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Working Paper

Big Tech, the platform economy and the European digital markets

CFS Working Paper Series, No. 711

Provided in Cooperation with:

Center for Financial Studies (CFS), Goethe University Frankfurt

Suggested Citation: Brühl, Volker (2023) : Big Tech, the platform economy and the European digital markets, CFS Working Paper Series, No. 711, Goethe University Frankfurt, Center for Financial Studies (CFS), Frankfurt a. M., <https://nbn-resolving.de/urn:nbn:de:hebis:30:3-691406>

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No. 711

Volker Brühl

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Big Tech, the platform economy and the European digital markets

Volker Brühl¹

Abstract:

Digital platforms have become an important part of the digital economy by facilitating transactions between large numbers of users and by fostering innovation on collaborative platforms. In combination with technical platform services, some platform operators have managed to create powerful ecosystems that create network externalities and benefit from economies of scale and economies of scope. It is striking that, due to the specific economic drivers of the digital infrastructure, platform-based or platform-related services are dominated by a select number of global players. Most of the global platform operators are headquartered in the US, including Alphabet, Amazon, Apple, Meta and Microsoft, also known as the “Big 5”. Some are located in Asia (e.g. Alibaba, Tencent). In Europe there are only a limited number of platform operators with a small market share.

Much research has been conducted on the emergence and characteristics of platforms, network externalities and platform competition. However, there has been very little research on whether or not one can identify common features that might explain the success of Big Tech. The following article focuses on an analysis of the Big 5 based on their strategies and development paths. The comparison reveals certain commonalities, from which several conclusions can be drawn regarding the success factors of the Big 5. These insights could be helpful for business decision-makers when shaping digital strategies. But also policy makers, especially in Europe, could benefit from these lessons learned to improve the European technology ecosystem.

JEL L14, L22, L25

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1. Introduction

The digital economy has created new markets and business models such as social media and online shopping, but it has also revolutionised traditional sectors such as manufacturing, logistics or process industries. Smart industries are evolving by connecting the physical and virtual worlds. Smart factories, smart homes and smart mobility are just a few examples that reflect the accelerating transformation of our economy and society.

New technologies such as artificial intelligence, cloud technologies, distributed ledgers, big data and high performance computing are affecting more or less all industries to varying degrees. Furthermore, various forms of digital platforms have emerged, facilitating transactions between large numbers of users and offering technical platform services. A successful digital transformation is obviously crucial for the future competitiveness of individual companies, but also for countries and regions such as the EU to remain attractive for investment and talented people, thus ensuring economic prosperity in the digital age.

It is striking that, due to the specific economic drivers of the digital infrastructure, platform-based or platform-related services are dominated by a select number of global players. Most of the global platform operators are headquartered in the US, including Alphabet, Amazon, Apple, Meta and Microsoft, also known as the "Big 5". Some are located in Asia (e.g. Alibaba, Tencent). In Europe there are only a limited number of platform operators with a small market share.

Much research has been conducted on the emergence and characteristics of platforms, network externalities and platform competition. However, there has been very little research on whether or not one can identify common features that might explain the success of Big Tech. The following article focuses on an analysis of the Big 5 based on their strategies and development paths. The comparison reveals certain commonalities, from which several conclusions can be drawn regarding the success factors of the Big 5. These insights could be helpful for business decision-makers when shaping digital strategies. But also policy makers, especially in Europe, could benefit from the lessons learned from Big Tech to improve the European technology ecosystem and thus increase the chances of becoming the home base for the next Big Tech. It should be noted that, despite the plausibility of these findings, the hypotheses put forward in this article are preliminary and require further research to be validated.

2. Digital platforms and the platform economy

The digital age has given rise to various electronic platform-based business models. One can distinguish between traditional ("one-sided") e-commerce platforms, such as Amazon.com, which are essentially retail businesses that sell and distribute products and services through web stores rather than physical stores. In contrast to this "merchant model", two-sided platforms allow "affiliated" sellers to sell directly to "affiliated" buyers (e.g. Baldwin and Woodard 2009, Hagiu 2007, Rochet and Tirole 2003) or, in more general terms, multi-sided platforms (MSPs) facilitate direct interaction within or between multiple user groups (e.g. Abdelkafi et al. 2019, Evans and Schmalensee 2016, Verfaillie et al. 2021) which may result in transactions among users (e.g. Ebay) or the matching of users (e.g. online dating platforms). In contrast to conventional e-commerce platforms, the platform enables transactions between different users without being a contracting party itself.

They help to reduce transaction costs between users and between market participants, but can also foster innovation by facilitating collaboration or sharing common technological building blocks (e.g. Cusumano et al. 2019, Nambisan et al. 2018). Therefore, the platform economy describes the following phenomenon: due to the digital transformation of the economy, business models have emerged that focus on providing digital infrastructure and related services that allow many suppliers, customers or users to transact on the same platform (Verfaillie 2021, Evans and Gawer 2015, Goldfarb and Tucker 2019). One can distinguish several types of platforms that can be classified by the type of user relationships (B2B, B2C, C2C etc.), the business model (transacting, matching, sharing, innovating), or the sector in which they are primarily active (travel and tourism, pharmaceuticals, car sharing etc.).

MSPs often form the basis of rapidly scaling business models due to their flexibility, adaptability and low incremental transaction or matching costs (e.g. Verfaillie et al. 2021, McAfee and Brynjolfsson 2017, McIntyre and Srinivasan 2017). The success of platforms depends inter alia on their potential to create network effects among their users, which can be direct or indirect (e.g. Shapiro and Varian 1999, Shy 2001). Direct network effects arise when a given user's utility increases with the number of other users of the platform. Such effects can be observed, for example, in social media networks. Indirect network effects, or cross-side network effects, occur when the individual utility of a user depends on the increased usage of other market participants. Examples can be found in the market for credit cards, where the value of a given card for the user depends on the number of credit card terminals of companies accepting this payment method.

Scientific studies have identified strong network effects and an early market entry as common features of successful platforms. First or at least early movers can attract many users in a short period of time. Due to network externalities, platforms can grow at a high rate, creating high barriers to entry for new entrants. However, the design of the platform's technological architecture has to facilitate interconnectivity between users and easy integration of additional products and services (e.g. Verfaillie et al. 2021). On the other hand, empirical findings suggest that many platform initiatives fail, mainly due to mispricing on one side of the market, failure to develop trust with users and partners, prematurely dismissing the competition or entering the market too late (Yoffie et al.. 2019).

3. Platforms and the contestability of markets

A lot of research has been conducted on network externalities and platform competition (e.g. Armstrong 2006, Roche and Tirole 2003). Related research topics cover the impact of platforms on industrial structures, the contestability of markets and antitrust issues (e.g. Parker et al. 2020, Hagui and Wright 2015, Evans 2003).

The increasing relevance of platforms and their underlying economics create new challenges for competition policy and antitrust authorities. If platform-based networks become more attractive with each additional user, a self-reinforcing process can lead to higher adoption rates, which in turn creates additional incentives for new users to join the network. Depending on the industry and the type and size of network effects, markets may become highly concentrated, with only a few or even a single platform operator dominating the industry. Consequently, those markets become less contestable if potential competitors face high barriers to entry, as they have to cope with structural disadvantages compared to first or at least early movers in the market.

Furthermore, the characteristics of platforms, such as the fact that they often require subscription to specific technical services in order to use the platform, may pave the way for business practices that prevent fair and open competition. Detecting such unfair market practices is particularly challenging in the case of platform-based businesses, as they tend to offer a variety of services that are more or less technologically and/or economically interdependent. For example, search engines may offer e-mail accounts, online advertising services, customer relationship tools, translation or learning tools, or publishing services.

Abuse of a dominant market position can also take very different forms in digital markets. Examples of unfair market practices include the pre-installation of applications on digital devices, the bundling of ancillary services with core platform offerings, discriminatory pricing or the mandatory consent of third party users to data collection by platform operators. Such business practices, especially when applied by Big Tech, can prevent fair competition if they impede third party access to the platform's end users. High prices, limited consumer choice and reduced innovation are likely consequences.

The following examples of antitrust cases in the EU illustrate the spectrum and relevance of Big Tech's unfair market practices. Similar cases have been brought in the United States, for example. The cases described below are for illustrative purposes only and do not necessarily reflect the final outcome of the respective court decisions.

For instance, Google was sued in Europe in 2017 for abusing its dominant position as a search engine provider by granting an unfair advantage to another Google service (Google Shopping) by placing its own service ahead of other comparison services in search results. Other cases concern the alleged abuse of its online advertising service AdSense for Search (2018). Another example concerns the Android operating system, where Google required manufacturers of Android phones to pre-install certain Google applications.

Meta has been accused of abusing its dominant position in social networks by making the use of a service conditional on the user's consent to the collection and pooling of data from other subscribed services. Meta has also been accused on several occasions of violating data protection rules in both Europe and the US.

The list of legal claims against Microsoft (MS) for abusing its dominant market position in operating systems for PCs, laptops or tablets and office applications is similarly long. In 2013, for instance, the EU Commission imposed a fine on Microsoft for not offering Windows users the option of using web browsers other than the pre-installed Internet Explorer. Other claims related to the fact that MS did not publish the application programming interfaces (APIs) necessary to connect other services to MS programs.

An accusation levelled at Amazon is that it abuses its dual role as the world's largest online retailer and as an operator of a marketplace for third-party sellers. Other allegations include that Amazon favours platform sellers that use Amazon's logistics and distribution services.

Apple has also been the subject of antitrust proceedings in various regions. For example, the EU Commission is investigating a complaint by Spotify that Apple abuses its dominant position in the music streaming business. The complaint alleges that Apple charges high fees for access to its App Store, which significantly reduces the chances of successful market entry.

In response to Big Tech companies increasingly leveraging their financial and technological resources in related markets, the EU has put in place a new regulatory framework to ensure fair and open competition in digital markets. In particular, the regulations address the role of Big Tech companies as "gatekeepers" to their platforms.

4. The Digital Markets Act (DMA) and the Digital Services Act (DSA)

Preparing Europe for the digital age has been on the European agenda for some time. In 2020, the EU adopted the Digital Market Strategy to facilitate cross-border digital services and boost innovation activities in the EU. At the same time, digital data protection and privacy must be safeguarded and cybersecurity prioritised to protect critical infrastructure (European Commission 2023, European Commission 2022, European Commission 2021). Key elements include building high-speed digital infrastructure, improving people's digital skills, significantly increasing the number of IT professionals and accelerating the adoption of cloud computing, big data and AI, including for SMEs. The Digital Service Act (DSA) and the Digital Markets Act (DMA) are important elements of the Digital Strategy and the Digital Decade policy programme 2030 (European Commission 2023).

The DSA ((EU) 2022/2065), which came into force on 16 November 2022 and will apply in all EU countries from 17 February 2024, sets out clear rules and obligations for online platforms to ensure a safe, credible and reliable online environment and the functioning of online services. This includes procedures for the immediate removal of illegal content such as hate messages or fake news. The DSA covers intermediary services (e.g. internet service providers), hosting services (cloud computing, web hosting) and online platforms (e.g. marketplaces, app stores and social media platforms).

The Digital Markets Act (DMA) (COM(2020) 842 final) complements existing EU (and national) competition rules. It was adopted on 1 November 2022 and applies from 2 May 2023 to address the growing importance of platforms in certain digital markets. The DMA was introduced to protect Europe's digital markets from anti-competitive behaviour by "gatekeepers" that control access to key platforms. The DMA addresses platform-based business models and the potentially abusive business practices associated with them. The various antitrust cases brought by the European

Commission, but also in the US, provide ample evidence that a clear regulatory framework for and close supervision of such gatekeepers are essential to protect consumers from abuse of dominant market positions, while at the same time ensuring a level playing field for existing and potential competitors in Europe's digital markets. It is important to note that the DMA clearly defines a gatekeeper role in terms of services and company size, making the DMA primarily applicable to Big Tech companies. The DMA covers so-called core platform services, which can be exploited by their providers if they have a strong market position, such as:

- app stores
- online search engines
- social networks
- certain messaging services
- video sharing platforms
- virtual assistants
- web browsers
- cloud computing services
- operating systems
- online marketplaces
- advertising services.

Core platform services are often characterised by strong network effects, economies of scale and/or scope, lock-in effects, or a substantial degree of dependency of both business users and end users. Dominant providers of core platform services may abuse their strong market position and control of access to the platform through unfair practices such as bundling of products and services, control of APIs, data pooling or self-preferencing of products.

Many companies use tools to extensively track and profile users, and combine vertical services, such as authentication, payment or fulfilment services, which may form a network of interconnected services, so that the platform essentially controls not only the use of the platform itself, but also access to the platform's ecosystem. A gatekeeper position may result in companies providing services as part of an integrated ecosystem to which third parties do not have access or do not have equal access. This allows gatekeepers to extend their strong market position to other markets. Some operators even control an ecosystem of multiple platforms in the digital economy. This structural advantage makes it very difficult even for efficient and innovative new players to enter these markets successfully. As a result, the contestability of the markets is limited by high barriers to entry.

The DMA sets out criteria for the definition of "gatekeeper" companies, which have the potential to use their market power to prevent fair access to such platforms and thus to prevent fair competition between users of such platforms. Companies designated as gatekeepers are required to refrain from certain conduct that could jeopardise fair competition in such markets.

Companies providing one or more of these "core platform services" may qualify as gatekeepers in the EU if they meet all of the following requirements:

- **A size that impacts the internal market:** this is presumed to be the case if the company achieves an annual turnover in the EU of at least €7.5 billion in each of the last three financial years, or has an average market capitalisation or equivalent fair market value of at least €75 billion in the last financial year, and provides a core platform service in at least three Member States.;
- **The control of an important gateway for business users towards end consumers:** this is presumed to be the case if the company operates a core platform service with more than 45 million monthly active end users established or located in the EU and more than 10,000 yearly active business users established in the EU in the last financial year;
- **An entrenched and durable position:** this is presumed to be the case if the company met the second criterion in each of the last three financial years.

In order to ensure fair, open and innovative digital markets, gatekeepers must refrain from any practices that limit the contestability of the respective markets through unfair market practices based on the strong market position of the gatekeeper, thereby disadvantaging business users or end users compared to the services offered by the gatekeeper.

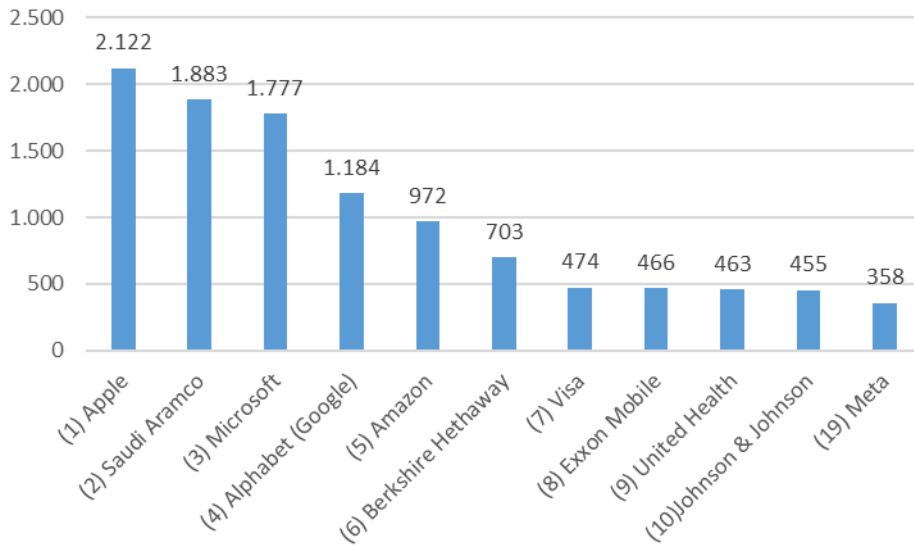
For instance, gatekeepers must not combine personal data obtained from their core platform services with personal data from other services offered by the gatekeeper. Gatekeepers are also prohibited from collecting data from business users if they compete with them on their own platform. In addition, gatekeepers must allow end users to easily uninstall pre-installed apps or change default settings on operating systems, virtual assistants or web browsers. They must also allow end users to install third-party apps or app stores that use or interoperate with the gatekeeper's operating system. It remains to be seen whether other jurisdictions will address platform-related antitrust issues under their existing competition laws, or whether they will follow the lead of the EU in establishing a gatekeeping role (e.g. Schweitzer 2021).

5. The Case of Big Tech – lessons learned

While the DMA will lay the foundations for fair competition in the EU, including against "gatekeeping" Big Tech, it is important to gain a better understanding of how and why today's Big Tech companies have managed to become digital champions, and what Europe could potentially learn to help the European corporate sector catch up and harness the emerging market potential in future digital markets. Otherwise, the risk remains that existing Big Tech will continue to diversify into new growth markets, leveraging its existing huge customer and user base in combination with immense financial resources. These insights may help to further shape the European digital strategy and provide the framework to bring about competitive European digital champions that would reduce dependence on American and Asian players in key technologies.

Many digital services markets are dominated by US or Chinese companies. This is reflected in the regularly published ranking of the world's largest companies by market capitalisation. The Big 5 are all in the top ten except for Meta, which is in 19th place (Figure 1). This is of course just one indicator among many, and it does not tell the full story, but it is striking that there are no European companies in the top ten, only two in the top 25 and no German companies in the top 50. Only one German company (SAP, 90th) makes it into the top 100. It can be argued that the ranking only covers listed companies and that this is only a snapshot in volatile markets, which is certainly true.

Figure 1: Largest companies by market cap in bn USD (13 January 2023)

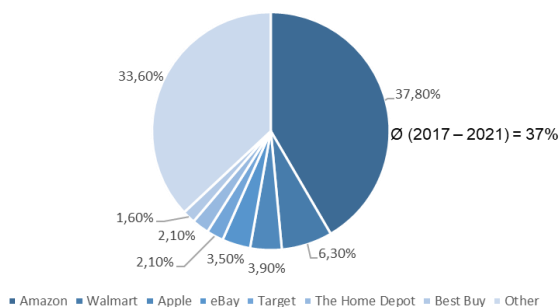


Source: <https://companiesmarketcap.com>

When we look at the Big 5, we see that all of them have more or less created and defined a new market with their products that hardly existed before. This is true of Amazon (e-commerce), Apple (smartphones, tablets), Microsoft (OS, Office), Meta (social media) and Alphabet (search engines). All of them have managed to keep a high market share in its core business until today which underlines high barriers to entry and a reduced contestability of the respective markets. In the following we take a look at recent market shares of the Big 5 and their development over time to the extent that the data is available.

More than 20 years after its founding, Amazon is still by far the largest e-commerce player with a market share of about 37% which has been quite stable over the past six years across all categories in the United States (Figure 2), followed by Walmart with a market share of about 6%, which is mainly focused on the US market. The picture is similar in Europe, while Alibaba, the Chinese e-commerce giant, has a similar position in China.

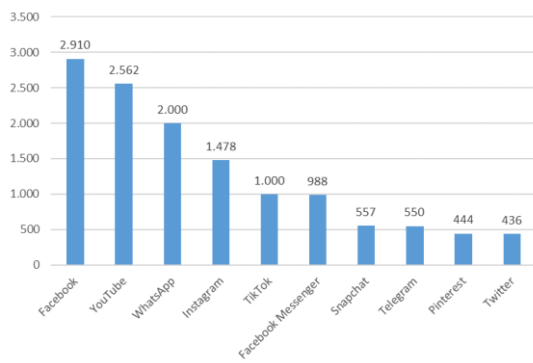
Figure 2: Market shares of retail e-commerce companies (United States 2022)



Source: eMarketer 2022, own calculations

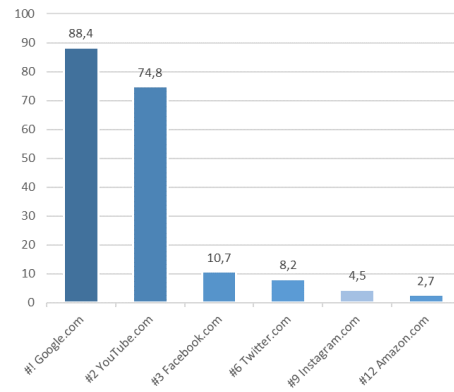
Meta's position is very much based on its leading position in social media networks and the traffic generated on their websites (Figure 3a and 3b), which it successfully translates into a high market share in online advertising, Meta's main revenue driver (figure 5).

Figure 3a: Global social networks (number of users in million 2022)



Source: DataReportal 2023

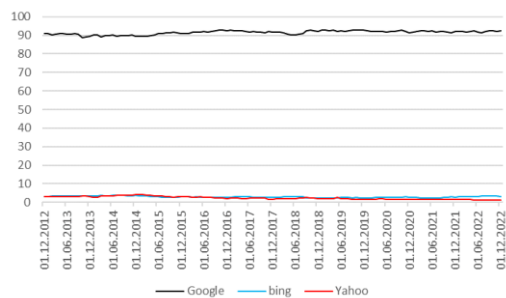
Figure 3b: Largest websites by traffic (average monthly visits 2022, in billion)



Source: DataReportal 2023

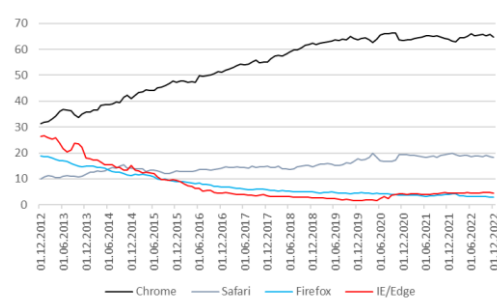
The picture is even more pronounced in the case of Alphabet (Google), whose search engine business, supported by a strong position in web browsers (Chrome), is a major driver of its advertising revenues (Figures 3b, 4a and 4b). Market shares in search engines in excess of 90% across platforms and regions speak for themselves. It is also striking how stable Google's market share is over time possibly benefiting in the future from the increasing market penetration of its browser Chrome.

Figure 4a: Global market share search engine desktop, mobile & tablet search engine (2012 - 2022)



Source: Statcounter GlobalStats, own calculations

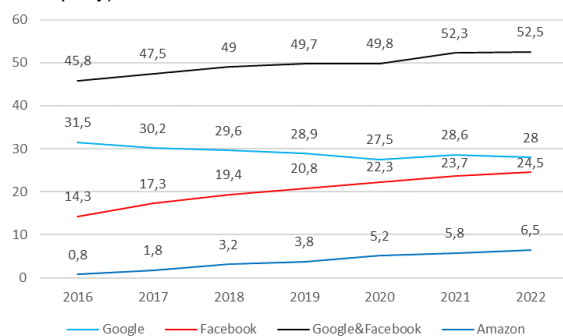
Figure 4b: Global market share desktop, mobile & tablet browser (2012 - 2022)



Source: Statcounter GlobalStats, own calculations

Figure 5 illustrates the development of the relative proportions of the online advertising revenues of Google, Facebook and Amazon. While Google's share is slightly declining over time, Facebook's share is increasing with a combined share of Google and Facebook exceeding 50% of the online advertising revenue pool.

Figure 5: Online advertising revenues 2016 – 2022 (worldwide per company) in %

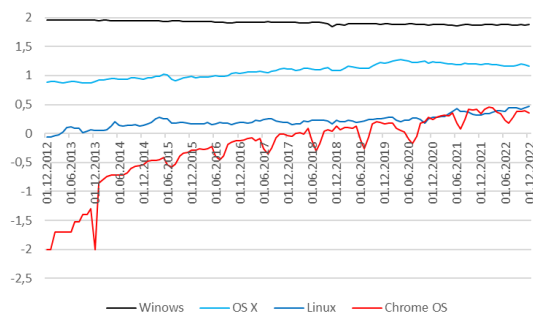


Source: eMarketer 2022, own calculations

These trends support the hypothesis that network-based business models pursued by Google and Facebook create high barriers to entry allowing for persistent high market shares and corresponding revenue streams.

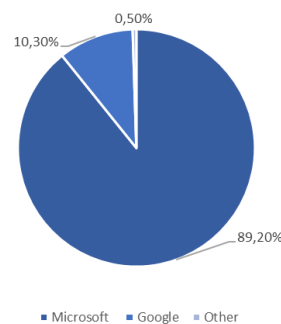
Microsoft has been the undisputed global market leader in operating systems for desktops and laptops (Windows, Figure 6a) and for office software products for decades (Figure 6b). Most recent data suggest a market share of about 90% for office software products. Google has so far not been able to attack Microsoft’s leading position especially in the segment for business users with its products Google Workspace (G Suite) although these products are offered at a much lower price compared to MS office products. Historical data on market shares are not available as these products are reported as part of larger business units, e.g. Google’s product offerings are reported as part of Google’s Cloud solutions.

Figure 6a Global market share (desktop OS, December 2022)



Source: Statcounter GlobalStats, own calculations

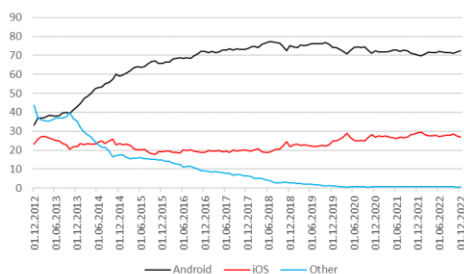
Figure 6b: Global market share (office software products 2020)



Source: Gartner

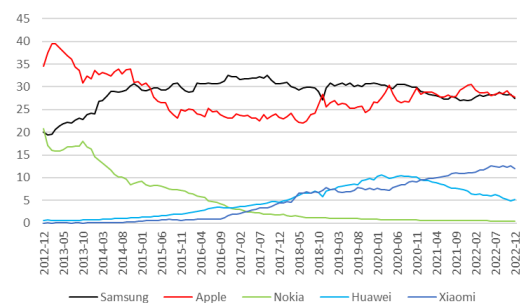
Apple's growth engine for many years has been its core product lines around the iPhone and iPad. Combined with its high market share in mobile operating systems (iOS, Figure 7a), Apple has been able to keep its strong position in smartphones and tablets (Figure 7b). In addition Apple has expanded its franchise into wearables and value-added services such as Apple pay, Apple TV or iTunes. On the other hand, Google is trying to gain market share in smartphones based on its market-leading Android OS, which is also used by other major smartphone vendors such as Samsung.

Figure 7a: Global Market Shares, mobile OS 2012 - 2022



Source: Statcounter GlobalStats, own calculations






Figure 7b: Global Market Shares, mobile devices and tablets 2012 - 2022



Source: Statcounter GlobalStats, own calculations

Figure 8 summarises our outside-in analysis of the core competencies of the Big 5, the platforms they operate and whether or not they benefit from network effects and economies of scale or economies of scope. It should be noted that our observations are based on company statements and our own analyses based on the corporate development of the Big 5 so far. Hence our conclusions are preliminary and could be subject of future research. Especially the access to company internal information would be useful to further validate our hypotheses about the driving forces behind the success of Big Tech companies that we propose in the following.

Figure 8: Platforms and sources of competitive advantages

BigTech	Core competencies		Platforms	Metrics	Network effects		Economies of Scale	Economies of Scope	
	common	distinct			direct	indirect			
	Innovations, Web-technologies, Cloud computing, Software development, AI, Data science, Brand management, CRM, Platform design	SCM, Category Management	amazon.com, amazon.marketplace, AWS	300 m active customers (B2C); amazon.com 2,6 bn visitors globally 2/2023	✓	✓	✓	e.g. logistics, procurement, IT infrastructure	✓ e.g. web technologies, software development, platform operations
	Innovations, Web-technologies, Cloud computing, Software development, AI, Data science, Brand management, CRM, Platform design	Search engines, Semantic web, Online advertising	google.com, youtube.com	97 bn visitors (globally, 2/2023); youtube 80.5 bn visitors	✓	✓	✓	e.g. data analytics, IT infrastructure	✓ e.g. web technologies, Software development, platform operations
	Innovations, Web-technologies, Cloud computing, Software development, AI, Data science, Brand management, CRM, Platform design	Product design, Hardware development, Manufacturing excellence	apple.com, iTunes, apple pay, apple TV, iPhone, iOS, Mac, MacOS	active iPhones (2022); 1.3 bn; more than 2bn active devices (Mac, iPad, iPhone)	✓	✓	✓	manufacturing, logistics, procurement, IT infrastructure	✓ e.g. manufacturing, product development
	Innovations, Web-technologies, Cloud computing, Software development, AI, Data science, Brand management, CRM, Platform design	Operating systems, App development, Software manufacturing	microsoft.com, MSN, Microsoft 365, Office 365, LinkedIn	1.4 bn customers; more than 250 m monthly users of office; more than 1bn Bing users daily; 900m members of LinkedIn	✓	✓	✓	e.g. software development, manufacturing, IT Infrastructure	✓ e.g. common platform operations for skype, teams, azure
	Innovations, Web-technologies, Cloud computing, Software development, AI, Data science, Brand management, CRM, Platform design	Social Media, Online advertising	facebook.com, instagram.com, whatsapp.com	Facebook: 12.5 bn visitors globally 2/2023; Instagram 5.2 bn	✓	✓	✓	e.g. software development, IT infrastructure	- e.g. common platform operations for facebook, instagram, whatsapp

Source: Own analysis

Establishment of a new market

Today’s digital champions have established a new market for digital products or services with an inherently high growth potential.

Platform-based business model

Big Tech companies typically operate one or more platforms, which may or may not be multi-sided. For example, Amazon operates its e-commerce platform Amazon.com, the Amazon marketplaces for third parties and AWS as a web technology platform, e.g. for cloud computing (Figure 8). A closer look at their business models shows that they tend to be active in a number of markets, with a significant proportion of their revenues and profits coming from non-platform business activities. The growth of the core business of the Big 5 is driven by consumer demand (B2C). This is obviously not a necessary condition for becoming a dominant digital player, but it seems to be a common feature of some Big Tech companies in their early stages of development.

Strong network economies

Competitive advantages of Big Tech companies in their core business are based on direct and indirect network economies (Figure 8). Amazon's marketplaces and Meta's social media networks are good examples of strong network effects driving the accelerated growth rates in the use of these platforms. Microsoft's operating systems and office applications generate both direct network externalities among their users and indirect network effects by linking complementary technologies to these platforms. Similar effects can be observed in Apple's hardware and software

platforms (iPhone, iPad, iOS, iTunes, Apple pay, etc.) and in Alphabet's business portfolio around Google.com.

Economies of scale and economies of scope

Big Tech's competitive advantages are based not only on strong network effects, but also on economies of scale (e.g. in manufacturing, overhead functions), economies of scope (e.g. in marketing and distribution, technology) or lock-in effects created by hardware or software solutions. Scale, scope and network economies often act as mutually reinforcing drivers of first-mover advantages, deterring potential competitors and ultimately leading to high barriers to entry. Figure 8 provides an overview of the operating platforms, the associated network effects and the nature of the complementary economies of scale or scope.

For instance, Amazon's e-commerce platforms benefit from economies of scale in IT infrastructure, procurement and logistics, as well as economies of scope in certain technical domains such as web technologies, software development and platform operations. In addition, direct and indirect network effects play a role in Amazon's marketplaces, which in turn increase the utilisation of shared assets such as IT or logistics infrastructure. Similar observations can be made, for example, at Meta, whose large social media networks are based on - mainly direct - network externalities. At the same time, Meta's business model exploits economies of scale in basic IT infrastructure.

Reduced contestability of core markets

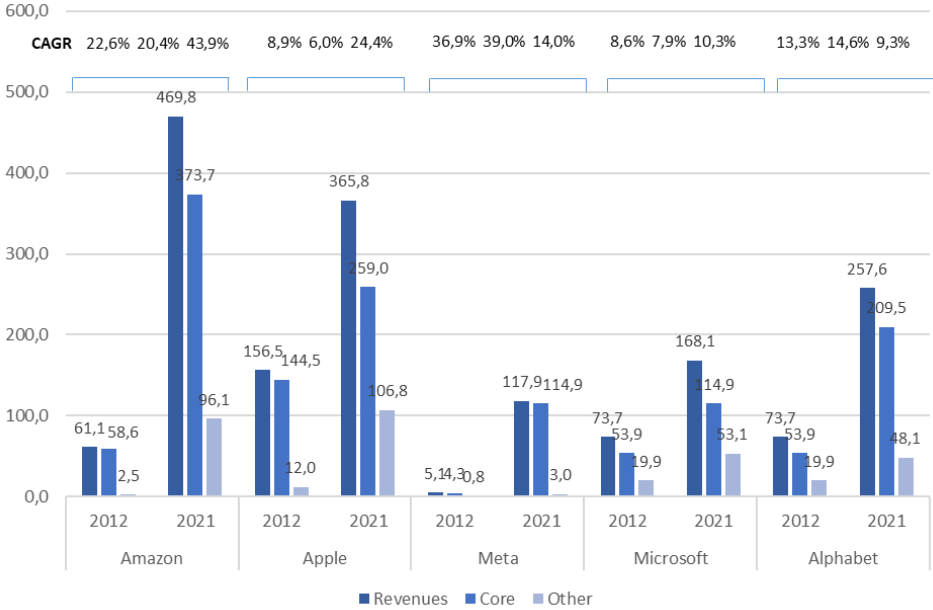
High barriers to entry reduce the contestability of markets, giving rise to highly concentrated market structures. These are often characterised by a small number of market leaders and a limited number of smaller players that remain in a marginal position or even exit the market due to insufficient profitability. Consequently, increasing concentration in growing markets leads to high margins in these businesses, at least for a period of time, during which these companies generate exceptionally high cash flows, which they then use to invest heavily in new, usually adjacent, markets.

The analysis of selected key financial figures over a 10-year period (2012 to 2021) for the Big 5 (Figure 9) shows that all of them have experienced extraordinary growth rates overall. Looking at selected market share data, in most cases they have maintained or even expanded their dominant market position in these original core businesses. Thus, even in fast-changing digital markets, barriers to entry appear to have remained high. While the growth of the original core business remains strong, the new businesses into which the companies have gradually diversified have established steeper growth trajectories.

Figure 9 displays the respective total revenues and their split between original core and other businesses in absolute terms (USD) and the respective CAGR in %. While all of them have shown high growth rates over a long period of time, Amazon and Apple in particular have generated much higher growth rates in their new businesses than in their historical core business.

Alphabet and Microsoft have managed to grow their new businesses at rates close to those of their established businesses, while only Meta lags somewhat behind with its relatively new Metaverse activities. Nevertheless, it can be concluded that the fast growing core business provides the basis for entering new attractive market segments with high growth potential.

Figure 9: Growth of Big 5 tech companies – core versus non-core 2012-2021



Source: company information, SEC filings (10-k), own calculations






Diversification into adjacent markets

In order to leverage their dominant position in their core market, it is crucial for Big Tech companies to conquer new markets, ideally by exploiting synergies between their core and new businesses. These synergies may be based on similar technologies, a common user base or other factors. Combined with strong growth rates and high free cash flows, big tech companies have quickly built up a strong capital base, enabling them to accelerate their corporate development both through organic growth and mergers and acquisitions (M&A) (Figure 10). Amazon, for instance, has diversified into areas such as web technologies, including cloud computing, media and artificial intelligence (AI), including robotics. Alphabet has also moved into online advertising, social media, cloud computing and AI/robotics. For many years, Microsoft focused on strengthening its core software competencies through a series of smaller, mostly people-driven acquisitions before expanding into cloud computing, social media, gaming and even the mobile device market. Meta has also long focused its acquisition activity on social media networks, adding to the Facebook network. Only in recent years have acquisitions been made to build the Metaverse business, which is expected to become a key element of its future business portfolio. Even Apple, the least diversified of the Big 5, has acquired more than 120 companies since its inception.

Intensive M&A activity

Figure 10 illustrates that M&A is an important strategic tool for the Big 5, as each of them has made numerous acquisitions in a relatively short period of time. It is striking that their M&A strategy changes over time. Initially, they acquire companies to strengthen their core business by gaining market share or defending their market leadership position. Over time, they focus on diversifying into related businesses where they can leverage their core competencies and monetise their user/customer base. In any case, the smooth integration of new companies into the group is an important skill for Big Tech companies to implement their ambitious growth strategies.

Figure 10: Selected mergers and acquisitions of the Big 5

	Diversification Strategy	Large Acquisitions (selection)
 amazon.com more than 100 take-overs since 1998	<ul style="list-style-type: none"> • AWS (Web-Technologies, Cloud, Artificial Intelligence) • Robotics • Media 	iRobot (2022), One Medical (2022), Metro-Goldwyn-Mayer (2021), Zoox (2020), Whole Foods Market (2017), Zappos (2009), Kiva Systems (2012), Twitch Interactive (2014), PillPack (2018)
 Alphabet more than 250 take-overs since 2001	<ul style="list-style-type: none"> • Robotics/AI/VR/AR/Analytics • Online Advertising, Cybersecurity • HW-Technology, Smart Home 	Mandiant (2022), Raxium (2022), Fitbit (2021), Looker (2019), HTC (parts) (2017), Deep Mind Technologies (2014), Nest Labs (2014), Waze (2013), Motorola Mobility (2011), DoubleClick (2007), YouTube (2006)
 more than 120 take-overs since 1988, mostly after 2010	<ul style="list-style-type: none"> • Strengthening core business (iphone, iPad, iOS) • Related services (Apple Music, iCloud, Apple Pay, Siri) • Mostly small acquisitions 	Mobeewave (2020), NextVR (2020), Intel (modem business) (2019), Shazam (2018), Lattice Data (2017), Turi (2016), Beats Electronics (2014), Topsy (2013), AuthenTec (2012), Anobit (2011)
 Microsoft more than 200 take-overs since 1986	<ul style="list-style-type: none"> • Software, Cloud, Artificial Intelligence, Cyber Security • Social Media, Mobile Apps • Gaming 	Activision Blizzard (2022), Nuance Communications (2021), ZeniMaxMedia (2020), Affirmed Networks (2020), GitHub (2018), LinkedIn (2016), Mojang (2014), Nokia mobile phones unit (2013), Skype (2011), aQuantitative (2007), Navision (2002)
 Meta more than 90 take-overs since 2005	<ul style="list-style-type: none"> • Social Media Platforms • Meta Labs (AR, VR) • Technology Talent 	Many smallish acquisitions, Armature Studio (2022), Twisted Pixel Games (2021), Within (2021), Giphy (2020), Dreambit (2016), WhatsApp (2014), Oculus VR (2014), Instagram (2012),

Source: company information

Monetisation of customer/user base

The Big 5 companies try to monetise their huge customer and user bases for online advertising and potentially selling advanced analytics services to third parties. A substantial portion of Big Tech's revenue tends to come from advertising if the business model is primarily data-driven, as in the case of Alphabet and Meta. Intelligent algorithms collect big data to develop precise user profiles, enabling targeted online advertising campaigns. Another common feature is the provision of complementary services (e.g. payments) to deepen their customer relationships and gain deeper insights into customer and user data. Big Tech companies tend to build an ecosystem around their core and ancillary businesses in which their service offerings are mutually compatible, creating lock-in effects and increasing switching costs for their users. Such developments can raise serious antitrust issues if, as noted above, Big Tech companies act as gatekeepers to their platforms.

Similar core competencies

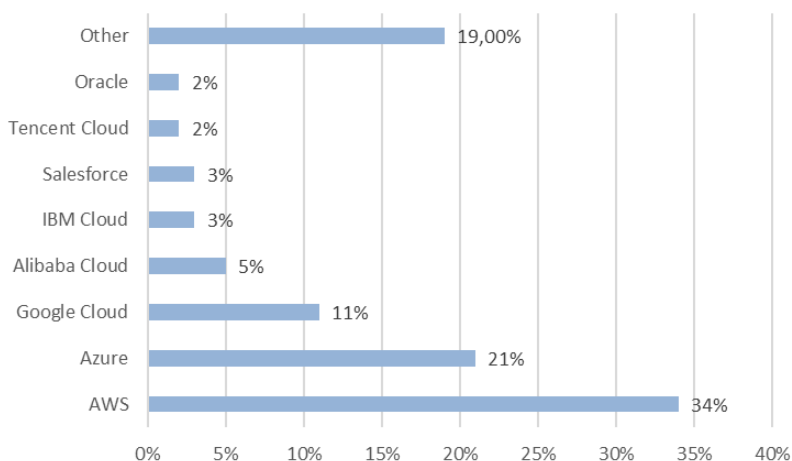
A closer look at the core businesses and their development both organically and through M&A suggests that the Big 5 share at least partially similar core competencies in terms of technology (web technologies, cloud computing, software development, AI, data science) as well as innovation, marketing and customer relationship management. Combined with outstanding industry-specific capabilities such as supply chain management or category management in the case of Amazon, or product design and development in the case of Apple, this seems to provide the basis for building and expanding a strong leadership position in the respective sector.

An important ingredient in their success is undoubtedly their ability to attract the best talent in engineering, computing and data science, coupled with attractive individual development opportunities, flat hierarchies and the financial incentives that come with fast-growing companies. The ability to smoothly integrate acquired companies and their teams is another success factor, as M&A plays a key role in their growth strategy.

Convergent activities among Big Tech companies

It can be observed that Big Tech companies become competitors in new markets, even though their original core activities were quite different. One example is the growing business of cloud computing, in which the Big 5, with the exception of Meta, all play an important role (Figure 11).

Figure 11: Worldwide market share of cloud infrastructure providers (PaaS, IaaS) 2022



Source: Synergy Research Group

With some similar core competencies in terms of digital skills and strong financial resources, a further convergence of business activities among the Big 5 does not seem far-fetched.

We have already seen some Big Tech players attack others on their home turf, such as Microsoft launching its Bing search engine as an alternative to Google, or Alphabet positioning its Google Work Suite to challenge MS Office. Google, Amazon and MS have entered the smartphone market, while Apple is challenging Amazon Prime with its Apple TV. Other areas where the Big 5's business interests are converging include autonomous driving, mobility services, wearables, gaming, virtual reality and e-health.

Early access to public capital markets

Because Big Tech companies need to raise large amounts of capital to fuel their high growth, early access to public capital markets is important. Most of the "Big 5" companies went public on the NASDAQ within a period of less than ten years after their founding, i.e. Apple in 1980 (four years after founding), Amazon in 1997 (three years after founding), Google in 2004 (six years after founding) and Facebook (Meta) in 2012 (eight years after founding). Only Microsoft launched its IPO somewhat later, in 1986, 11 years after it was founded. In some cases, venture capital played an important role in the early stages of their development. But access to a major stock exchange was a key factor in their rapid rise.

8. Conclusions

Big Tech companies play an increasingly dominant role in many digital markets. These companies have successfully conquered a specific market in which they have achieved a leading position relatively quickly. Moreover, due to the underlying characteristics of these markets, they benefit from network effects, often combined with economies of scale or scope, which reinforce their competitive advantages in these markets. The contestability of such markets declines over time due to high barriers to entry for potential competitors. At the same time, fast-growing technology groups such as the "Big 5" (Alphabet, Amazon, Facebook (Meta), Apple, Microsoft) use their exceptionally high cash flow base to expand into adjacent markets, gradually extending their market power beyond their original core business. These companies can act as gatekeepers to

new incumbents, reducing the contestability of some digital markets. This trend may hinder the development of European competitors, damage the ecosystem for technology start-ups and even jeopardise Europe's core strengths in manufacturing industries. Therefore, the amendment of the existing antitrust rules by the Digital Markets Act and the Digital Services Act were appropriate steps to ensure fair and open conditions in Europe's digital markets.

On the other hand, the comparative analysis of the Big 5 reveals some common success factors from which entrepreneurs, investors as well as European regulators and policy makers can learn in order to improve Europe's chances of becoming home to emerging digital champions. The lessons show that successful platform-based business models rely on strong network externalities, usually combined with both economies of scale and economies of scope. The success of the Big 5 is based on common core competencies such as high innovation capacity as well as outstanding expertise in web technologies, cloud computing, software development, AI, data science, brand management, customer relationship management (CRM) and platform design. These competencies seem to be necessary conditions to become a successful Big Tech company over time. In addition, Big Tech players need to be equipped with distinct industry-specific competencies that allow them to build and expand a strong leadership position in the respective sector. Furthermore, the Big 5 were all first or at least early movers in their initial core market. M&A plays an important role both in extending leadership in the core market and in diversifying into adjacent markets. Monetising the growing user or customer base with data-driven applications can also be identified as a common feature of the Big 5. In addition, early access to public capital markets has been an important means of financing high growth rates.

The evidence presented in this article suggests that the focus of both start-up activities and European industrial and research strategy should not be on a "me too" approach, e.g. building a serious competitor in one of the fields already occupied by the Big 5. Such an approach has little chance of success. The strategic focus of European initiatives should be on markets such as GreenTech, B2B platforms or AI, where the markets are "in the making" and not yet dominated by the Big 5. An important element in restoring the competitiveness of Europe and European companies is the Gaia-X project, which aims to build a modern data infrastructure that promotes the digital sovereignty of European users of cloud services. Transparency, openness, privacy and security are key features of the project, which will be launched in 2019 and is expected to be more widely implemented in 2025 and beyond, with some use cases being rolled out earlier.

Looking at the educational backgrounds of Big Tech founders, it is not surprising that they all have a technical background in computer science, electronics/electrical engineering, acquired either through formal university studies (e.g. Jeff Bezos, Larry Page, Sergey Brin, Mark Zuckerberg) or through self-taught practical training (Steve Jobs) or a combination of both (Bill Gates). Although many ingredients combine to produce a stunning entrepreneurial success story like that of the Big 5, an ecosystem that supports tech talent, a regulatory framework that encourages innovation, and substantial funds available to finance innovative business models increase the likelihood of building a thriving economy in the digital age.

The European Commission has estimated that the EU will face a shortage of 8 million IT professionals by 2030 (Anderson 2022, European Union's Digital Compass, 2021) and that the EU lags significantly behind the US in terms of AI, cybersecurity and cloud technology experts (Anderson 2022, European Union's Digital Compass, 2021, European Commission 2021a). The EU has well acknowledged the need for action to close the gap in basic digital skills and to modernise Europe's education system with the launch of The European Skills Agenda in July 2020 (European Commission 2020a), followed by the renewed Digital Education Action Plan in September 2020 (European Commission 2020b), both established to close the high-tech skills gap.

Another lesson learned from the Big 5 is that M&A plays an important role, especially when tech companies enter their expansion phase after having successfully established their initial products and services. It should therefore be discussed whether the pan-European regulatory framework for M&A could be reformed to speed up the approval process, especially for smaller to medium-sized transactions. In addition, there is currently no stock exchange in Europe that can compete with the US technology exchange NASDAQ. Almost all major technology IPOs in recent years

have ended with a listing on the NASDAQ. In the absence of a credible European alternative to the NASDAQ, the possibility of creating a European tech exchange, jointly operated by all the major stock exchange operators in the EU, should be explored. Such a joint pan-European effort could, over time, substantially improve equity funding opportunities for European tech companies.

It should be noted that the findings presented in this article are based on public information disclosed by the respective companies and are therefore preliminary. Access to detailed non-public company data could help to gain a deeper understanding of the structural, procedural and technical interdependencies between the original core businesses and the adjacent businesses that the Big 5 have entered over time. As the Big 5 are active in different fields, not all of which are platform-based, a future area of research could focus in particular on the relationships between the different parts of Big Tech companies and their impact on value creation. Another research topic could be the impact of regulatory frameworks on the creation and successful development of Big Tech companies.

Frankfurt a.M., 28 April 2023

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