Special features of the digital economy

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What we expect to learn

- Why new technologies are important?
- General purpose technologies
- Special features of digital economy
- The role of data
- Why are government intervention or regulation needed in digital markets?

Why new technologies are important?

Why new technologies are important?

- For companies, new technology creation (= innovation) enables escaping competition, getting to the productivity frontier and reaping higher profits.

- For society as whole, technological development is the most important source of economic growth and welfare improvements.

Creative destruction as a driver of growth

- Creative destruction = process by which new innovations displace old ones; innovation cause old inventories, ideas, technologies, skills, and equipment to become obsolete (Schumpeter, 1942).

- Disruptive: loss of demand of certain materials, disappearance of jobs, and the destruction of firms.

- Creative destruction can lead to a more efficient allocation of resources. Resources are shifted to the companies and industries that are growing as new innovations displace old ones.

Creative destruction as a driver of growth

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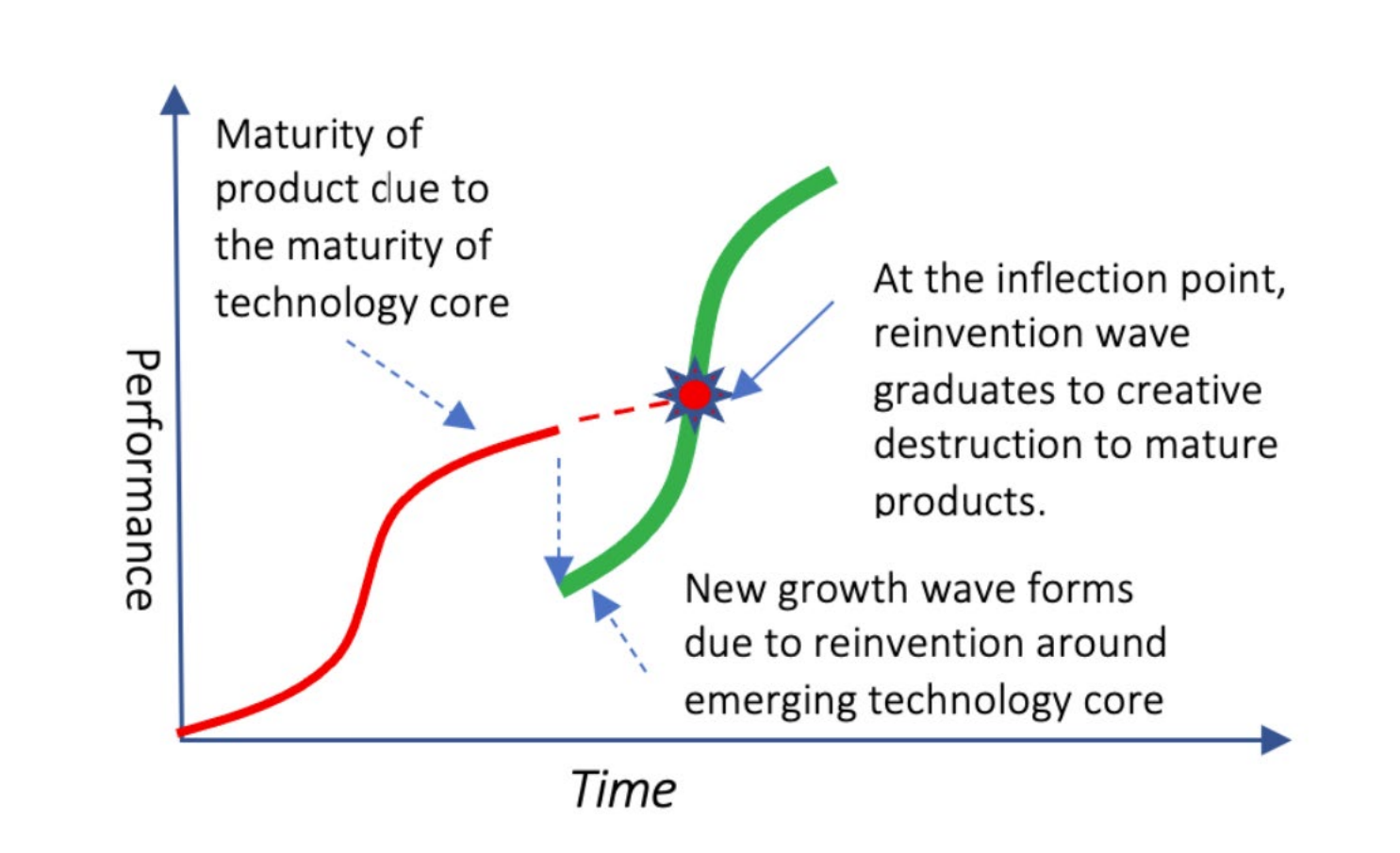
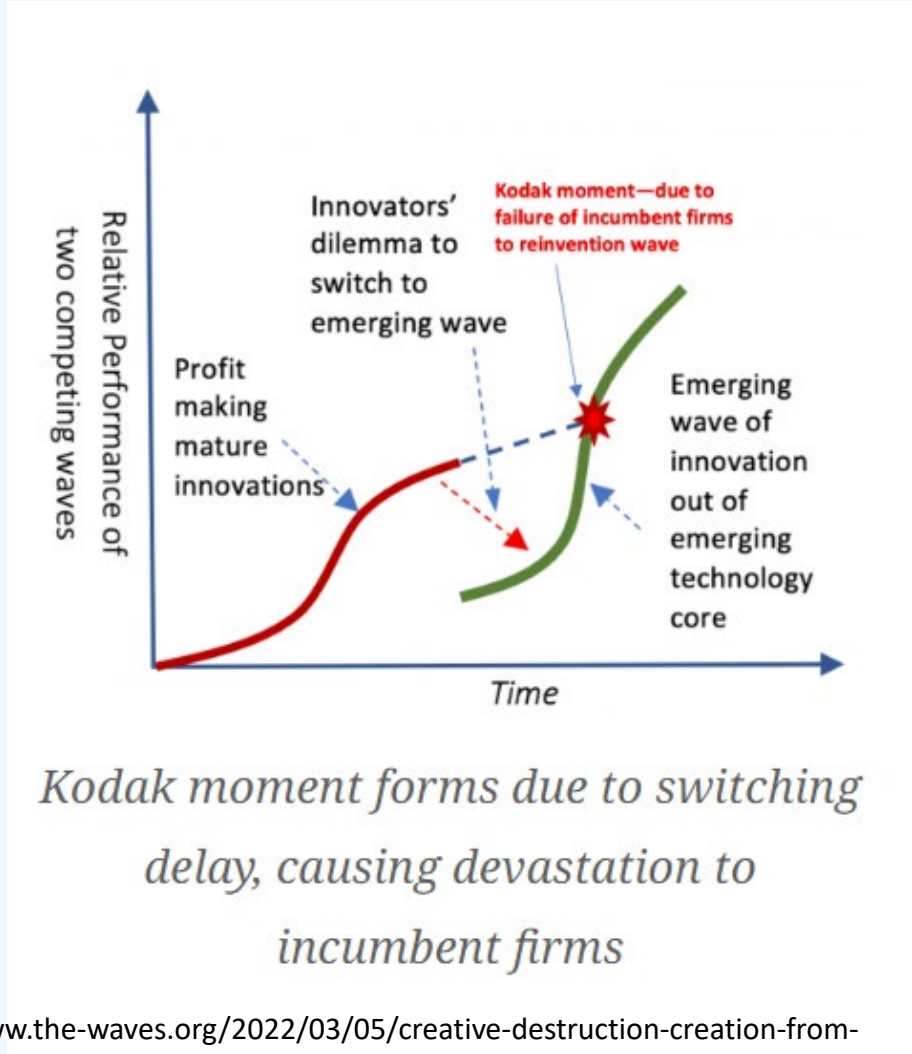


Source: https://www.the-waves.org/2022/03/05/creative-destruction-creation-from-reinvention/

Creative destruction as a driver of growth



Kodak moment forms due to switching delay, causing devastation to incumbent firms

Source: https://www.the-waves.org/2022/03/05/creative-destruction-creation-from-reinvention/

Example: Kodak's technology core was in film photography

Kodak invented digital camera & produced 1st commercialized model. But it did not want to cannibalize its film camera markets & was unable to make a successful transition to digital photography. Kodak filed for bankruptcy in 2012, and it has since undergone a significant restructuring.

See also: https://www.dpreview.com/news/8351591575/video-how-kodak-became-yet-another-victim-of-the-juggernaut-of-changing-technology

GDP & labor productivity growth

- Gross domestic product (GPD) = Sum of value added in the economy = Value of all goods produced in all sectors - value of all purchased intermediate goods for production.

- GDP = (GDP/hour worked) x $\sum$ hours worked

$\Rightarrow$ GDP = labor productivity x $\sum$ hours worked

$\Rightarrow$ Δ GDP = Δ labor productivity + $\Delta \sum$ hours worked

- The size of the working age population declines in many developed economies.

$\Rightarrow$ GDP growth depends on productivity growth & immigration.

New Growth Theory

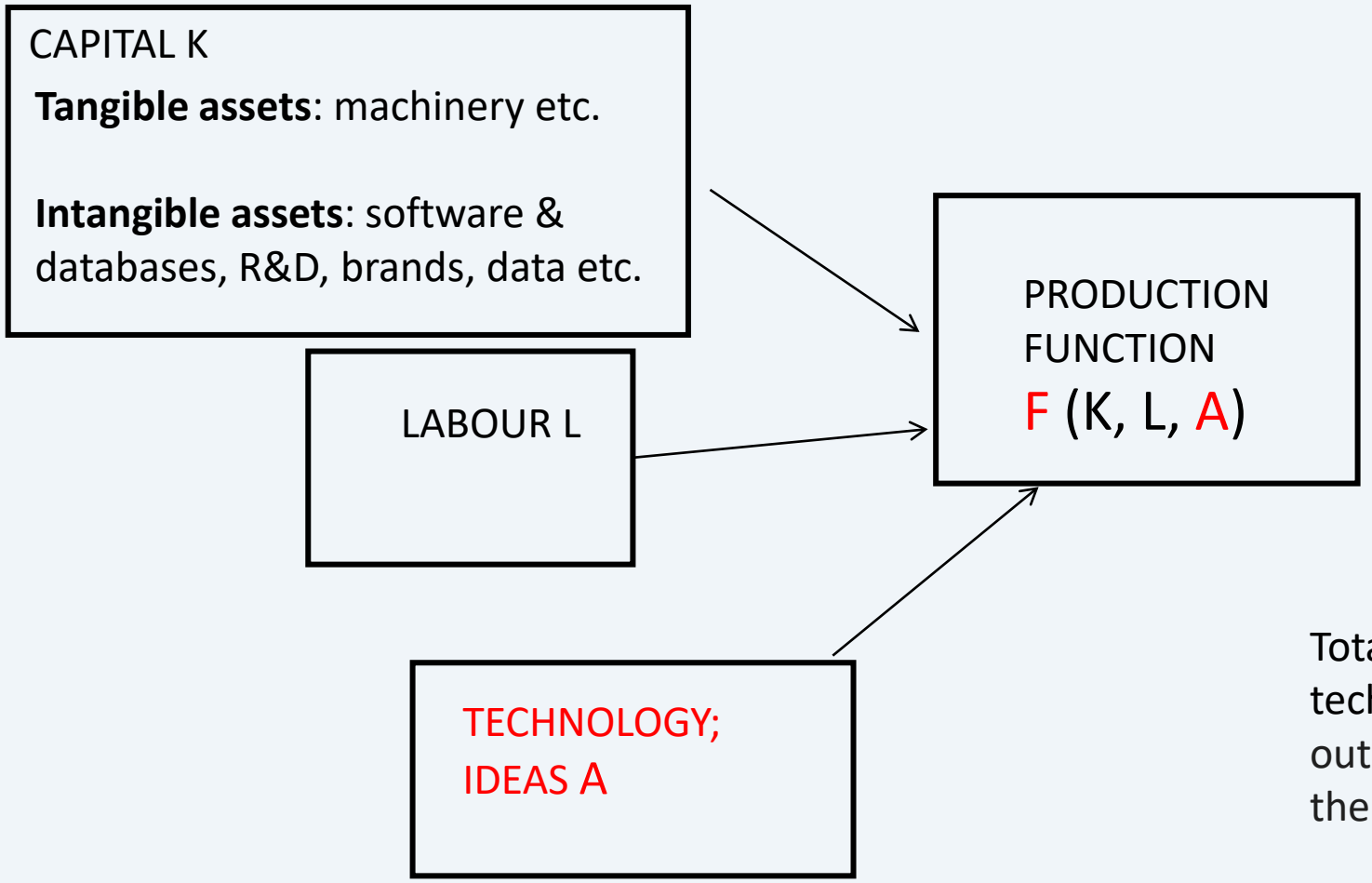
- Endogenous growth theory: technological progress at the center of the growth; new **ideas** (and accumulation of knowledge) are major source of productivity growth (Romer, 1990; was awarded Nobel prize in economic sciences in 2018).
- The produced output Q is modeled as *production function* F:

  Q = F(K,L, A), where K=capital, L=labor, and A= technology or ideas are *factors of production*

- Ideas ("recipe") improve the technology of production
- A new idea allows a given bundle of inputs (K,L) to produce more or better (quality) output.
- The long-run growth rate of the economy is determined by the parameters of the production function for ideas and the rate of growth of researchers, which is ultimately given by the rate of growth of population.

Endogenous Growth Theory

Factors of Production:



Total factor productivity (TFP) growth: technological progress; growth in output that cannot be explained by the growth in inputs K & L.

Industrial society: value creation via the utilization of tangible assets (e.g., machinery, equipment) and raw materials (e.g., metals, oil).

Digitalization of economy → increasing role of services and intangible assets & goods in value creation

WEF (2011): Data represents a post-industrial opportunity.

Economist (2017): The world's most valuable resource is no longer oil, but data.

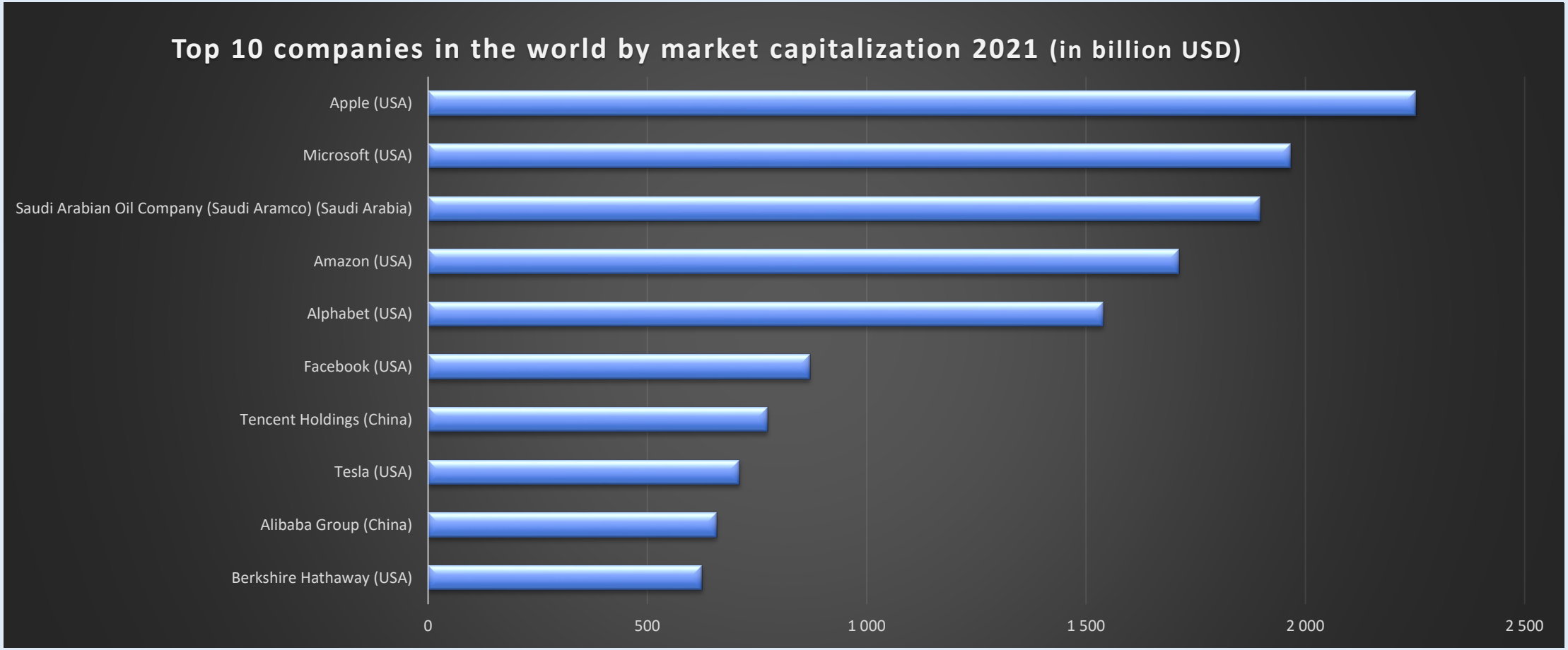
The pace of structural change towards digital/data-based value creation is determined by various factors (e.g., VC funding, availability of skilled workers, consumer preferences and their change, investments in ICT/AI).

Data generates growth

- Most valuable companies in the world depend on data.
- Data-intensive firms form a notable share of the top fastest growing companies both in Europe and in the US.

See also: https://americanbusinesshistory.org/most-valuable-companies-the-last-25-years/

The most valuable companies in the world depend on data…



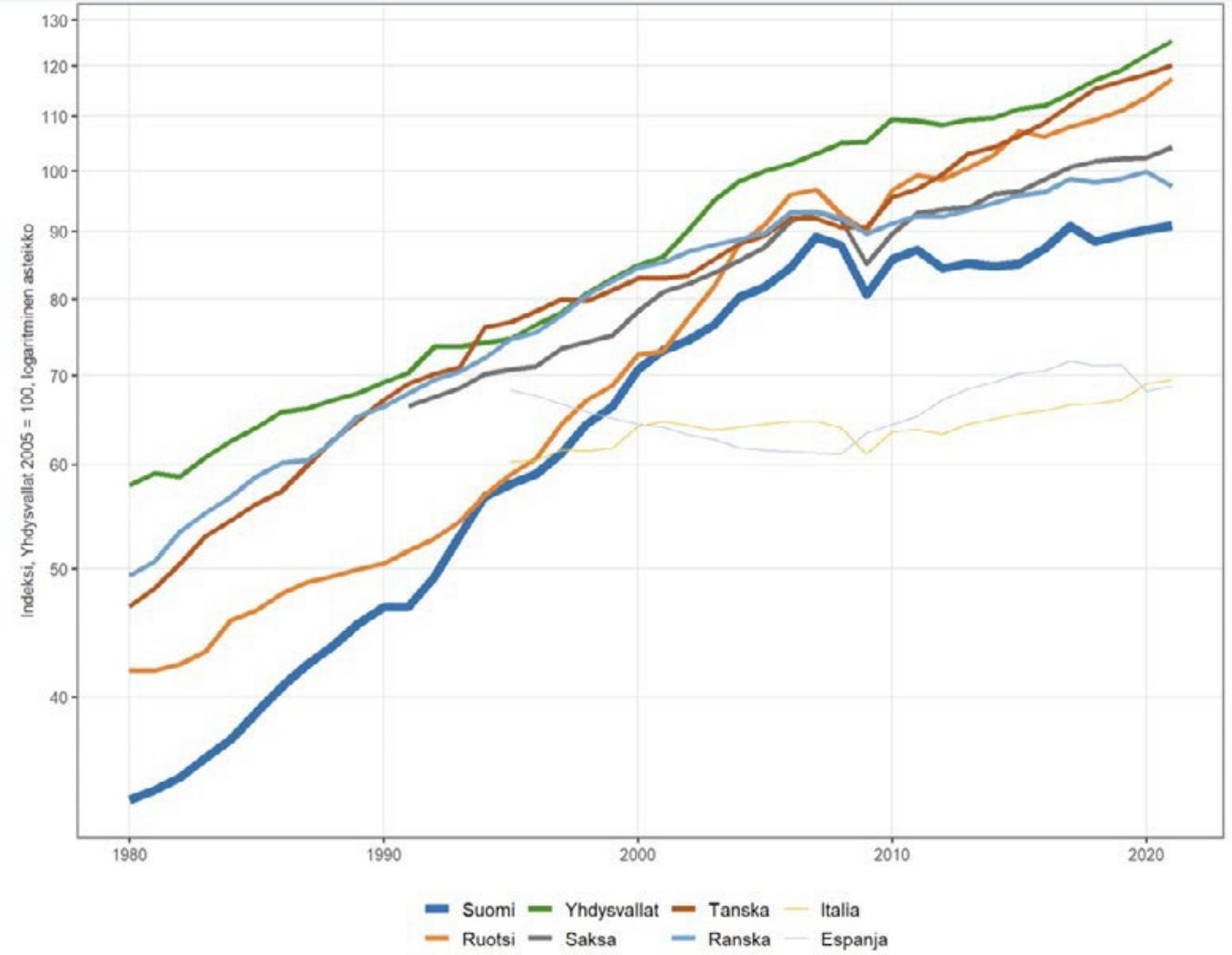
…while oil used to generate highest market capitalization

Company name	Location	Industry	Rank +/-	31 March 2018		31 March 2009	
				Rank	Market Cap ($bn)	Rank	Market Cap ($bn)
Apple	United States	Technology	32	1	851	33	94
Alphabet	United States	Technology	20	2	719	22	110
Microsoft	United States	Technology	3	3	703	6	163
Amazon.com	United States	Consumer Services	-	4	701	N/A	31
Tencent	China	Technology	7	5	496	N/A	13
Berkshire Hathaway	United States	Financials	6	6	492	12	134
Alibaba	China	Consumer Services	-	7	470	N/A	-
Facebook	United States	Technology	-	8	464	N/A	-
JPMorgan Chase	United States	Financials	19	9	375	28	100
Johnson & Johnson	United States	Health Care	-2	10	344	8	145
ICBC	China	Financials	-7	11	336	4	188
Exxon Mobil	United States	Oil & Gas	-11	12	316	1	337
Bank of America	United States	Financials	74	13	307	87	44
Samsung Electronics	South Korea	Consumer Goods	39	14	298	53	61
Royal Dutch Shell	United Kingdom	Oil & Gas	-6	15	263	9	139
Walmart	United States	Consumer Services	-13	16	264	3	204
China Construction Bank	China	Financials	-4	17	259	13	133
Wells Fargo	United States	Financials	37	18	256	55	60
Nestle	Switzerland	Consumer Goods	-4	19	246	15	129
Visa	United States	Financials	58	20	246	78	42

FT 1000 fastest-growing European companies in 2021

Labor productivity in the business enterprise sector

USA in 2005 = 100, log scale



“The productivity puzzle”, why economic productivity had declined over the past decades?

- Low hanging fruits of technological progress picked already, more effort and expenses required to reach higher branches (Gordon, 2016)
- Ideas are getting harder to find (Bloom et al., 2020): Number of researchers have to double every 13 years just to maintain the same overall rate of economic growth
  - Economic growth = Research productivity ↓(falling) × Number of researchers ↑(rising)
- Lack of competition: higher prices, lower investment & productivity growth (e.g., Philippon, 2019)
- General purpose technologies (GPTs) require adjustment costs & complementary investments, e.g., artificial intelligence (Brynjolfsson et al., 2021)

General purpose technologies

General purpose technologies

- General purpose technologies (GPT): radical innovation with *pervasive* use and application throughout the economy, *wide scope for improvements* (cost reductions, quality improvements), and *lead to complementary innovation*.

- Examples of GPTs: steam engine, electricity, and microprocessor/ICT

- Widespread adoption and implementation of general purpose technologies (GPTs) required before benefits materialize at the aggregate level, also complementary innovation and organizational investments and changes needed.

Technological disruptions typically slow and unpredictable

Future car, 1910s

Image: Schenectady museum; hall of electrical history foundation/corbis.

Future car, 2020s

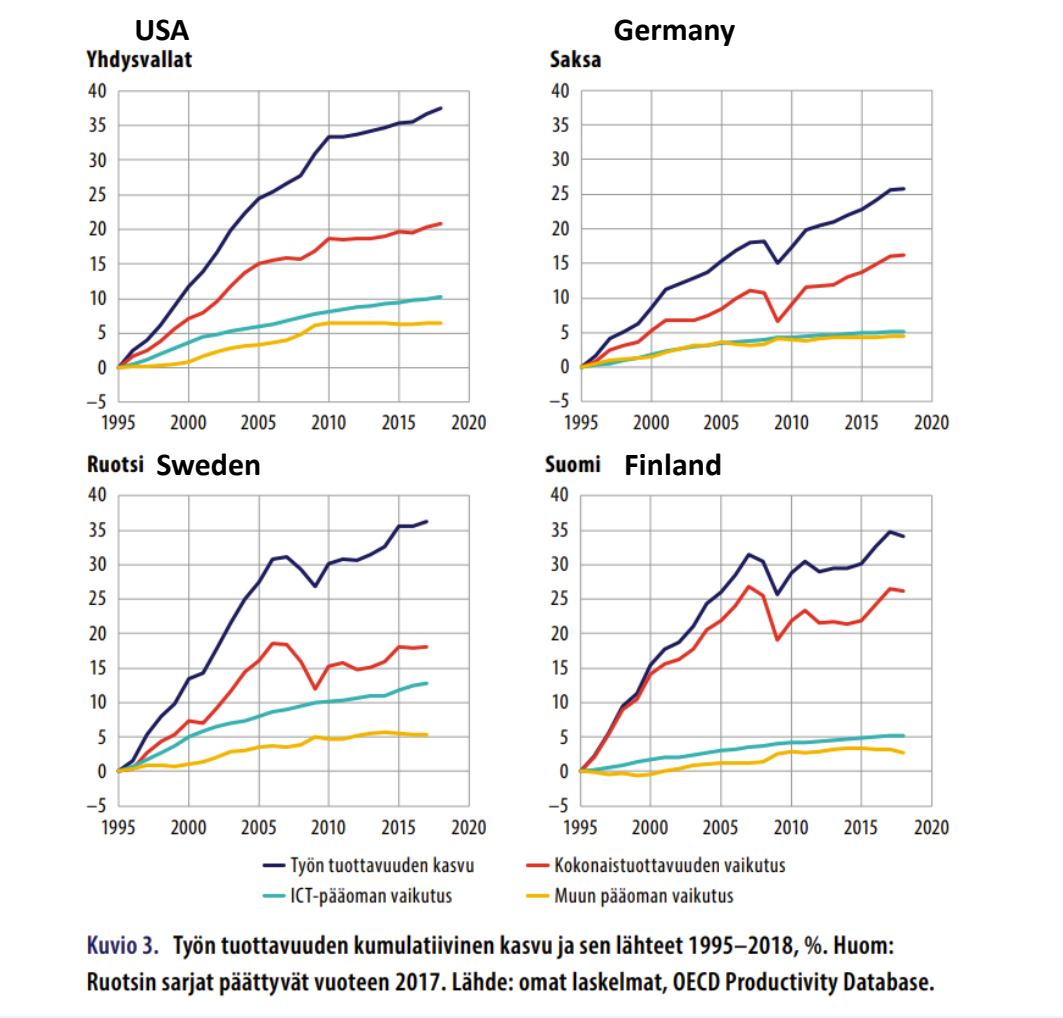
General purpose technologies

- Impact of GPT on growth at the aggregate level typically minor during the first years after the introduction and notable only after decades of diffusion and use.
- “The 1st industrial revolution”, industrial **steam engine** 1698: GPD growth impacts peaked 100 years after invention
- “The 2nd industrial revolution”, **electricity** (industry), late 19th century: GDP impacts not notable until 1920s
- ”The 3rd industrial revolution”, **ICT**, began after invention of transistor (1947) and was accelerated in the 1970s after the invention of microprosessor.

The aggregate economic impacts of ICT

- ICT affects aggregate productivity through:
  - i) ICT-sector production (e.g., computers, software, game industry, IT services) = productivity growth in ICT-producing industries.
  - ii) ICT-use sectors (e.g., real-time data collection on product use and modification of products to match user needs in manufacturing; applying robotics in service industry)
  - iii) ICT is a general-purpose technology: it can be utilized and applied widely in different sectors of the economy, leads to complementary innovations and can accelerate technological development on a large scale.

In Finland, 3/4 of increase in labor productivity is due to an increase in total factor productivity



Kuvio 3. Työn tuottavuuden kumulatiivinen kasvu ja sen lähteet 1995–2018, %. Huom: Ruotsin sarjat päättyvät vuoteen 2017. Lähde: omat laskelmat, OECD Productivity Database.

Black = labor productivity growth
Red = Impact of total factor productivity
Turquoise = Impact of ICT capital
Yellow = Impact of other capital

Source: Pohjola (2020)

Investments in ICT increase productivity

- Empirical studies employing firm-level data: ICT investments are generally positively related to productivity growth.

  ✓ 10% increase in investments in ICT leads to an average 0.5-0.6% increase in output at the firm level.

  ✓The productivity growth-promoting effect of ICT capital is most evident in the USA; the effects are less clear in Europe (Cardona et al., 2013).

  ✓ The US multinationals obtained higher productivity from IT than their EU counterparts, and also companies taken over by US multinationals increased their productivity; the role of management practices (Bloom et al., 2012).

The use of robotics increases productivity

- The use of robotics increases productivity at the firm level (e.g., Acemoglu et.al., 2020; French manufacturing sector 2010-2015) and at the level of economy as a whole (Graetz & Michaels, 2018; 17 countries, 1993-2007).

- According to Graetz&Michaels' calculations, the effects of the adoption of robotics on productivity growth at the level of the entire economy have been smaller than those reported for ICT.

- We still know very little about the effects of AI on firm-level productivity. Czarnitzki's (al. 2022) research indicates that both the use of AI and the intensity of use are positively related to firm productivity.

The 4th industrial revolution: AI?

- AI/machine learning, applications learning from data; machines with intelligence similar to humans using features that mimic human cognitive capabilities: visual recognition, learning, solving new problems.
- AI fulfills the criteria of GPT:

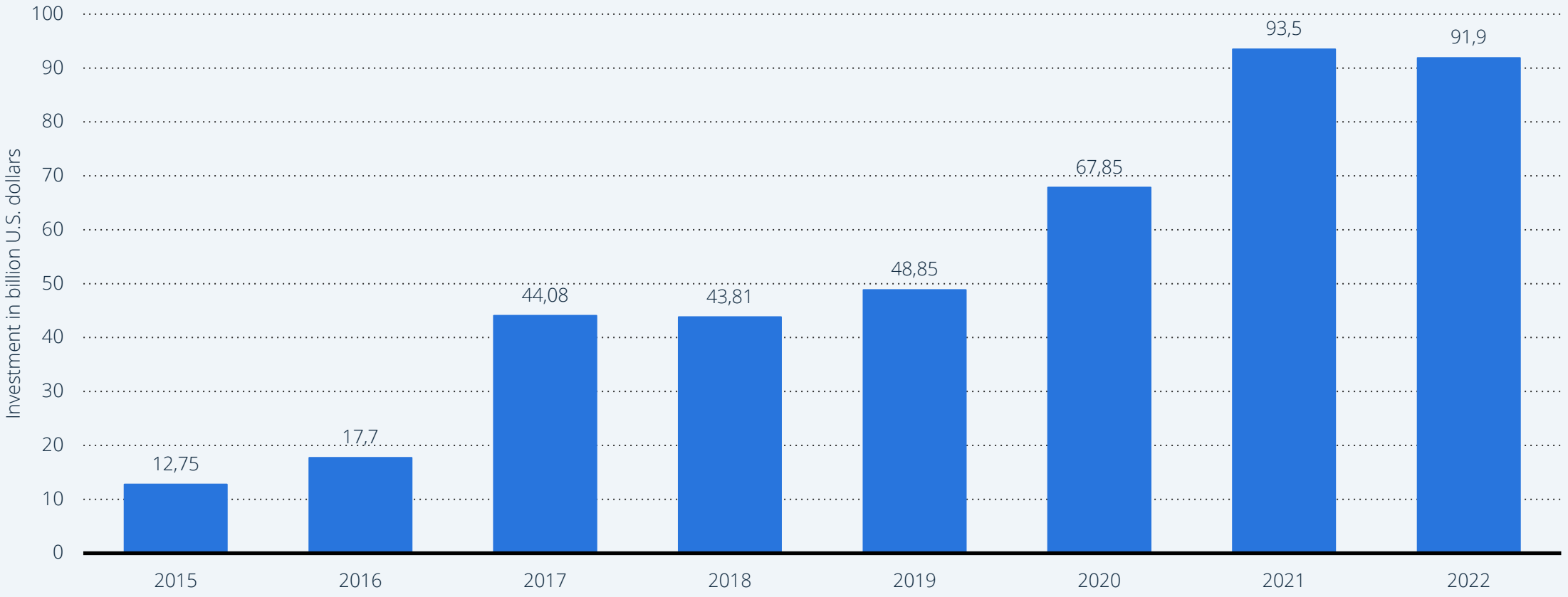
1. AI is pervasive, potentially disrupting almost all sectors of the economy.
   - ✓Enables automation of tasks
   - ✓Improved ideas production function (AI could replace (most) researchers?)

2.There are continuous technical improvements in the field of AI concerning performance, applicability and AI techniques (e.g., machine learning, natural language processing)

3. AI enables further innovation such as new types of goods/services (e.g., self-driving cars).

Global total corporate artificial intelligence (AI) investment from 2015 to 2022 (in billion U.S. dollars)

AI corporate investment worldwide 2015-2022

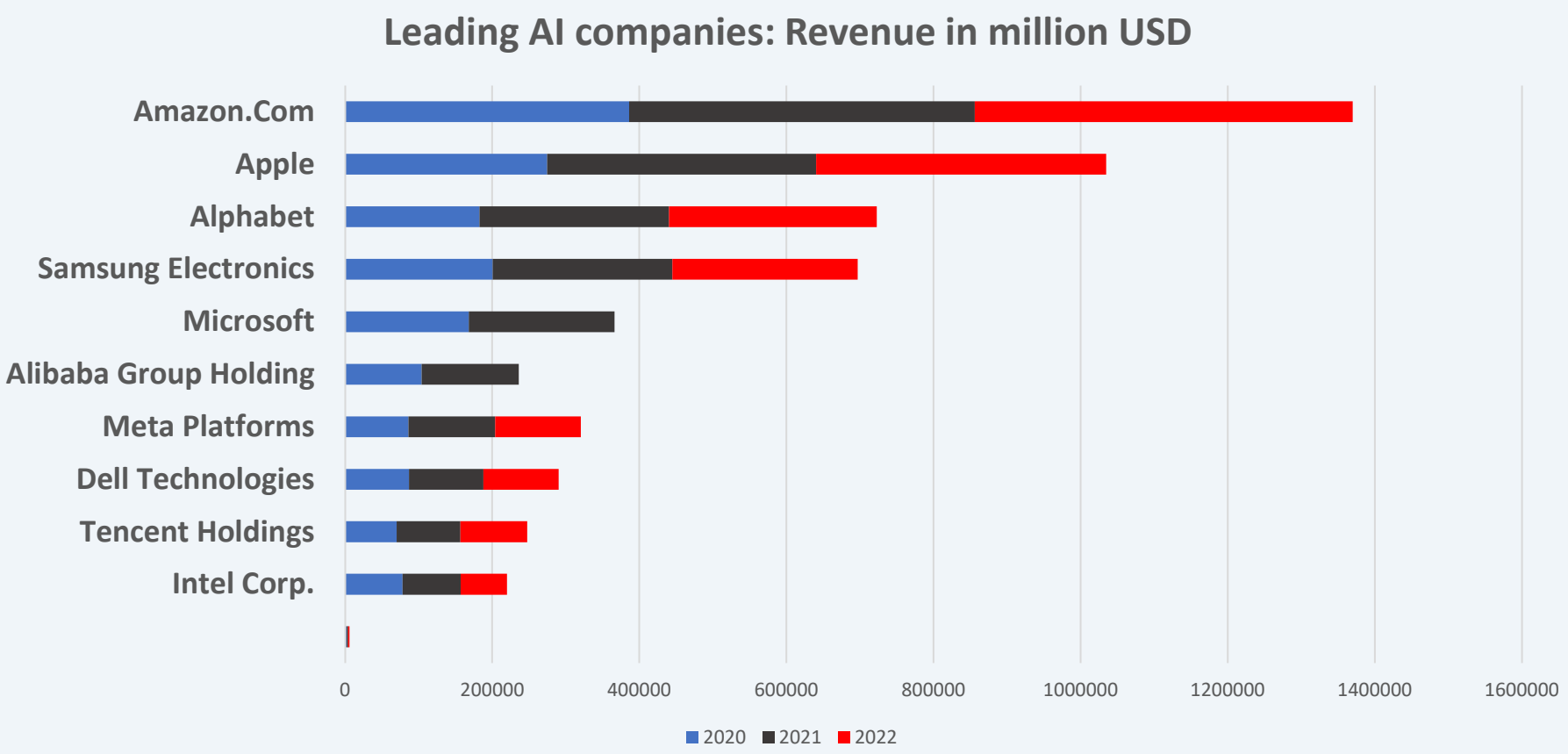


Note(s): Worldwide; 2015 to 2022

Further information regarding this statistic can be found on page 8.

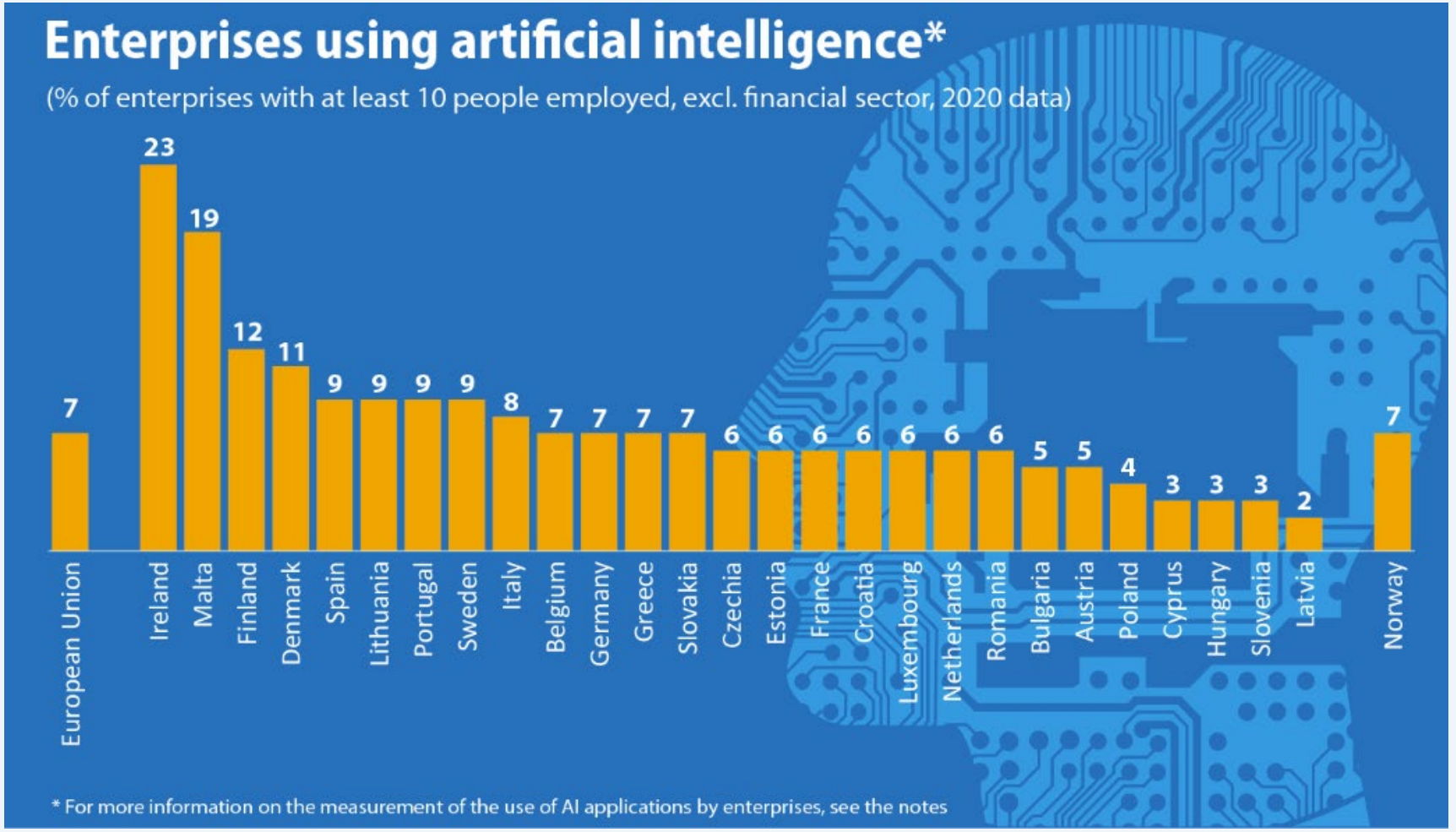
Source(s): Stanford University; S&P Capital IQ; CrunchBase; NetBase Quid; ID 941137

Globally leading companies in AI



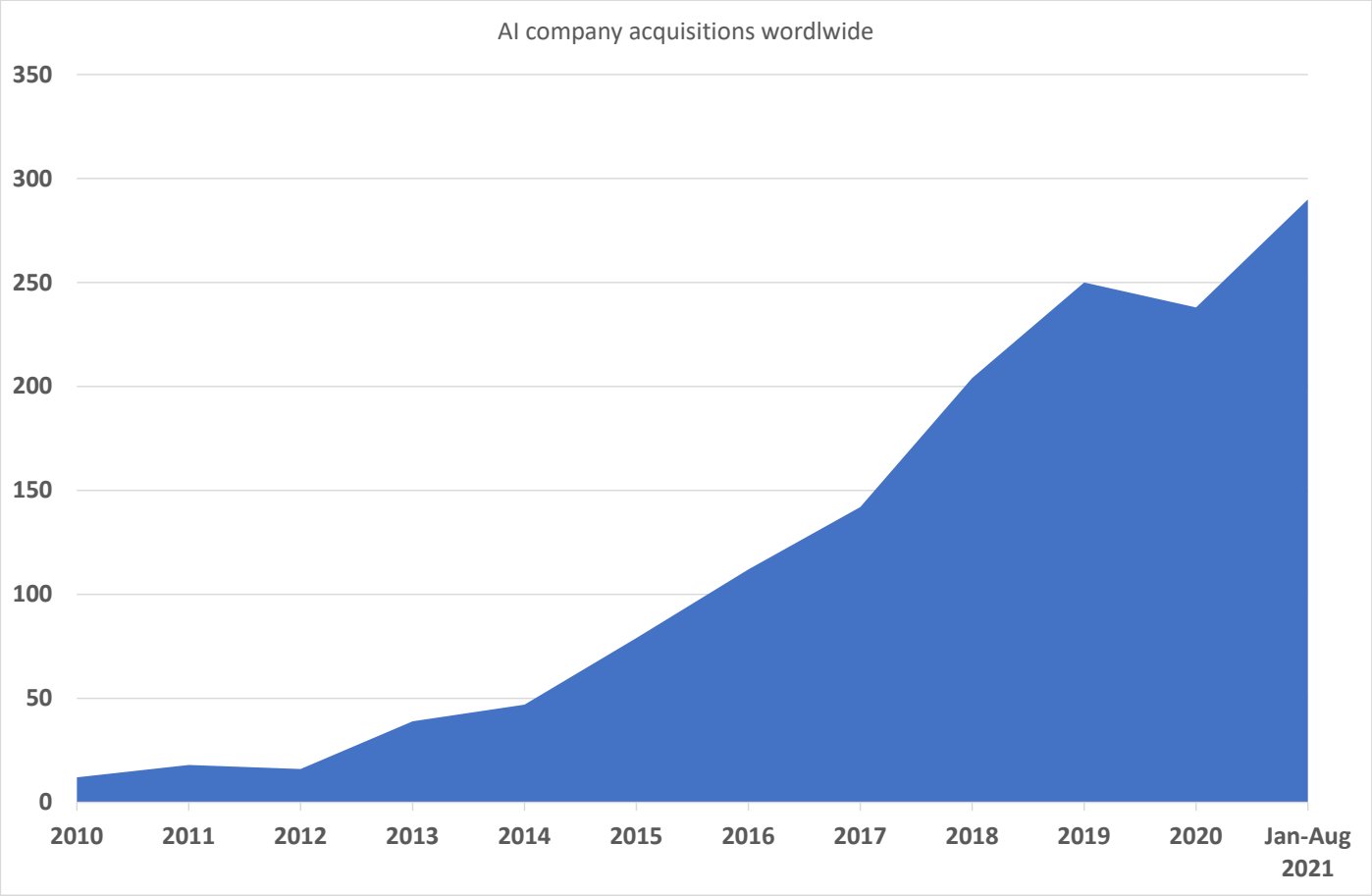
Source: Statista

AI adoption rates among companies in EU



Source: Eurostat

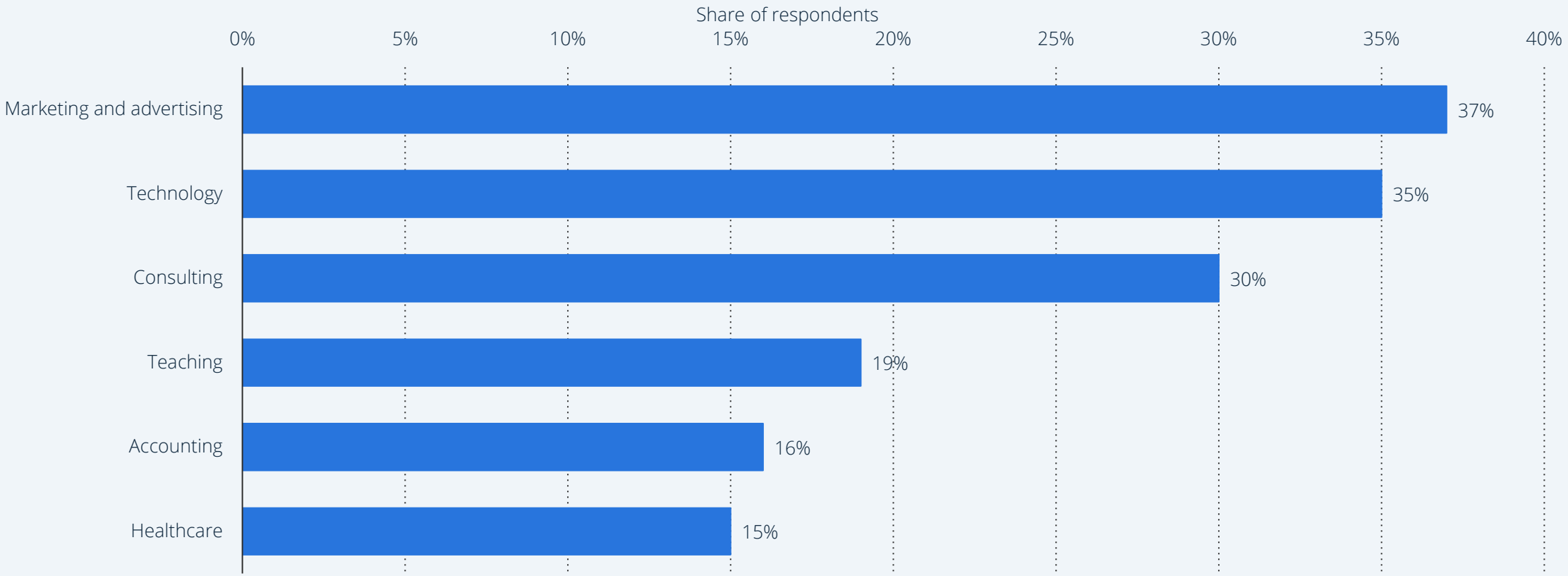
Massive growth in the acquisitions of AI companies during the 2010s



Data source: Crunchbase

Rate of generative AI adoption in the workplace in the United States 2023, by industry

Generative AI adoption rate at work in the United States 2023, by industry



Note(s): United States; January 4th to 8th, 2023; 4,500 respondents
Further information regarding this statistic can be found on page 8.
Source(s): Fishbowl; ID 1361251

Special features of digital economy

Special features of digital economy

Network externalities/effects (NE)

- Value of a product or service increases as more people use it.

- **Direct Network Effects:** Value of a product/service to a user increases as the number of other users of the same product or service grows (e.g., Instagram).

- **Indirect Network Effects:** Value of a product/service increases as more complementary products or services become available (e.g., Playstation: more users means more PS game developers. The more games available, the more appealing the PS console to users).

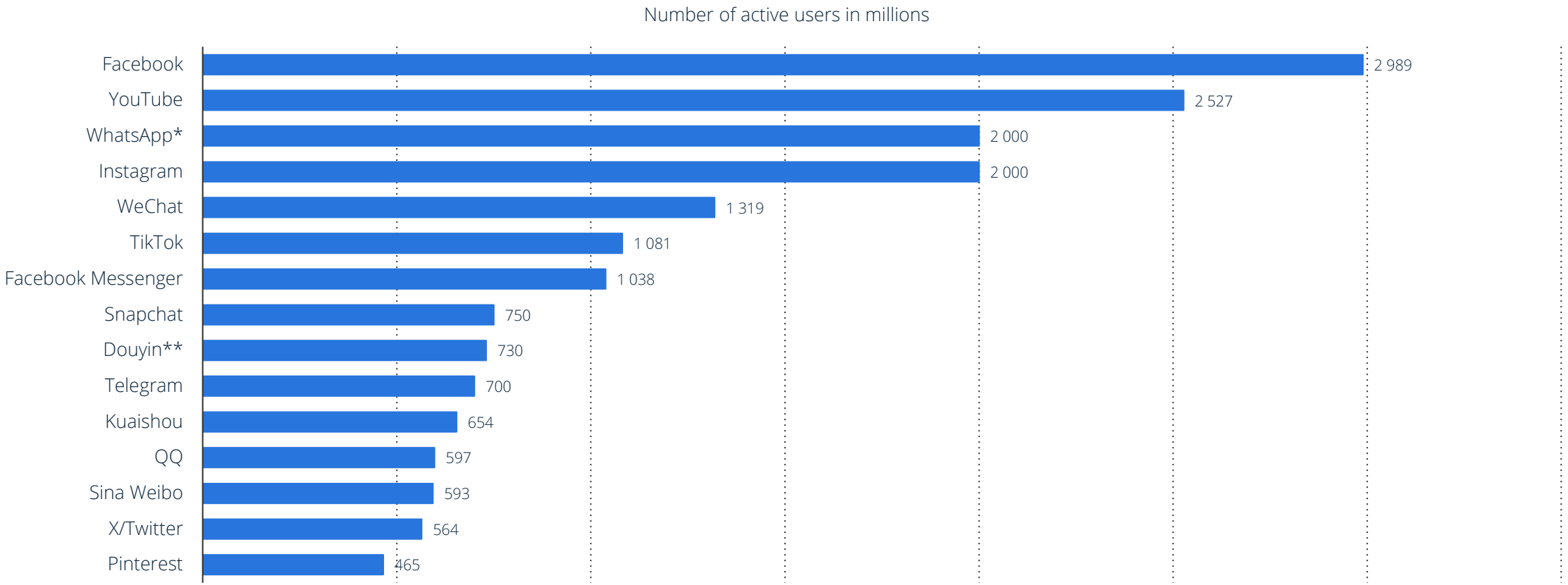
Special features of digital economy

1. Network externalities/effects (NE) & lock-in effects

- **Lock-in effects** arise from network effects
- Inferior technology may become standard due to being first on the market and obtaining large user base on condition there are **switching costs** and incompatible competing technologies on the market. (path dependence; dominant design are not always optimal, e.g., QWERTY).
- Switching costs such as financial costs of purchasing a new equipment, cancellation charges, costs of learning to use new technology (time and effort), or data portability.

Most popular social networks worldwide as of July 2023, ranked by number of monthly active users (in millions)

Global social networks ranked by number of users 2023



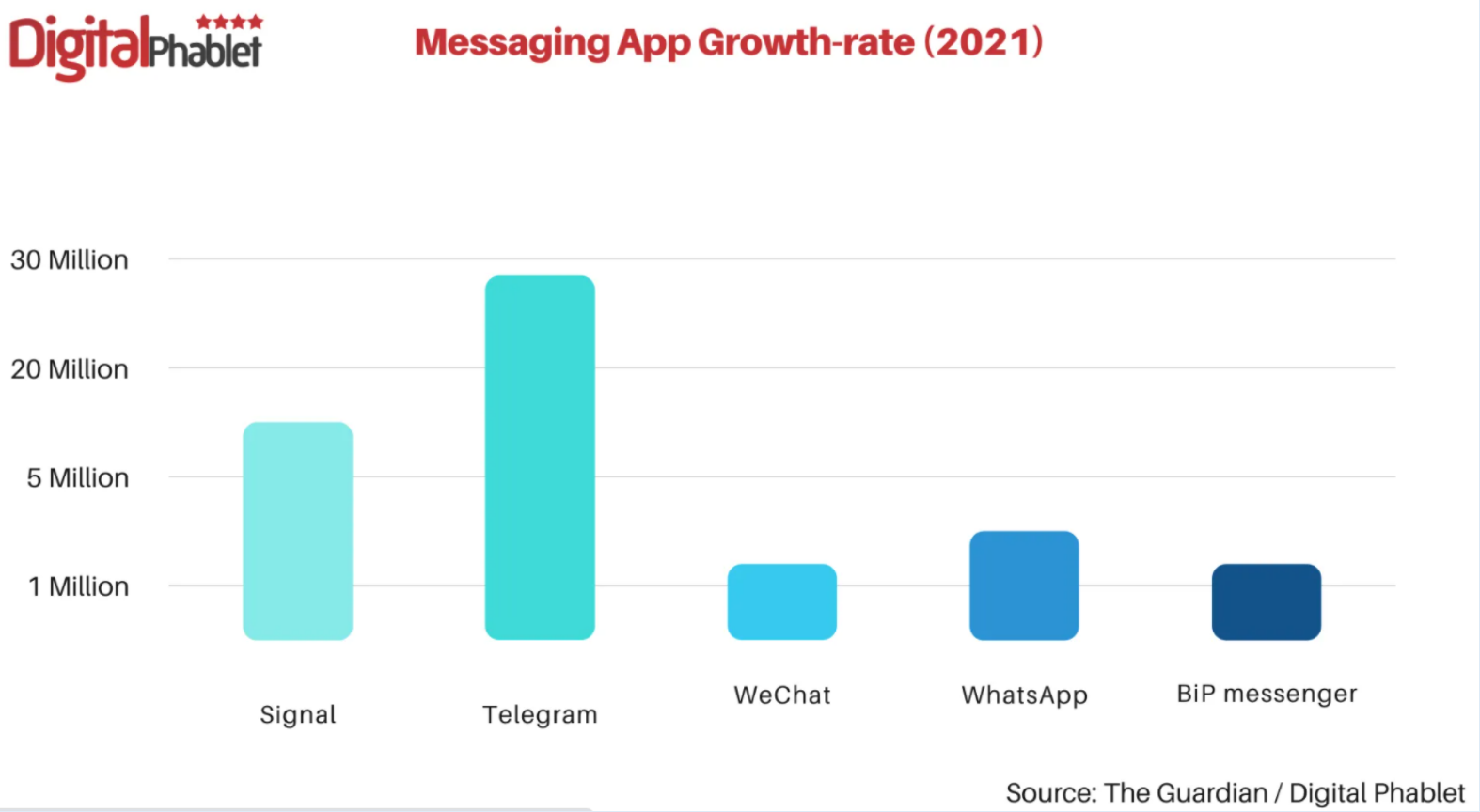
Note(s): Worldwide; July 2023; social networks and messenger/chat app/voip included; figures for TikTok does not include Douyin
Further information regarding this statistic can be found on page 8.
Source(s): We Are Social; DataReportal; Meltwater; ID 272014

Special features of digital economy

Network externalities/effects (NE) **& lock-in effects**

- Winner-takes-all, monopolies; difficult for new entrants to compete
- NE may prevent a superior platform from displacing an established incumbent.
- Consumers do not prefer new technology or service with better quality and/or lower price unless they are convinced to coordinate their migration to the new technology/service. (FB-WhatsApp case; Signal 12/2020: 20 million users → 01/2021: 40 million users; Mastodon case)

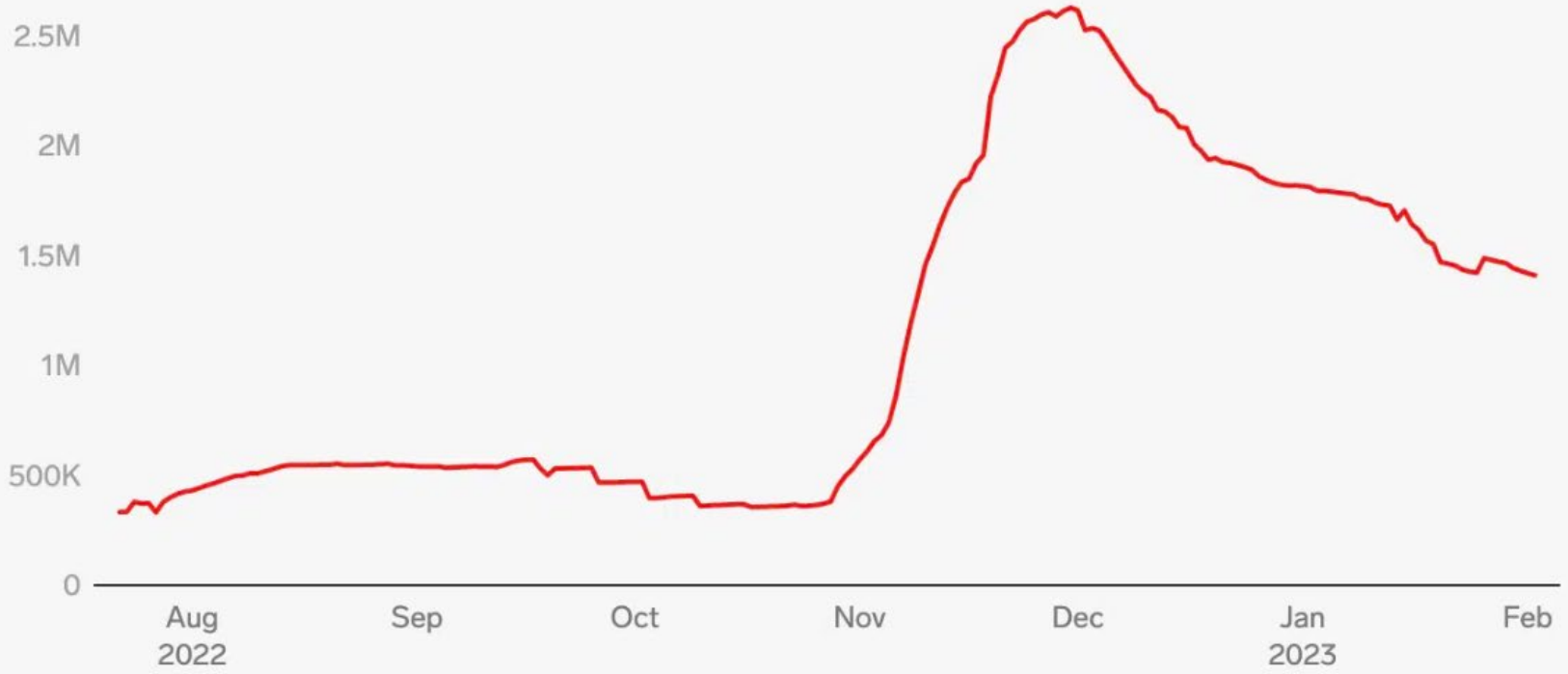
According to the figures shared by the UK Parliaments home affairs committee, Signal has gained 8 million users worldwide during the first three weeks of January, and Telegram has gained nearly 25 million users. A total number of 33 million people left Whatsapp.



Source: https://www.digitalphablet.com/33-million-users-leave-whatsapp-privacy-policy-update/

Mastodon Users Surged, Then Slumped

Active users on the decentralized platform soared after Elon Musk bought Twitter in October. Not all of them have stuck around.



SOURCE: MASTODON

Special features of digital economy

Network externalities/effects (NE) **& lock-in effects**

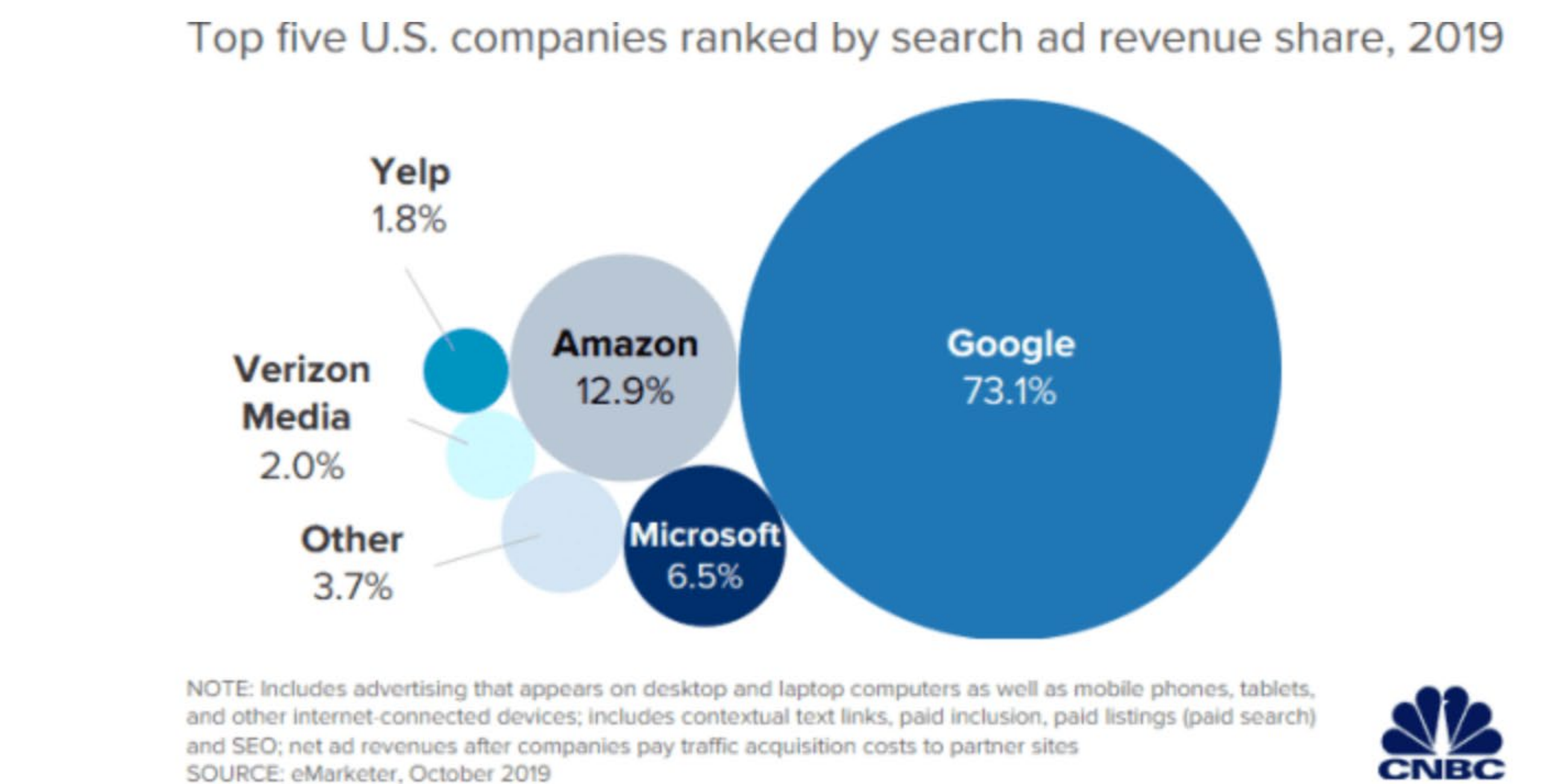
- Market leaders often aim to keep switching costs high making it challenging for customers to leave for competitor; switching costs as a competitive advantage (“incumbency advantage”).
- Firm strategies, for instance:
  - ✓ Cheap devices & expensive complementary products (e.g., printers and ink cartridges)
  - ✓ High cancellation fees for contracts (e.g., fixed-term mobile subscription)
  - ✓ Design technology incompatible with the competitors’ devices (e.g., videogames for a specific console)
  - ✓ Making it difficult for consumer to switch their data from one platform to another (e.g., reputation data on AirBnb)

Special features of digital economy

Very high returns to scale

- Initial cost of production of digital services or products high, MC of provision or transmission close to zero.
  → Significant competitive advantage for incumbents
  → Niche markets opportunities for entrants

- Free services – consumers attracted by zero price. When returns to scale & attraction of free strong, firm that obtain income from advertising rather distributes it at zero price than charges for its service.



Top 5 companies in the U.S. ranked by search ad revenue

Special features of digital economy

Changes in information asymmetries (one party of a transaction has more or better information than the other party).

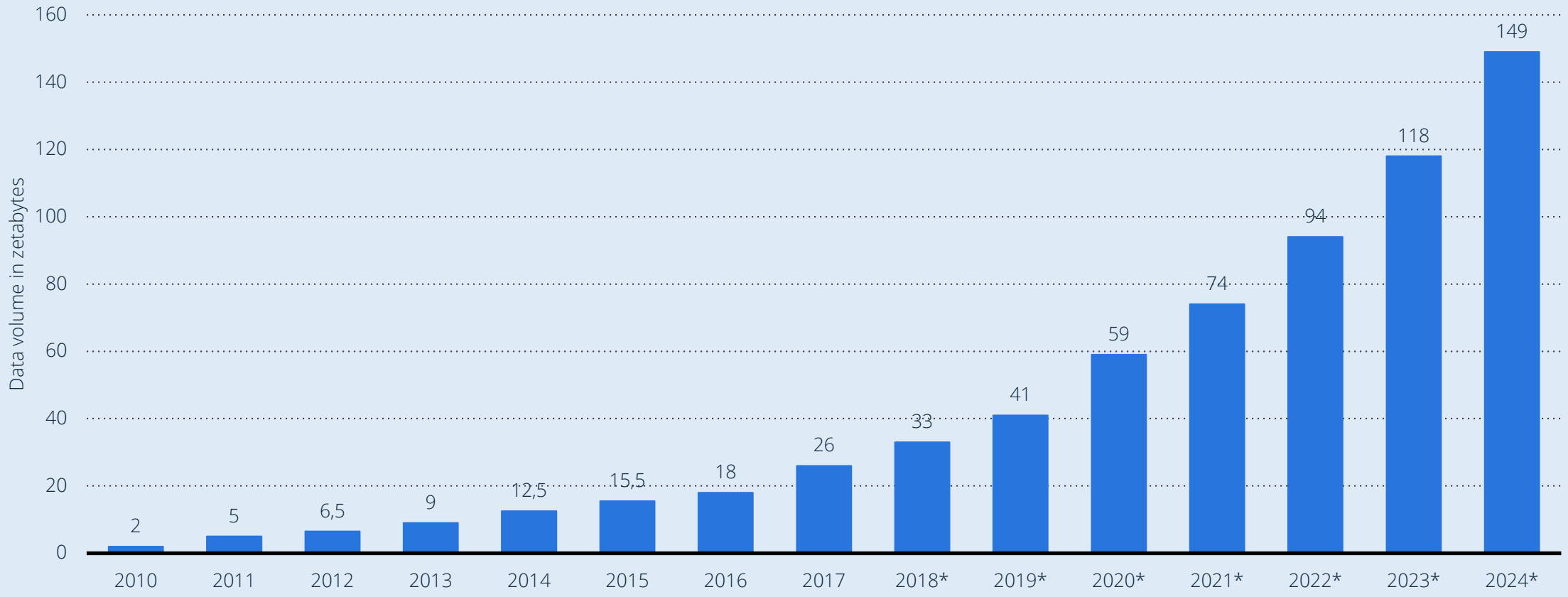
- **Increased transparency**, e.g., online review platforms allow consumers to share their experiences of products and services, comparison of prices.
- **Reduced search costs and improved price comparisons**; decreased time buyers need to spend looking for info about products, e.g., quick and easy comparison of prices and product features via online search engines.
- **Algorithmic price discrimination** (more information on users' preferences and willingness to pay for the seller; not the benefit of consumer)
- **Data collection & targeted advertising**: consumers may not be aware of how companies use their data and try to influence their behavior.
- **Fake news**

Special features of digital economy: role of data

- Data vs. ideas
  - ✓Idea is a production function (e.g., instruction for making a good).
  - ✓Data can be a **factor of production** (e.g., IoT, product/service improvements, aftermarket services).
  - ✓Data may also be **intermediate product** used in production (e.g., IoT data bought from another company, fridge, smartwatch), or **final product** used by consumers (e.g., personal health/fitness information).
  - ✓Access more important than ownership (licensing)

Volume of data/information created, captured, copied, and consumed worldwide from 2010 to 2024 (in zettabytes)

Amount of information globally 2010-2024



Note(s): Worldwide; 2010 to 2020

Further information regarding this statistic can be found on page 8.

Source(s): IDC; Seagate; Statista estimates; ID 871513

Special features of digital economy

- Data can be:

i) Volunteered (provided voluntarily by the user, e.g., video posted on social media)

ii) Observed (obtained automatically from the users' activity, "digital trace", e.g., Google Map's location data, IoT sensors, machine operations), or

iii) Inferred (obtained by transforming previous sets of data, e.g., predictions of person's movie preferences: Netflix movie recommendations).

- Different types of data:
  - ✓Personal/individual data (non-anonymous vs. anonymous use) vs. non-personal data
  - ✓aggregated data
  - ✓contextual data (e.g., maps, road network information)
  - ✓historical vs. real-time

Heterogeneity of data

- Personal data generated, e.g., via web search, applications, social media, digital marketplaces and location-based services (purchase history, health/fitness information, person's location and movements etc.)
  - ✓ **Insufficient privacy protection**: Firms may overuse personal data, not sufficiently respect consumer privacy (without regulation: GDPR, General Data Protection Regulation that came into force 05/2018)

- Different underlying reasons for data usage
  - ✓ For instance, using web search data to improve search engine and browsing services, or to train algorithm using a person's health data gathered via apps to make risk assessments for the persons health insurance.

Economic value and importance of data depends on the type of data, and how, on what market (by who) and for what purposes it is used

Is data a new oil? NO, because…

- Data in non-rivalrous, oil is rivalrous.
- Data is non-excludable, oil is excludable.
  - - Technical/legal restrictions needed to limit data use.
- Data is non-fungible, oil is fungible.
- Data MC=0, oil MC>0.
- Data is experience good (value uncertain until purchased and used), oil is search good (i.e, value can be assessed prior to purchasing)
- Returns to scale decreasing for data, constant for oil.

Strategies to gain competitive advantage via data use

Best strategies to use data to gain competitive advantage are market-specific, some widely applicable examples:

- Data-driven decision making
- Exploiting data to better understand consumers' preferences and willingness to pay (e.g., purchase history, browsing behavior, and social media activity).
  - → Improve existing products and services to better meet user needs
  - → Customer segmentation, personalization and recommendation
  - → Price discrimination via algorithmic pricing
- Identifying the least profitable products and discontinuing their production
- Supply chain optimization by improving inventory management, demand forecasting, and logistics.

Data is the key resource of platform economy

- Global tech giants dominate platform markets and use platforms as essential source of data they exploit in various ways in value creation.

Dominant platforms as “gatekeepers”

- Gatekeepers are platforms with a dominant position over access to a large group of users.

  → Gatekeepers can collect more data than their competitors: data/ information asymmetries and considerable informational advantage.

- Gatekeepers can control:

1. Access by third-party firms to its users (e.g., advertisers can only reach such a large audience through largest online social media platforms).
2. When large number of users use a single platform (“single-homing”), firms selling products online may have no other viable alternative than use it as intermediator for its products.

   ✓ Gatekeepers may control users’ access to content and products offered by third parties (e.g., online search engines determine the ranking of search results and visibility of products for users; if only one search engine, no access to different rankings and wider range of options).

Dominant platforms as “gatekeepers”

- Users can choose to single-home due to the innovative nature and/or higher quality of the products that the platform offers.
- The gatekeeper may promote single-homing through
  - ✓ Increasing costs of multi-homing (e.g., tying: Google made access to its app store conditional on the pre-installation of its Google Search app and Google Chrome browser on Android devices; exclusive contracts: Netflix & content providers).
  - ✓ Personalization of products (tailoring them to user needs) may enhance user experience; increases the switching costs for users to move to another platform.

- Examples: platforms operating in online marketplaces, app stores and social networks.

Large tech companies have developed technologies to exploit personal data: Examples of the titles of patented personal data related innovation

Company	Artificial intelligence
Google	Methods, systems, and media for personalizing computerized services based on mood and/or behavior information from multiple data sources, Systems and methods for promoting search results based on personal information, Estimating age using multiple classifiers.
Apple	Intelligent automated assistant, content item recommendations based on content attribute sequence.
Facebook	Systems and methods for identifying users in media content based on poselets and neural networks, Systems and methods for estimating user attention, Tag prediction for content based on user metadata, Methods and systems for recommending applications.
Amazon	User tracking based on client-side browse history, Method for using customer attributes to select a service representative, Determining user interest from non-explicit cues.

Data asymmetries and competition

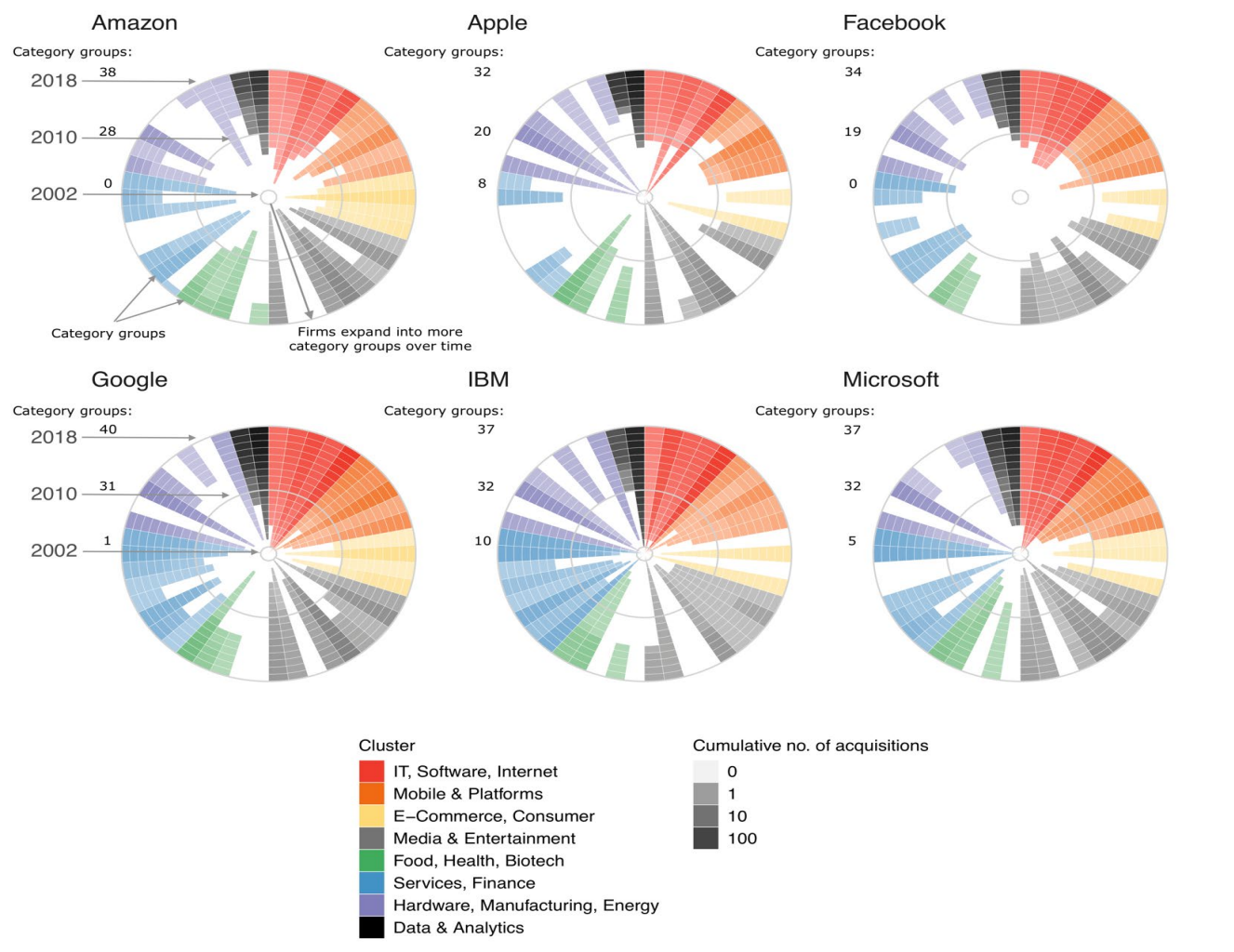
- The data generated by consumers on one market, can be used to develop new products in related and unrelated markets (economies of scope).
- When dominant firm in one market can exploit consumer data outside its primary market, it tends to become dominant in the 'connected markets' it enters. Tipped markets: low incentives for innovation and may deter the market entry of new firms. (Prufer and Schottmüller ,2017)

→ Incentive to large companies for conglomerate acquisitions (i.e., acquisitions of firms active in seemingly unrelated markets providing non-substitutable products with the acquirer).

Wearable tech makers ramp up opposition to Google's $2.1bn Fitbit deal

Groups criticise what they see as a move to monopolise the sector

Large tech companies' acquisition patterns across different product markets



Source: Koski et al. (2020). Killers on the road of emerging start-ups

Large tech companies' acquisitions may reduce creative destruction

- Acquisitions may facilitate transfer of technologies, generate efficiencies & synergies as established firms possess competencies, assets, and financial resources needed to commercialize innovative ideas and products of acquired start-ups.

BUT

- Acquisitions of newly established companies
  - eliminate potential future competition, reduce innovation and have detrimental effects on competition and consumers.
  - may be "killer acquisitions" (Cunningham, et al. 2021) incumbent acquires its potential competitor in the early stage of developing its innovative project to terminate it after the acquisition (avoids the risk of its own product becoming obsolete).
  - may generate "kill zone" for start-ups (i.e., reduced availability of venture capital funding and thus fewer prospects to grow, Kamepalli et al., 2020)

EU digital regulation (DMA, DSA, Data Act, AI Act, GDPR, PSD2)

- Many parts of new digital regulation aim at regulating large companies or are stricter to them (e.g., DMA & Data Act); prevent the use of anticompetitive practices of large tech companies with market power.

- Increasing regulation burdensome for companies; compliance costs.

- New data available: i) DMA, largest platforms must give their business users access, free of charge, to data generated by platform users, ii) Data Act: (primarily large) manufacturers of connected devices must give their users access to data generated by devices.

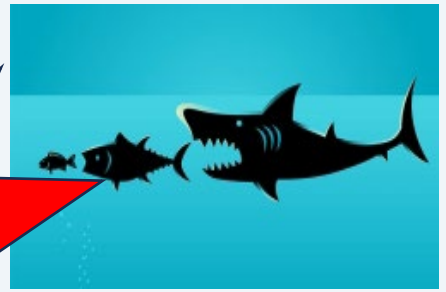
- **Potential**: more widely shared data enables innovation and the creation of new markets; provides opportunities for high value-added production, scaling, and internationalization.

Government intervention needed to address **market failures** (i.e., free market fails to achieve socially efficient outcomes)

BIG TECH WITH MARKET POWER

Abuse of market dominance

MARKET FAILS*



- Killer acquisitions
- Kill zone

- Information/data asymmetries
- Insufficient privacy protection

- Network effects
- Switching costs
- Lock-in

* Reduced market entry & competition
* Less innovation and creative destruction
* Consumer harm (less variety or consumer choice, higher prices etc.)