelerator chips, computing infrastructure, cloud capacity and technical expertise.[13] As mentioned above, depending on the economic context, each of these may qualify as a potential barrier to entry or expansion,[14] or potentially lead to an anticompetitive practice.

First, in relation to data, the necessity of very large, high-quality datasets for pre-training, the preparatory phase of the AI foundation model, may represent a bottleneck. Accessing such data appears very costly and availability seems limited. According to the consultation, several factors are contributing to this. One factor is that, despite successful pre-training experience on public data, navigating the uncertainty on the application of copyright laws and the need for new, specialized datasets may pose challenges in the future. Another factor is the costs of data licensing agreements between large players and the right holders of high-quality online content, such as publishers and news outlets, which are at the moment high enough to pose a significant barrier to entry in the AI foundation model developing sector, in particular for startups, unless they benefit from substantial funding by large digital platforms. Finally, while useful, it is also generally considered that synthetic data (i.e. artificial data generated by large language models) cannot be a complete substitute for high-quality real-world data. The more the datasets are complete, accurate, relevant, and unique, the more they are considered valuable.[15]

Second, the cost and scarcity of the specialised chips supporting AI neural networks, such as GPUs, TPUs and other AI accelerators, may also represent an important bottleneck. Waiting times for buying an H100 chip (used for AI applications) from the biggest manufacturer at present (Nvidia), for example, were nearly 12 months at end of 2023. This waiting time is now reduced to 3-4 months, but costs remain quite high (reported to be up to 30 or 40 thousand US dollars per unit, and possibly more for the faster GB200 NVL72),[16] especially if one considers that thousands of GPUs are required to train and operate AI foundation models.[17]

Computing capacity, in the form of large clusters of chips, can be made available in the form of physical data centres or on the cloud (or a mix of these two options). Despite the availability of many compute power providers, costs remain very high also for cloud capacity, which also consume a very substantial amount of energy. Several partnerships concluded in this industry have precisely the objective of providing promising startups with compute capacity at cost in exchange for access to the startups' AI technology and intellectual property. For instance, press reports describe partnerships between Microsoft and OpenAI, Microsoft and Mistral AI, as well as Amazon and Anthropic as concluded for this purpose.[18] Some companies are also racing to strategically secure access to renewable energy to meet the

[13] See responses to Question 1 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3). See also French Opinion 24-A-05, fn. 8, paras. 122 and ss.; the Portuguese Issues Paper, fn. 8, pp. 14 and ss.; and the UK CMA's Update Report, fn. 8, p. 6-7.

[14] See responses to Questions 2 and 3 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

[15] See responses to Questions 1 and 7 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

[16] Anton Shilov, Nvidia's next-gen Blackwell AI Superchips could cost up to $70,000 — fully-equipped server racks reportedly range up to $3,000,000 or more, *Tom's Hardware*, 14 May 2024, available at https://www.tomshardware.com/pc-components/gpus/nvidias-next-gen-blackwell-ai-gpus-to-cost-up-to-dollar70000-fully-equipped-servers-range-up-to-dollar3000000-report.

[17] Anton Shilov, Nvidia's H100 AI GPU shortages ease as lead times drop from up to four months to 8-12 weeks, *Tom's Hardware*, 10 April 2024, available at https://www.tomshardware.com/pc-components/gpus/nvidias-h100-ai-gpu-shortages-ease-as-lead-times-drop-from-up-to-four-months-to-8-12-weeks; Anton Shilov, Wait times for Nvidia's AI GPUs ease to three to four months, suggesting peak in near-term growth — the wait list for an H100 was previously eleven months, *Tom's Hardware*, 16 February 2024, available at https://www.tomshardware.com/tech-industry/artificial-intelligence/wait-times-for-nvidias-ai-gpus-eases-to-three-to-four-months-suggesting-peak-in-near-term-growth-the-wait-list-for-an-h100-was-previously-eleven-months-ubs; Anton Shilov, Nvidia's H100 AI GPUs cost up to four times more than AMD's competing MI300X — AMD's chips cost $10 to $15K apiece; Nvidia's H100 has peaked beyond $40,000: Report, *Tom's Hardware*, 2 February 2024, available at https://www.tomshardware.com/tech-industry/artificial-intelligence/nvidias-h100-ai-gpus-cost-up-to-four-times-more-than-amds-competing-mi300x-amds-chips-cost-dollar10-to-dollar15k-apiece-nvidias-h100-has-peaked-beyond-dollar40000.

[18] See above fn. 9.

growing energy needs of data centres, which are needed for the operation of AI applications. This is the case, for instance, of the Microsoft and Brookfield agreement for more than 10.5 gigawatts (reported to be almost eight times larger than the largest power purchase agreement ever signed by a company).[19]

Third, a recurring issue is also the difficulty of finding highly skilled labour in generative AI. While startups may have the ability to offer equity shares to attract talent, some respondents noted the difficulties of competing with the salaries and conditions offered by large players, especially US-based. The consultation did not highlight a widespread use of non-compete clauses restricting the mobility of AI engineers to other jobs and the market for the acquisition of AI talent seems to be dynamic at this stage. It highlighted, however, a general scarcity of highly qualified experts in the AI field. The intense fight to procure this precious input may thus lead to "acqui-hires", i.e. transactions whereby a player acquires all or almost all the key employees of the target company, such as in the recent case of Microsoft and Inflection where almost all of Inflection´s employees, in addition to the chief executive of AI, were hired by Microsoft together with a non-exclusive license.[20] It may also lead to attempts to foreclose competitors by making it difficult to secure talent needed to establish oneself or grow in the industry.

Other potential barriers to entry and expansion

The generative AI sector also seems to present other barriers to entry and expansion. Some of these are characteristic of digital markets in general, such as economies of scale and scope, and the presence of ecosystems of large players which may facilitate the penetration of neighbouring markets.

Other characteristics are quite different and mark a substantial difference in the analysis of the anticompetitive risks potentially arising in generative AI related markets. For instance, the fact that there are, at least at present, very high marginal costs attached to the actual operation of the model (e.g. answering a prompt), alongside the high initial fixed ones for the pre-training of the foundation model which strongly favour large players.

According to respondents and interviewees, some uncertainty remains around how powerful data feedback loops and network effects will be and whether they will constitute barriers to entry and be associated with anticompetitive concerns as has been the case in the past in relation to some digital markets.

While data cannot be continuously fed into a model after the pre-training phase to perfect it, due to the costs and time required to pre-train a model, it still seems possible for AI models and applications to significantly benefit from feedback data loops, particularly in multimodal AI foundation models. Feedback data loops can, for instance, occur in the deployment phase, when the model continues its learning from the interaction with the user (e.g. correction or precision of the prompts, forms of feedback, etc.) or from the data uploaded by the users for further elaboration (e.g. requests for translation of an uploaded pdf file).

As data feedback loops may in turn reinforce network effects, the latter may be significant because the models with the largest user base are more likely to provide accurate answers and, in turn, attract more users.[21] This may be the case, for example, for AI applications with plug-ins which facilitate access to different services, because the higher the number of plug-ins, the more attractive that specific AI interface will become. Such effects may also appear or be boosted when generative AI applications are integrated into larger digital ecosystems of other products and services, thanks to data integration, seamless user experience and fewer interoperability issues (see further on generative AI ecosystems below in the section on *Ecosystems dynamics in the generative AI industry*). [22] Important network effects may therefore end up constituting barriers to entry for new rivals and contribute to the creation or the strengthening of market power in these markets.

Barriers to entry may also affect neighbouring markets, which may then indirectly also harm competition in generative AI markets. For instance, switching cloud service providers seems to remain challenging, due to pricing strategies, such as cloud credits and committed spend discounts, the lack of interoperability and data portability, and various software licensing practices, which may lead to customers' lock-in.[23] DG Competition has come across similar allegations in its on-going investigations in the cloud sector.

Competition enforcement in generative AI related markets – A reference framework

Competition authorities have an important role in preserving competition in generative AI related markets, both at the upstream and the downstream level, and in preserving choice and innovation for consumers in a pivotal sector for the future of the European economy.

[19] Brookfield Press Release, Brookfield and Microsoft Collaborating to Deliver Over 10.5 GW of New Renewable Power Capacity Globally, 1 May 2024, available at https://bep.brookfield.com/press-releases/bep/brookfield-and-microsoft-collaborating-deliver-over-105-gw-new-renewable-power.

[20] Tabby Kinder, Microsoft hires DeepMind co-founder Mustafa Suleyman to run new consumer AI unit, *Financial Times*, 19 March 2024, https://www.ft.com/content/5feedf3a-ff7a-4c89-9b1d-f9b48834ff4c.

[21] See also French Opinion 24-A-05, fn. 8, p. 63; and the Portuguese Issues Paper, fn. 8, p. 40; and the UK CMA's Update Report, fn. 8, pp. 20-21.

[22] See also French Opinion 24-A-05, fn. 8, p. 58 and ss.; the Portuguese Issues Paper, fn. 8, pp. 16 and 25; and the UK CMA's Update Report, fn. 8, p. 20.

[23] See, for instance, French Competition Authority, Opinion 23-A-08 of 29 June 2023 on competition in the cloud sector, available at https://www.autoritedelaconcurrence.fr/en/opinion/competition-cloud-sector, and Competition and Markets Authority, working papers in the cloud services market investigation, published on 23 May 2024, available at https://www.gov.uk/cma-cases/cloud-services-market-investigation#working-papers.

The primary focus of competition authorities has been to ensure that conduct and transactions by generative AI players remain compliant with competition law. DG Competition has been vigilant to catch early on any potential anticompetitive issues that could emerge in these markets, both from the antitrust and, where appropriate, the merger control viewpoint.

As regards antitrust enforcement in generative AI, and in light of the market tendencies and emerging risks highlighted above, DG Competition is looking into possible vertical or other concerns relating to the investments and partnerships between large digital players and generative AI developers.

It is also looking into whether agreements between Google and OEMs (such as Samsung) for the pre-installation of Google's small AI model "Gemini Nano" on mobile devices may raise anticompetitive concerns by making it more difficult for other foundation models to be accessed or pre-installed on those devices.

DG Competition is also monitoring from the merger control viewpoint investments and partnerships between large digital players and generative AI developers, including the one involving Microsoft and OpenAI. While it was preliminarily concluded that, even following the firing and re-hiring of the CEO of OpenAI and the granting of an observatory seat for Microsoft on the OpenAI board in November 2023, Microsoft did not acquire control of OpenAI on a lasting basis, DG Competition is keeping this and other partnerships under close scrutiny.

DG Competition also monitors whether transfers of highly skilled employees between two undertakings (sometimes via acqui-hires), like the hiring by Microsoft of most of the employees of Inflection, are subject to scrutiny under EU merger rules. While it is for the parties to a transaction to assess whether their agreements need to be notified for merger control, they may approach the Commission with a consultation in case of doubt.

In the case of Microsoft and Inflection, based on information provided to the Commission by these companies, the Commission considers that the transaction involves all assets necessary to transfer Inflection's position in the markets for generative AI foundation models and for AI chatbots to Microsoft.[24] Taking further into account that Inflection itself announced on 19 March 2024 that the "new Inflection" would shift its focus to its AI studio business,[25] the Commission regards the agreements entered into between Microsoft and Inflection as a structural change in the market that amounts to a concentration as defined under Article 3 of the EUMR.

To the extent that such concentrations do not meet the turnover thresholds under the EU Merger Regulation, the Commission will work together with Member States and the parties to assess whether they will be reviewed under national merger control regimes or referred to the European Commission in line with the legal requirements for such referrals as clarified in the recent *Illumina* judgment of the European Court of Justice.[26]

The following sections provide a non-exhaustive list of possible avenues that may be adopted, depending on the circumstances, for framing the analysis of potential anticompetitive issues that may arise in generative AI related markets (upstream and downstream), within the current EU competition law framework.[27]

Possible relevant market definitions and useful criteria for the identification of market shares

Whilst defining relevant markets is an exercise that can only be conducted in the context of a full-fledged competition investigation, the information gathered by DG Competition so far suggests that the following elements could be starting hypotheses for the purpose of relevant market definition in investigations in the AI sector.

It may be useful to distinguish between the upstream and the downstream levels. The relevant markets ***upstream*** may typically be those for the purchase by the AI developer of the necessary inputs. Examples would include the possible market for the purchase of high-quality data for pre-training, the possible market for the purchase of cloud capacity from cloud services providers, the possible market for the purchase of data centre services, or the possible market for attracting AI engineering talent. Depending on the specific case, and for each of these markets, there can of course be further segmentation and product differentiation, for instance, in relation to data for general purpose pre-training and specialised datasets for a specific domain in the form of model-as-a-service; in relation to generalist cloud compute and specialised cloud services; in relation to the type of skillset of the concerned employees; or in relation to different types of AI accelerators (such as GPUs, TPUs, or others).

The relevant markets ***downstream*** could typically be markets for the sale or supply of generative AI foundation model services. Further segmentation and product differentiation may include a distinction, for instance, between consumer-facing and business models, cloud-based and on-device models, general purpose and specific purpose models, or unimodal and multimodal models. At this level, given the nascent state of the industry, where many AI foundation models are yet to be fully monetised[28] and therefore revenue streams are not necessarily a proxy of market power,

[24] See DG COMP's Press Release of 18 September 2024, IP/24/4727, Commission takes note of the withdrawal of referral requests by Member States concerning the acquisition of certain assets of Inflection by Microsoft, available at https://ec.europa.eu/commission/presscorner/detail/en/ip_24_4727.

[25] See Inflection's Press Release, The new Inflection: an important change to how we'll work, 19 March 2024, https://inflection.ai/the-new-inflection.

[26] Joined cases C-611/22 P and C-625/22 P, *Illumina v. Commission and Grail v. Commission*, 3 September 2024, EU:C:2024:677.

[27] See responses to Question 11 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

[28] See responses to Question 5 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

alternative metrics for the assessment of market shares may have to be considered. At present, these could include, for instance, the following:

(1) The activity volume, such as the average number of users, the number of interactions or of tokens (units of data) processed, which would suggest the frequency of use of a given AI foundation model;
(2) The costs and power of the processing capacity used for inferencing[29] (as one of the possible proxies of quality of performance of the models);
(3) The number of purchases or downloads of the model (or downloads of the original model and number of models derived from the original one for the open-source ones);
(4) Other specific deployment parameters (such as the number of calls to one's APIs).

Because of their importance in generative AI related markets, market definition may also need to take into account network effects and ecosystem dynamics. As noted in the European Commission's revised Market Definition Notice in relation to digital ecosystems,[30] the presence of network effects, switching costs and customers' lock-in, and single- or multi-homing might have to be part of the analysis (see further below the section on Ecosystems dynamics in the generative AI industry).

Possible theories of harm

Based on the responses to the call for contributions and on-going market investigations, some potential anticompetitive concerns that may materialise in generative AI related markets in the future were raised.

DG Competition will therefore remain vigilant, particularly (but not exclusively) in relation to following five possible types of competition risks in these markets:[31]

(1) The risk that incumbent large digital players, which may currently enjoy preferential access to generative AI's key components, grant it to third parties on an exclusive basis, or prevent competitors from accessing it. This may affect access to any of the key inputs described above, including computing infrastructure (such as GPUs, supercomputing power, and cloud capacity), data or talent. One example would be that of a large digital player reserving exclusive access to its AI computing infrastructure to a specific player or providing preferential access to a certain player and access at worse conditions to all other players. Another example would be that of a large vertical buyer[32] or a dominant player entering into an exclusive licensing agreement to secure high-quality data content from one specialised upstream source, should this prevent other players from pre-training or fine-tuning a model in that specific domain. A further example would be a dominant integrated player active both in cloud and at the level of generative AI development refusing to give access to its cloud infrastructure to competitors with the effect of foreclosing those competitors. Another example would be a dominant generative AI player with deep pockets engaging in acqui-hires or predatory hiring of talent, with the effect of foreclosing competitors by hiring their AI key staff. This practice may lead *de facto* to the dissolution of an active or of a potential competitor by absorbing the expert talent in its entirety or near-entirety, thus leading to a loss of choice or innovation or the reduction of competitive constraints downstream.[33]
(2) The risk that large players offering generative AI foundation models may use their market power to limit choice or distort competition in downstream markets, when distributing and commercialising AI applications. This can take the form, for instance, of exclusivity clauses or leveraging behaviour, including self-preferencing, refusal to supply, tying or bundling, non-compete and lock-in strategies.[34] One example would be one where a large player would offer its own AI foundation model on its marketplace alongside other models and would put in place conditions that lead to offer a preferential display of its AI foundation model, while demoting the display of the competitors' ones. Another example could involve the tying of a distinct digital product, such as, for instance a search engine, to an AI foundation model owned by the same digital player, thus forcing consumers to acquire or use both products.[35]
(3) The risk that agreements between horizontal competitors may reduce competitive constraints between such players or enable unlawful exchange of commercially sensitive information.
(4) The risk that vertically integrated players may adopt pricing policies for the purpose of margin squeezing other players.
(5) The risk of killer or reverse killer acquisitions, that is acquisitions aimed at eliminating nascent competition in generative AI related markets to protect the acquirer's

[29] Inferencing is typically the process of using a trained generative AI model to generate output, for instance, making predictions or answering prompts based on the data it has been fed during the pre-training phase.
[30] European Commission's Notice on the definition of the relevant market, fn. 10, p. 40.
[31] See responses to Question 4 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).
[32] For an analysis of vertical foreclosure, see also Commission Regulation (EU) 2022/720 of 10 May 2022 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of vertical agreements and concerted practices (VBER) and the Guidelines on vertical restraints, OJ C 248, 30 June 2022, p. 1–85.
[33] Depending on the concrete assessment, this conduct may be relevant under merger control or antitrust scrutiny.
[34] For companies offering online intermediation services, see VBER and Vertical Guidelines, fn. 32 above.
[35] Some of these theories of harm have already been applied in other digital markets (for instance, self-preferencing in *Google Shopping* and exclusivity - in the form of anti-fragmentation - and tying in *Google Android*) and they are likely to be a suitable reference also in the generative AI domain.

position in those markets, which may harm choice and innovation in the longer term at that level of the supply chain.

Further, it may be noted that investments in small AI developers by large companies are seen by the industry as important for developing and distributing AI systems, securing necessary capital, accessing intellectual property, and gaining technological insights. When not granting exclusivity rights, these partnerships can be pro-competitive. However, in some circumstances, they may create the conditions for the concentration of key inputs in the hands of few players, for foreclosure strategies or for other distortions of competition, warranting monitoring by competition authorities to maintain a level playing field.[36] This means that they may undergo merger control or antitrust scrutiny.

Ecosystems dynamics in the generative AI industry

Given the connections between different products and services in the AI production and supply stack and the way in which dominance in a generative AI related market may have an impact on several other markets, a holistic view of ecosystem dynamics in the generative AI industry may be particularly relevant as a way to better capture market realities.

The existence of dynamics within an ecosystem played an important role, for example, in the recent DG Competition prohibition decision of the *Booking/eTraveli* merger.[37] The case took into account, among other things, the importance of considering the specific features and effects of ecosystem dynamics, of network effects, as well as of behavioural biases, such as defaulting, customer inertia or single-homing.[38] These features have also been analysed in other transactions, such as *Meta/Kustomer*,[39] and in abuse of dominance cases like *Google Android*.[40] The attention to these issues is dictated by the nature of competitive dynamics in the technology space.

Some of these factors may be relevant (and likely to be applied) also in the analysis of the competitive dynamics in generative AI related markets.[41]

As mentioned above in the section on *Possible relevant market definitions and useful criteria for the identification of market shares*, if an ecosystem approach is considered appropriate in a specific case, it may also have to be reflected in the way in which the relevant market is defined and market shares are accounted for. This is because the assessment of market shares in a specific relevant market, depending on the specific circumstances of the case, may not be, alone, fully informative of the actual competitive position of the analysed player.

As recommended by the Market Definition Notice in relation to digital markets, it may also be important to consider supply and demand-side issues, like network effects or the capacity to multi-home of users, to better understand market dynamics.[42]

Furthermore, while not all generative AI players are structured as a platform, the experience relating to multi-sided market definition may be of relevance in those cases where generative AI players opt for a business model that charges only one side of the market, for instance, by selling advertising, while offering some AI functionalities or services to final users for free (e.g. chatbots or search engines).

Potential efficiency gains to be considered

Since generative AI development and deployment are characterised by their technological innovation, due consideration should be given to concrete efficiency gains that may arise from practices or agreements between undertakings in the generative AI sector, under the framework of both Article 101 and 102 TFEU. Specifically, regarding partnerships, examples of potential efficiency gains may include:

(1) combining complementary skills and assets of the involved players, which may result in the issuing of a better or new product or technology that would not otherwise come to light;
(2) disseminating technological expertise across the market, which may lead to further innovation; and
(3) reducing costs or dependencies when supply of a specific input is limited, which may increase supply and strengthen the internal market.[43]

Specific types of agreements may also fall under Article 101(3) block exemptions.[44] Relevant efficiencies that benefit consumers

[36] See also the French Opinion 24-A-05, fn. 8, paras. 290 ss. and the UK CMA's Initial Report on AI Foundation Models, available at https://www.gov.uk/government/publications/ai-foundation-models-initial-report, reviewed by an Update Report, fn. 8, pp. 17-18 and Figure 5.

[37] European Commission, M.10615, *Booking Holdings / eTraveli Group*, Decision of 25 September 2023, pp. 199 and ss.

[38] Ibid., pp. 118 and ss.

[39] European Commission, M. 10262, *Meta (formerly Facebook) / Kustomer*, Decision of 27 January 2022, pp. 110 and ss. See also European Commission's Competition Merger Brief, *Adobe/Figma: Much Ado(be) About Nothing?*, 2/2024, forthcoming at https://competition-policy.ec.europa.eu/publications/competition-policy-briefs_en#merger-brief.

[40] Case T-604/18, *Google and Alphabet v Commission*, 14 September 2022, EU:T:2022:541, para. 116.

[41] See also See also French Opinion 24-A-05, fn. 8, para. 128; the Portuguese Issues Paper, fn. 8, p. 33 and ss.; and the UK CMA's Update Report, fn. 8, p. 16.

[42] European Commission's Notice on the definition of the relevant market, fn. 10, p. 40.

[43] European Commission's Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, C(2023) 3445 final, p. 39.

[44] See, for R&D agreements, Commission Regulation (EU) 2023/1066 of 1 June 2023 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to certain categories of research and development agreements; for specialisation agreements, Commission Regulation (EU) 2023/1067 of 1 June 2023 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to certain categories of specialisation agreements; for technology transfer licensing, Commission Regulation (EU) No 316/2014 of 21 March 2014 on the application of Article 101(3) of the

also need to be considered in the context of mergers in the AI sector.

Generative AI related markets and the DMA

DG Competition sees the role of competition law enforcement in generative AI related markets and the implementation of the DMA as complementary, and equally important tools at its disposal. The objective of the DMA is to ensure contestable and fair markets in the digital sector where gatekeepers are present. It achieves these objectives by ordering designated gatekeepers to comply with specific obligations in relation to a predefined list of core platform services.

There are two main ways in which the DMA will be relevant for generative AI services. First, a generative AI player may offer a core platform service and meet the gatekeeper requirements of the DMA. Second, generative AI powered functionalities may be integrated or embedded in existing designated core platform services and therefore be covered by the DMA obligations. Those obligations apply in principle to the entire core platform service as designated, including features that rely on generative AI. For these purposes, DG Competition will continue to reassess the situation as the services evolve, as services that do not fall under the DMA currently may well do so in the future because of the integration of AI powered services into core platform services.

The DMA will not however cover all competition concerns related to generative AI services, in particular for non-designated companies and for conduct which goes beyond the scope of the DMA.

Competition advocacy and other pro-competitive initiatives in generative AI related markets

Competition authorities' activities

As the generative AI sector is nascent, efforts have been made by many competition authorities to better understand the competitive dynamics of generative AI related markets also conducting market studies and issuing reports.[45] As noted in the Introduction, DG Competition published for this purpose on 9 January 2024 two calls for contributions on competition and generative AI and held a workshop on 28 June 2024 to provide an overview of the results.[46] It also sent a series of requests for information to several players in the generative AI sector to gain a better understanding of the market dynamics.

In cooperation with the US Department of Justice (DoJ), US Federal Trade Commission (FTC), and UK Competition and Markets Authority (CMA), the European Commission also issued on 23 July 2024 a joint statement on competition in generative AI related markets, aimed at signalling the agencies' common readiness to prevent anticompetitive practices in this sector, raising awareness among customers and consumers about possible anticompetitive infringements they may witness, and clarifying their expectations of market behaviour by relevant players.[47] The European Commission also contributes its input in discussions and meetings at the G7, promoting a level playing field for the development of AI markets.

Other factors promoting competition in generative AI related markets

There are several factors that can be considered important to reduce potential barriers to entry or limit their effects, as well as directly or indirectly promoting competition in generative AI related markets. Some examples include:

(1) The presence of open-source models, which can promote choice and innovation in the sector and lower barriers to entry.[48]
(2) The availability of freely or easily accessible high-quality databases, which can support the pre-training phase for the development of different AI foundation models and can also promote wider offerings.
(3) The availability of freely accessible public supercomputers to researchers and stakeholders.
(4) The availability and mobility of AI talent.
(5) The ability of customers and consumers to switch and multi-home across different cloud or AI foundation model providers, potentially reducing the impact of network effects and making it easier for rival players to penetrate the market.
(6) The presence and dissemination of differentiated AI foundation models, for instance specialised ones for specific sectors or functions. This may largely depend on access to specific datasets, and in turn on the regulatory frameworks applicable to the licensing of such data, as well as the market price of such data.
(7) The presence of pro-competitive non-exclusive partnerships between generative AI developers and players with access to important inputs or access to consumers, enabling smaller or

Treaty on the Functioning of the European Union to categories of technology transfer agreements (TTBER); and for vertical agreements, Commission Regulation (EU) 2022/720 of 10 May 2022 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of vertical agreements and concerted practices (VBER).

[45] See, for instance, in the European Union, the French Opinion 24-A-05, fn. 8; the Hungarian competition authority's market analysis on the impact of AI on market competition and consumer behaviour (launched on 4 January 2024) available at https://www.gvh.hu/en/press_room/press_releases/press-releases-2024/gvh-launches-market-analysis-on-the-impact-of-artificial-intelligence and the Portuguese Issues Paper, fn. 8. See also, outside of the European Union, the UK CMA's Initial Report on AI Foundation Models, fn. 36 reviewed by an Update Report, fn. 8; and the US FTC's market inquiry into the investments and partnerships being formed between AI developers and major cloud service providers available at https://www.ftc.gov/news-events/news/press-releases/2024/01/ftc-launches-inquiry-generative-ai-investments-partnerships.

[46] The video recording of the workshop is available at the YouTube channel of DG Competition.

[47] Joint Statement on Competition in Generative AI Foundation Models and AI Products, 23 July 2024.

[48] See responses to Question 6 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

more innovative players to establish themselves on the market.

(8) Some well-targeted interoperability standards across different AI foundation models and across different level of the generative AI supply stack, which do not decrease incentives to invest but that allow customers of one AI foundation model, for instance, to interact upstream with different cloud providers and downstream with different generative AI system deployers or users.[49]

Public policy activities relating to these factors may therefore contribute to ensuring competitive generative AI related markets.

For instance, public authorities might engage in initiatives to promote open-source models and, when appropriate and necessary, interoperability standards, and to strengthen, wherever possible, the factors that limit or reduce barriers to entry to these markets.

Furthermore, the European Union, represented by the European Commission, is already investing significant resources to make public supercomputers accessible in several Member States. The European High Performance Computing Joint Undertaking (EuroHPC) is a government-industry collaboration aimed at developing and adopting the most innovative and competitive supercomputing systems in Europe, as well as expanding their access to European users, including SMEs and startups. So far, it successfully deployed eight supercomputers in different EU Member States, whilst a ninth exascale supercomputer (Jupiter) is currently under construction in Germany.[50] The accessibility of such public supercomputers enables innovation, by making the pre-training and the fine-tuning of foundation models accessible to a wider set of stakeholders.[51]

As part of its AI innovation package of January 2024, the European Commission launched several additional activities, including financial support to generative AI projects through, for instance, Horizon Europe and the Digital Europe programme, as well as support to education, training, skilling and re-skilling activities to strengthen the pool of generative AI talent European companies can draw from. Competition authorities may, for instance, ensure that companies do not agree on illegal no-poaching or no-hire of AI engineers or other key employees or promote Governments' initiatives to limit excessively long or unjustified non-compete agreements that may prevent them from moving to other jobs. Policies aimed at fostering education and re-skilling of workers in the AI domain may also be helpful to make AI talent as widely available to companies as possible.

Further, in the European Union, legislation has been adopted enabling free access to text and data mining while protecting copyright holders. The provision contained in Article 3 of the EU's Copyright Directive contains an exception to EU copyright law for text and data mining for scientific purposes and, while other exceptions may be implemented for text and data mining, Article 4(3) allows rightsholders to reserve the use of works where appropriate.[52] Another example is the Data Act, which will potentially facilitate switching, data portability and interoperability between cloud providers and other data processing services at no cost.[53]

The AI Act itself, while not directly focusing on competition, ensures that all providers of general-purpose AI models operating in the EU comply with copyright and related laws, in order '*to ensure a level playing field [...] where no provider should be able to gain a competitive advantage in the Union market by applying lower copyright standards than those provided in the Union.*'[54]

Finally, as mentioned above, the DMA allows prohibiting *ex ante* instances of potentially problematic conduct relating to the integration of generative AI services into other digital products by gatekeepers, as well as monitoring any potentially problematic acquisitions on the basis of Article 14 of the DMA.[55]

Virtual Worlds

Market dynamics and emerging tendencies

The virtual worlds industry features diverse players with distinct strategies, who invest in a variety of intertwined technologies and services. Stakeholders confirm that from a conceptual point of view, these can be grouped in three layers: enabling technologies, virtual worlds platforms and specific services.[56]

Enabling technologies power virtual worlds through a combination of hardware and software technologies, providing the infrastructure and the input and output devices that can support immersive experiences and interactions. Large digital players, such as Meta, Apple, Sony or Microsoft have invested in hardware technologies such as virtual reality headsets. High-

[49] See responses to Question 8 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

[50] See, for more information, https://digital-strategy.ec.europa.eu/en/policies/high-performance-computing-joint-undertaking; https://eurohpc-ju.europa.eu/index_en.

[51] See also the French Opinion 24-A-05, fn. 8, p. 52.

[52] See Articles 3 and 4(3) of Directive (EU) 2019/790 of the European Parliament and of the Council of 17 April 2019 on copyright and related rights in the Digital Single Market and amending Directives 96/9/EC and 2001/29/EC, OJ L 130, 17 May 2019, pp. 92–125.

[53] Articles 23 and ss. of Regulation (EU) 2023/2854 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act), OJ L, 2023/2854, 22 December 2023.

[54] See recital 106 of Regulation (EU) 2024/1689 of the European Parliament and of the Council of 13 June 2024 laying down harmonised rules on artificial intelligence and amending (Artificial Intelligence Act) OJ L, 2024/1689, 12 July 2024, available at http://data.europa.eu/eli/reg/2024/1689/oj.

[55] See responses to Question 12 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

[56] See responses to Questions 2 and 3 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

speed networks, cloud computing, chips, relevant intellectual property, AI and data are also key enabling factors, access to which can play a crucial role for vibrant competition in the virtual worlds sector.

A dynamic area within enabling technologies is the so-called "digital twins" technology, where several players, such as Bosch, Dassault Systèmes, General Electric, IBM, Microsoft, SAP and others are active. Digital twins are virtual models of physical objects or systems, such as an engine, factory or even entire supply chain. They can, for instance, be used for training purposes but also to predict and prevent points of failure or bottlenecks on the factory floor or within the supply chain. They have reportedly already led to improvements, e.g. in aircraft manufacturing and maintenance and in healthcare for enhancing patient care and medical training. With regard to digital twins and B2B applications in general, stakeholders see significant opportunities for the European industry, including SMEs, and highlight that an overall competitive environment and, in particular, access to live data and computing power, are essential to realise the full potential of this technology.

Virtual worlds platforms on which virtual worlds are developed and accessed are currently taking shape and it is not yet possible to define them clearly. Virtual worlds platforms can be distinguished between platforms in the B2C sector, such as gaming or virtual social spaces like Meta Horizon, and the B2B sector, such as work environment platforms or industrial virtual worlds like Nvidia's Omniverse. There are also virtual worlds maintained by public actors such as cities or public authorities.

Virtual worlds platforms have a number of specificities that set them apart from other platforms. They stand out due to their immersive and dynamic nature, compared to two-dimensional, often static platforms, such as an online marketplace or a news aggregator. They are persistent and continuous, allowing users to enter and exit, similarly to a permanent location in the physical world. They typically offer multiple ways of perception, sensing and manipulation, compared to touchscreens or displays. Finally, virtual worlds platforms offer unique development tools and they cater to diverse applications.

Some stakeholders consider that operating systems and app stores, some of which are already subject to DMA obligations, should also be regarded as separate layers of the value chain (rather than part of the platform layer).

On the third layer – services – companies specialise in offering specific and tailored services to businesses and customers on top of virtual worlds platforms and within the virtual worlds environment. The potential for such services is vast. Common examples for such services currently include (i) virtual work in immersive, remote workspaces, (ii) medical services, allowing high precision, robot-assisted or remote surgeries, (iii) a variety of industrial services based on digital twins, (iv) e-commerce of virtual goods or the sale of physical goods, such as furniture and other design products, in virtual spaces that simulate what the product will look like in the buyer's home, as well as (v) education and training in virtual classrooms or "gamified" environments.

If an undertaking is active across multiple layers of the value chain, vertical integration may give rise to foreclosure concerns.[57] Large digital players that control key technologies, such as virtual reality headsets, cloud computing services, chips, or already existing platforms, could be in the position to dictate what the other elements of virtual worlds ecosystems will look like.

Examples of vertical integration raised by stakeholders include Meta, which through its vertical integration, has taken early prominence in the consumer-facing virtual worlds space. By combining leading hardware (virtual reality headsets), app stores and virtual content with data created in its social media platforms, Meta is in an advantageous position to drive user adoption and engagement. Apple is another prominent player following a strategy of vertical expansion. Its virtual and augmented reality headset utilises its own chip and operating system, integrating its virtual worlds offering into its existing hardware and applications ecosystem. Nvidia is leading specialised chip development for industrial virtual reality applications, building on its expertise in 3D gaming, and also offers its Omniverse solution to build digital twins. Similarly, Microsoft provides key underlying technologies and hardware for virtual worlds, including headsets, Azure cloud computing services and digital twins, and gained ground in AI innovation.

At the same time, vertical integration can also be pro-competitive, creating greater efficiencies, better quality, or lower costs for consumers. That said, the strong positions of a number of large digital players in key enabling technologies and platforms may warrant the attention of competition law enforcement so as to ensure that potential entrants are not excluded through either foreclosing access to key inputs for their own virtual worlds or acquisitions.

There are diverging views on whether virtual worlds should adopt open standards and different platforms seem to explore different options in that regard. Many stakeholders consider that without seamless interoperability, virtual identities (avatars), virtually purchased goods or digital twin models cannot be moved between competing platforms. However, proponents of proprietary ecosystems emphasise that private standards and closed ecosystems could also have benefits by offering better security and more tailored experiences. Striking the right balance is considered crucial, and the potential impact on innovation should be carefully assessed.

[57] See responses to Questions 2, 3 and 8 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

Potential barriers to entry and expansion

Stakeholders raise[58] that strong scale effects can increase entry barriers in virtual worlds markets. The costs of the necessary investment and innovation are very high in the sector. Large digital players may have more financial means should they decide to invest heavily in the underlying infrastructure, technology, content and talent. In contrast, European start-ups and SMEs often lack access to funding, which makes it difficult for them to scale up and match the offer of the established tech companies.

Network effects, especially of platform-based services that connect a large number of users with service providers (e.g. multiplayer gaming or social media platforms that are transitioning into immersive virtual worlds), play a crucial role in driving user adoption and engagement within virtual worlds and they can make it difficult for new entrants to gain foothold: as more users join a platform, its value increases, attracting even more users. This draws service providers to the largest platforms, while small platforms may struggle to attract enough services, especially if proprietary development toolkits and standards make deployment for multiple platforms too costly. While this phenomenon may be more prominent in B2C platforms, its relevance should not be dismissed for B2B platforms either.

Customer lock-in can increase switching costs, if users have already invested money and time into a platform. Potential restrictions on switching, e.g. because of limited interoperability, cost of portability, exclusivity agreements or other factors that may result in customers' losing assets, such as digital twin models, can deter them from trying out new platforms.

Established digital platforms collect vast amounts of user data, which they use to improve services and target advertising.[59] Virtual worlds platforms will likely not be different, particularly because the personalisation of the immersive experience will heavily rely on data relating to user behaviour and interactions. Without fair access to this data, new entrants could be disadvantaged. Moreover, potential data portability restrictions could contribute to increasing switching costs and lock-in effects, strengthening existing positions of platforms and foreclosure of rivals by limiting their capacity to attract users. In that context, stakeholders point out that user ownership of their own data is critical.

Potential competition concerns

Some stakeholders argue in the call for contributions that it would be too early to make assumptions about possible competition concerns in virtual worlds markets and that the EU already has the right tools to address any issues that may arise. Several contributors, however, point at a number of already existing risks.

Rising concentration and cross-ownership in the video games sector could lead to the risk of existing market power in video game ecosystems potentially translating into market power in virtual worlds. Similar risks could arise in relation to vertically integrated players, where market power on critical inputs – being technology and infrastructure such as headsets or cloud, but also platforms such as app stores or social media – could be transferred into virtual worlds markets.

Consolidation of market power by a few dominant platforms could lead to gatekeeping behaviours, which could restrict entry and competition. Dominant platforms could also engage in exclusionary practices, limiting consumer choice, thereby stifling innovation. The competitive advantage afforded by the use of data for personalised virtual experiences could further entrench the market position of established players, especially if they limit data portability or their competitors' access to such data sets. In this context, several contributors raise the need to extend the scope of the DMA and reduce its thresholds.

Contributors also flag the risk of aggressive acquisition strategies. These can allow financially sound, leading tech companies to absorb innovative startups, diminishing the vibrancy and diversity of the ecosystem and eliminating potential challengers or innovative technologies that could be disruptive to their existing models. Beyond such "killer acquisitions", some contributors also point out a risk of "kill zones": in certain segments, the presence of some ecosystems could discourage other undertakings from investing or competing. In these zones, startups and competitors are less likely to thrive due to the perceived risks or lack of opportunities, which can stifle investment and innovation and ultimately chill competition.

Potential other anticompetitive practices, such as exclusivity agreements (e.g. between platforms and IP rightsholders), unfair trading conditions (e.g. major platforms imposing their own standards), self-preferencing, tying and bundling, refusal to supply interoperability information, predatory pricing and margin squeeze may also arise in virtual worlds markets.

Conclusions and next steps

Generative AI and virtual worlds technologies will considerably impact and shape numerous markets in the coming years. The deployment of these technologies will undoubtedly bring significant positive changes, as well as innovation, new business models and new ways of doing things.

They may also, however, give rise to competition concerns that may threaten the well-functioning of markets and negatively affect innovation, choice and quality. These concerns may include exclusionary practices or other forms of foreclosure by dominant players, such as exclusivity agreements, imposition of unfair trading conditions, self-preferencing, tying and bundling, refusal

[58] See responses to Questions 1 and 5 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

[59] See responses to Questions 1, 7 and 8 of DG COMP's Calls for Contributions on Competition in Virtual Worlds and Generative AI (see above fn. 3).

to supply, margin squeeze or predatory pricing, reducing choice and innovation for consumers.

They may also consist of acquisition strategies aimed at eliminating nascent competitors (killer acquisitions) or absorbing most of their key employees (acqui-hires) and critical know-how. Incentives to invest and innovate may be further chilled by the presence of ecosystems, network effects and tipping dynamics in the so-called "kill zones" described above.[60]

A heightened risk of horizontal collusion or exchange of commercially sensitive information may also emerge, as well as wage-fixing and no-poach agreements between employers vis-à-vis key employees.

Given the magnitude and extent of the impacts of these technologies and the risks they might entail, DG Competition is actively monitoring the AI and virtual worlds sectors to ensure that competition is not negatively affected. As mentioned above, DG Competition is already analysing the investments and partnerships between large digital players and generative AI developers, as well as agreements for the pre-installation of generative AI models on the devices to ensure they do not raise anticompetitive concerns.

DG Competition is also monitoring partnerships between large digital players and AI developers from the merger control viewpoint.

As regards virtual worlds, DG Competition is closely monitoring how these nascent markets evolve, as virtual worlds are expected to transform traditional markets (such as manufacturing, education, software, gaming, media, etc.). This will also allow DG Competition to apply existing knowledge of these markets to their virtual extensions, building also on its experience on the evolution of digital markets.

DG Competition currently has also preliminary investigations ongoing into markets that are crucial for the development of generative AI and virtual worlds, like the markets for cloud or for different types of specialised chips (such as GPUs, TPUs and other AI accelerators).

As a follow up to the joint statement published with the US DoJ and FTC and the UK CMA,[61] and given the global nature of the business operations of AI players, the European Commission is also committed to strengthening the coordination at the level of the ECN, ICN and OECD in relation to enforcement in generative AI related markets. It is also fully engaged in G7 discussions on these issues, advancing the global dialogue on goals including the reduction of barriers to entry in AI development, sustaining diversity of AI business models, and fostering innovation.

DG Competition will use all tools at its disposal to address potential concerns in the generative AI and virtual worlds sectors, including antitrust, merger control and the DMA, to ensure that these sectors remain competitive, contestable and fair.

[60] See above the section on *Virtual Worlds* – Potential competition concerns.

[61] See above the section on Competition advocacy and other pro-competitive initiatives in generative AI related markets and fn. 47.