GREAT
BRITAIN & NORTHERN IRELAND

Digital Technology

Trade challenges and opportunities post pandemic

RESEARCHED AND WRITTEN BY

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Foreword

The digital economy has enabled development of advanced products and services in numerous areas, including finance, healthcare, and education. The increasing reliance of organisations on data and the prominence of digital platforms as focal points of competition are the key drivers of digital economy growth. Global spending on ICT was steadily growing at a rate of 4% annually for several years, reaching a total of £3.5trn (US$4.9trn) before the Covid-19 pandemic. The sector is expected to expand faster from 2021 onwards, mainly driven by newer technologies.

Three technology sub-sectors currently attracting significant investments include artificial intelligence, cybersecurity and semiconductors. The proactive role of governments in developing digital industries goes hand in hand with the surge in the digital economy.

The UK is one of the global leaders in the digital economy regarding the production and export of digital products and services. Especially in developing and commercialising advanced technologies, the UK has been a long-term global leader in areas such as AI, robotics, and blockchain. The UK's digital and technology sector remain crucial to the UK economy – the digital sector was worth more than £400m a day to the UK economy in 2018. The digital economy is also a critical source of employment across the country and the UK Government has been working towards ensuring that businesses and employees across the country can successfully compete globally. This includes developing critical skills domestically and attracting the best talent from around the world.

Governments and business around the world grasp the critical importance of supporting technology innovation and development of the digital economy, yet this often involves protectionist interventions. However, open international trade in digital goods and services remains essential for long-term sustainable economic growth and prosperity. The UK Government is committed to supporting UK businesses' ability to innovate and offer their digital solutions to partners around the world, facilitating productivity growth and better economic opportunities across the country.

Andrew Mitchell
Director General
Exports and UK Trade
Department for International Trade (DIT)

About this report

Trade challenges and opportunities in the post-pandemic world: Digital Technology is an Economist Intelligence Unit (EIU) report, supported by **the UK's Department for International Trade (DIT).**

Through a range of expert interviews, secondary literature review and a data audit, this report explores the challenges and opportunities for global trade and investment in creative goods and services. The EIU would like to thank all experts for their time and insights.

Antonio Andreoni, Associate Professor of Industrial Economics, UCL

Kevin Brown, Managing Director, BT Security

Sabina Ciofu, Head of EU and Trade Policy, TechUK

Julian David, CEO, TechUK

Priya Lakhani, CEO, Century Tech

Torbjörn Fredriksson, Chief of ICT Policy Section, UNCTAD

Michael Nelson, Senior Fellow, Director of Technology and International Affairs Program, Carnegie Endowment for International Peace

Section 01

Global digital technology sector growth and outlook

01

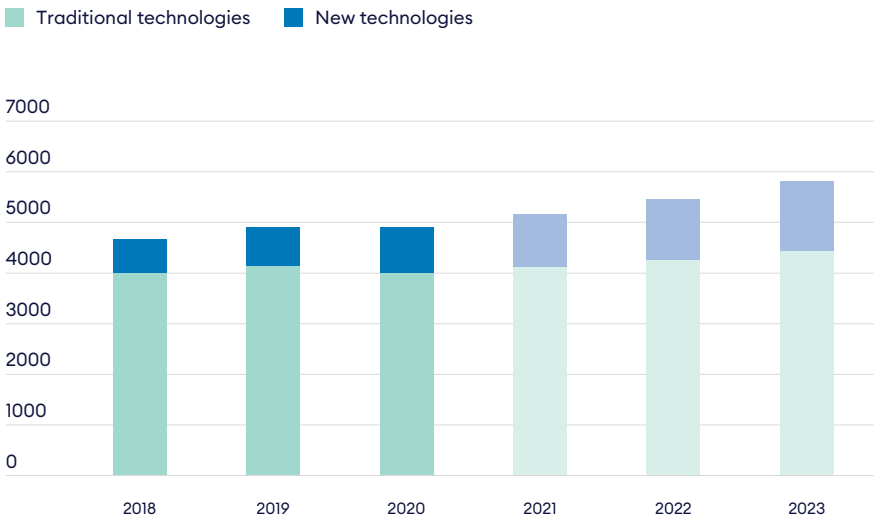
Global digital technology sector growth and outlook

The near complete intertwining of digital technology and economic activity in much of the world makes it increasingly complex to evaluate one separately from the other.

It remains useful, however, to track the production and sale of digital technology goods and services as a way of gauging trends in the adoption of different families of technology, as well as the contribution they make to economic growth in different countries.

Until 2020, global spending on ICT (information and communications technology)[1] had grown at a steady pace of around 4% annually for several years, reaching a total of US$4.9trn in 2019, according to technology research firm IDC. The pandemic interrupted that momentum as organisations cut back on spending on traditional types of hardware and enterprise software. IDC sees spending on these technologies rebounding in 2021, with spending on newer technologies, such as IoT (Internet of Things), robotics, 3D printing, AI, and augmented and virtual reality, continuing to grow at a faster pace. The firm expects global ICT spending overall to increase from an estimated $5.2trn in 2021 to $5.8trn in 2023, representing annual growth of around 6%. Much of that expansion will be driven by spending on newer technologies, which will account for 23% of total spend in 2023 (compared with just 14% in 2018).[2]

Figure 1: Rapid recovery: *Worldwide ICT spending, 2018-2023 (US$ bn)*



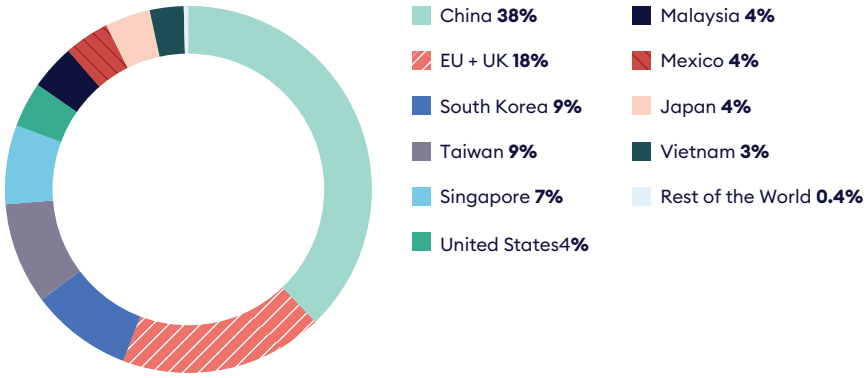
Source: IDC

Given the weight of large multinationals in technology provision, it is not surprising that the global value of international trade in digital technology is also considerable. In 2017, the most recent year for which there is reliable historical data, cross-border exports of ICT goods and services were around US$2.5trn worldwide.[3] We estimate that global exports totalled around US$2.74trn in 2020.[4]

Most of this value–about 75%–comes from trade in goods. However, trade in ICT services is growing at a considerably faster pace. Between 2010 and 2017, the compound annual growth rate (CAGR) of ICT services was 7.7%, far eclipsing the 1.5% growth in goods exports.[5]

In terms of country of origin, China is the world's dominant exporter of ICT goods, accounting for 38% of the global value of exports in 2017. The European Union and the UK together accounted for 18%, South Korea and Taiwan for 9% each, and the US for 4%.[6] US firms, however, are likely to account for a substantially higher share in actuality, as its multinationals' exports often originate from overseas subsidiaries.

Figure 2: Global play: *Share of global exports in ICT goods (%), by country, 2017*



Source: UNCTAD

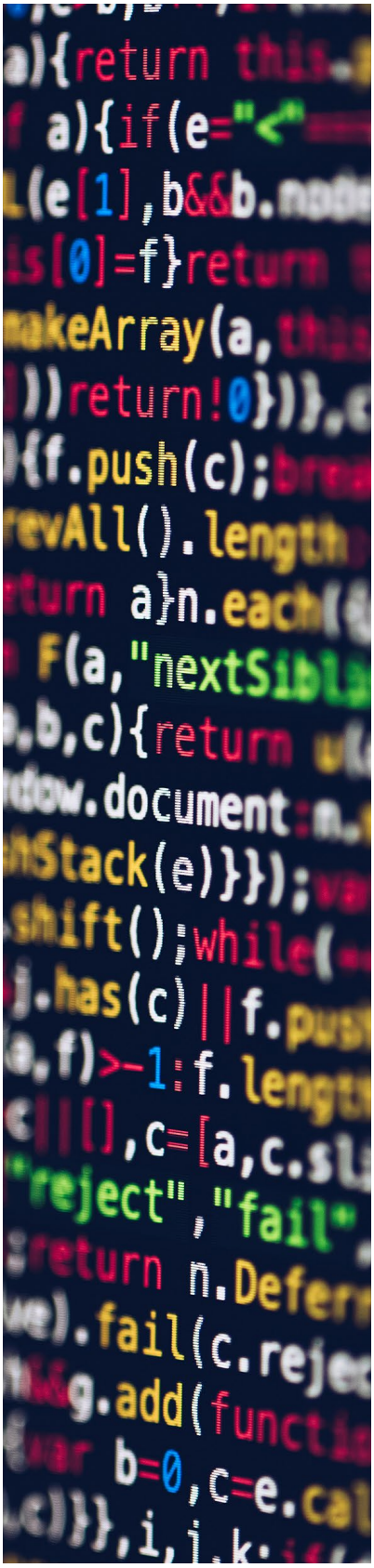
> "The big platforms have considerable advantages when it comes to translating access to data into something that can create value."
>
> **Torbjörn Fredriksson**, Chief of ICT Policy Section, UNCTAD

The wider digital economy

The above figures of course paint only a partial picture of the growth of the digital economy and the role of countries and companies in it. Digital technology is the prime enabler of entire families of advanced products and services such as fintech (financial services), healthtech (health and medical goods and services), edtech (education services)[7] and others. Aside from the US and China, countries such as the UK, India and Canada are home to companies at the forefront of these growing fields of activity.

Also hidden from view in the figures are what Torbjörn Fredriksson, chief of UNCTAD's ICT policy section, considers the key drivers of digital economy growth: organisations' reliance on digital data and the increasing prominence of technology platforms as a focal point of competition. The two trends are interlinked, he says, and serve to reinforce the power that US and Chinese technology companies in particular exercise in digital technology markets. "The big platforms have considerable advantages when it comes to translating access to data into something that can create value," says Mr Fredriksson, "and they use the proceeds from that to invest in advanced technology fields such as 5G, IoT and AI."

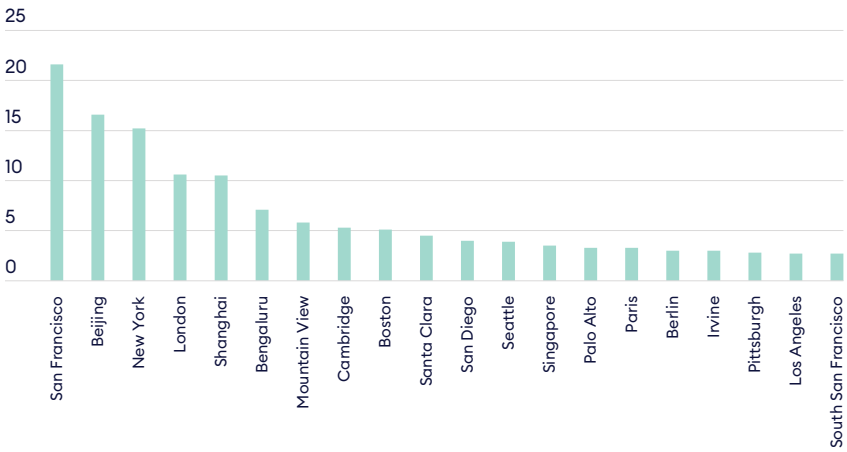
Some degree of market concentration is already a reality in advanced technology fields such as those cited above. As we will see below, however, countries other than the US and China are also influential generators of growth in their own right.



UK perspective: Advanced tech booming, but facing challenges

In terms of scale or market power, the UK's technology sector and its players generally occupy one or more tiers below those of the US and China. In the development and commercialisation of advanced technologies, however, the UK comes into its own. Julian David, CEO of TechUK, a trade association, notes that the country has long been among the global leaders in the development of "deep tech"–science-and-engineering-intensive fields such as AI, robotics and blockchain. This is due partly to the fruitful nexus between university-centred R&D, a strong start-up culture and a bubbling tech VC (venture capital) scene. London currently ranks fourth in the world, for example, behind San Francisco, Beijing and New York as a source of tech VC investment, and the UK as a whole ranks third in this indicator behind the US and China.[8]

Figure 3: City power: *Venture Capital (VC) investment in tech companies (US$ bn), by city, 2020*



Source: Tech Nation

Century Tech, a London-based edtech scale-up that uses AI to power its services, is one beneficiary of this ecosystem. Priya Lakhani, the firm's founder and CEO, says it has particularly profited from a knowledge transfer partnership it established at its inception with the engineering and education departments of University College London (UCL).

In the view of both Ms Lakhani and Mr David, there is one factor that could stall continued growth of the UK's role as a centre of deep tech commercialisation: a shortage of talent. Start-up and midsize tech companies alike have trouble attracting talent, says Mr David. Larger players have better success, he says, but they are concerned about their supply chains' access to talent. This is particularly pertinent as demand for skills in cutting-edge technologies such as cloud, artificial intelligence (AI) and robotics saw a resurgence in many cities across the country, such as Leeds, Edinburgh and Manchester in 2020.[9]

Moreover, as Mr David noted, many of the UK's fintech and deep tech success stories were staffed by engineers from the EU. And it is engineers, not website developers or digital marketers, says Ms Lakhani, that firms like hers need to further develop their AI capabilities. To address the talent shortage in these areas, TechUK has been calling for mobility provisions to be included in the free-trade agreements to revive the inflow of technology expertise to the UK. Even provisions for short-term stays will help, says Sabina Ciofu, the association's head of EU and trade policy. "Tech companies need to be able," she says, "to bring over engineers and other professionals from other countries for three, six or 12 months to help set up or fine-tune their systems."

Section 02

Sub-sectors driving broader digital revolution

02

Sub-sectors driving broader digital revolution

To better understand the dynamics underlying the growth of digital technology investment and trade, it is worth taking a close look at three technology sub-sectors currently attracting considerable corporate and VC investment.

> "A lot of good algorithms are being fed bad data, leading to bad results."
>
> **Michael Nelson**, Senior Fellow, Director of Technology and International Affairs Program, Carnegie Endowment for International Peace

Artificial intelligence

Any discussion of AI should start by clarifying what precisely it is. AI is best defined as a branch of science encompassing various fields that enable computer systems to perform tasks normally requiring human intelligence. Machine learning (ML) is one of the science's most important fields, a set of techniques that use algorithms and the crunching of large volumes of data to automate the learning process. AI and ML are not technologies in their own right, but rather enablers of intelligent technologies and services that have the potential to drive productivity gains, open new markets and transform business models.

For this reason, attempts to size an AI market are a complex undertaking. One effort to do so estimates worldwide revenue generated by the sale of AI-based software and services at US$62bn in 2020, increasing to US$998bn by 2028.[10] The McKinsey consultancy takes a different approach, estimating the potential value generated by the application of AI techniques in a range of industries to be between US$3.5trn and US$5.8trn annually. The sectors with the greatest potential value generation, according to the firm's research, are retail (up to US$800bn annually), consumer packaged goods, travel, and transport and logistics (each up to US$500bn), and automotive and assembly (up to US$400bn).[11]

The deployment of AI by businesses was widespread even prior to the pandemic, according to research conducted by MIT Technology Review.[12] Another study, from 451 Research, found that AI adoption had increased during 2020.[13]

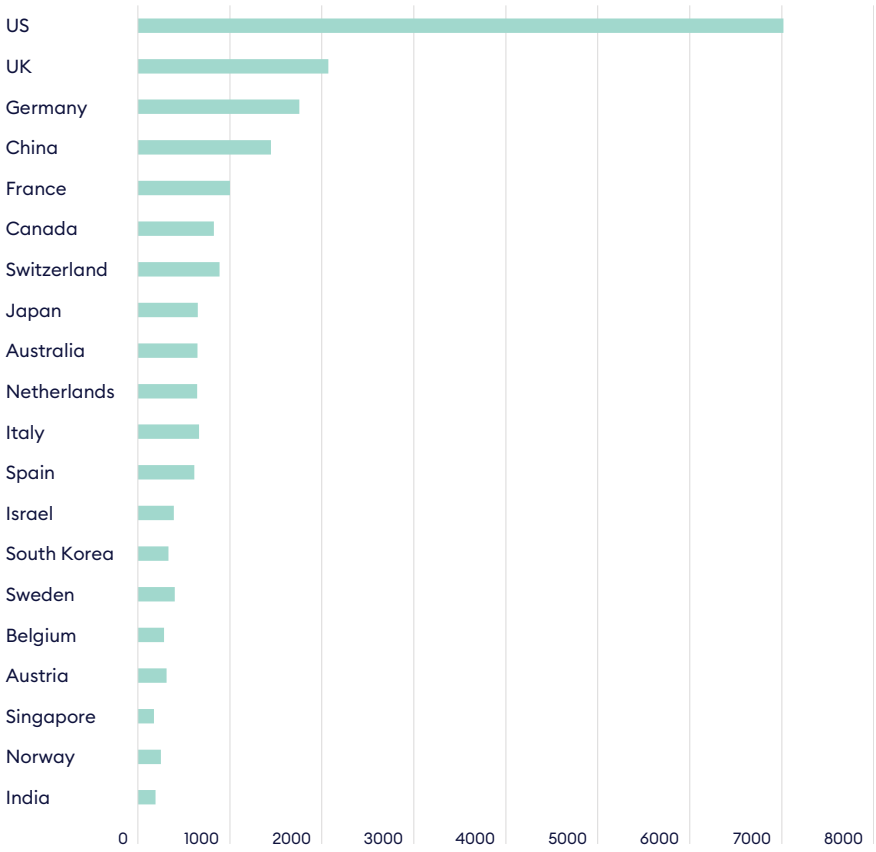
At the same time, the MIT study found that, while most large enterprises had incorporated AI into their operations to at least some extent, relatively few used it in more than a small percentage of processes.

According to Michael Nelson, a senior fellow at the Carnegie Endowment for International Peace and director of its Technology and International Affairs Program, two obstacles stand in the way of the widescale AI adoption that would generate the value cited above. One is a shortage of good-quality data. At present, he says, "A lot of good algorithms are being fed bad data, leading to bad results." ML in particular will not be able meet its potential without substantial improvement in the quality of data it is consuming.

The other barrier to AI growth is a shortage of talent to work with data. "We need a lot more data scientists than chip designers, and we don't have them," says Mr Nelson. "The relatively few who are available command skyrocketing salaries."

Geographically, the talent that drives these improvements is largely concentrated in advanced economies such as the US, UK, Germany and China. According to the Nature Index, which tracks the affiliations of high-quality scientific articles, researchers from the US published 7,020 articles in reputable journals between 2015 and 2019. This is followed by 2,073 for the UK, 1,756 for Germany, and 1,446 for China.[14] This talent is not just a measure of academic skill. The proportion of PhDs who transition into related industries was 65% in the US in 2019, up from 44% in 2010.[15]

Figure 4: Artifical Intelligence (AI) publications: *Number of AI articles in scientific journals, by country of author, 2015-2019*



Source: Nature Index 2020

Note: The country figures shown represent the number of articles for which there was at least one author from that country.

Cybersecurity

Global revenues for cybersecurity services are projected to grow from an estimated US$67bn in 2019 to US$111bn in 2025.

Almost every day or week brings a new reminder of the seemingly inexorable growth of cybersecurity threats facing organisations and wider society. That is the prime driver behind the steady growth of this part of the technology market. Global revenues for cybersecurity services are projected to grow from an estimated US$67bn in 2019 to US$111bn in 2025, which represents an CAGR of 8%.[16] The sub-sector is also a major generator of export revenue: UK firms, for example, generated £3.96bn in cybersecurity export revenue in 2019, a more than twofold increase over the figure registered in 2016.[17]

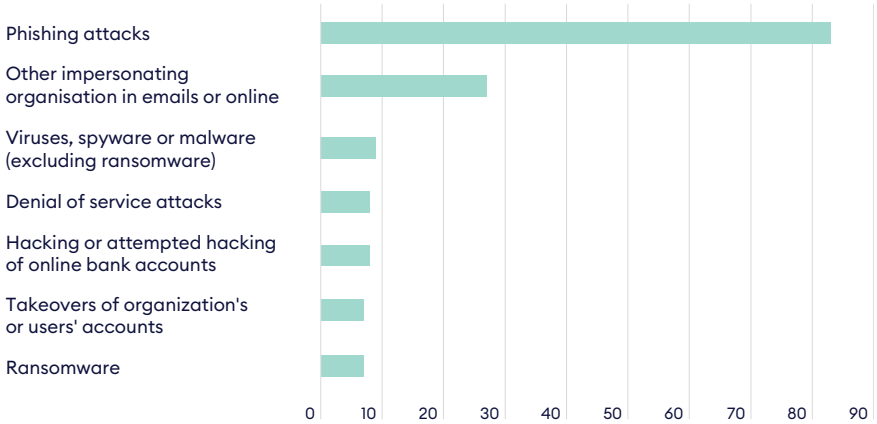
Growth of funding for companies providing cybersecurity solutions shows no sign of abating. According to Crunchbase, this category of investment has increased ninefold in the past decade, reaching a record level of US$7.8bn globally in 2020. The lion's share of investment in cybersecurity companies originates in the US–76% of the global total in 2020. Israel accounted for 8% of the total in that year and the UK 3%.[18] The latter country's cybersecurity firms raised US$821m in new investment in 2020, more than twice the figure raised the previous year.[19]

The pandemic served to deepen two sources of security vulnerabilities that organisations face. One is the use of cloud infrastructure and services, which took a leap in much of the world in 2020 as organisations that hadn't previously done so shifted much of their sales, customer service and other operations to a public cloud environment.

Cloud security was by far the fastest-growing category of cybersecurity spending in 2020, increasing by 42% year-on-year, according to technology research firm Gartner.[20] The other source of expanded vulnerability is the mass shift to remote working. The suddenness of the exodus from corporate offices to homes caught many security teams unprepared, leading to new spending on remote security solutions to plug gaps. Employees are returning to offices, but hybrid office/home work regimes are likely to be commonplace, and hackers are certain to probe for new windows into corporate networks through employees' devices.

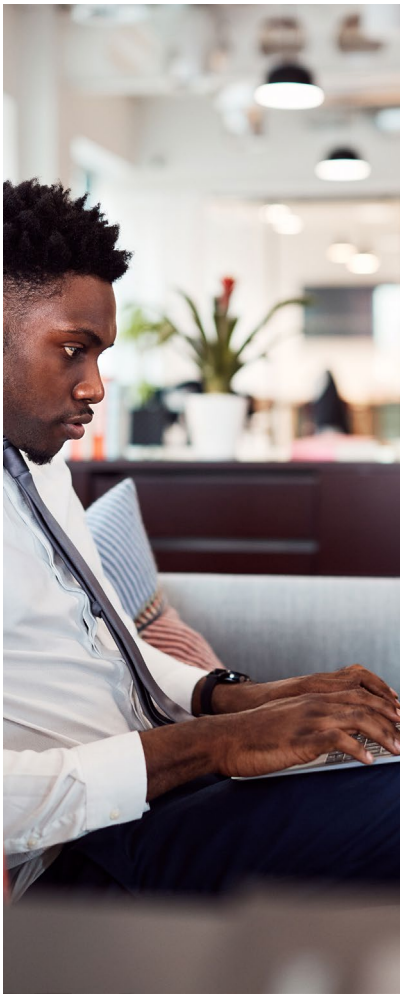
The UK's National Cyber Security Centre and its commercial partner Netcraft took down more than 15,000 coronavirus-related malicious campaigns in 2020.[21] Phishing attacks, in which hackers impersonate organisations or individuals to induce employees to reveal passwords or other information, are by far the major type of breach suffered by businesses in that country. Breaches due to phishing attacks are often the precursor to ransomware attacks; a particularly damaging example of the latter was suffered by the Colonial Pipeline energy distribution network in the US in May 2020.[22]

Figure 5: Something's phishy: *Share of cyber security breaches reported by UK companies over previous 12 months, by type of breach*



Source: UK Department for Digital, Culture, Media and Sport

Note: *Data from a UK government survey conducted between October 2020 and January 2021



UK Perspective: The ever-changing cybersecurity environment

To describe how network security has changed in the past few years, Kevin Brown, managing director of BT Security, prefers to use a food analogy. "It's no longer about protecting a hardened perimeter, like a coconut, within which all an organisation's network activity took place," he says. "With the rise of the cloud and predominantly software-defined activity, the perimeter has fallen away, leaving something like an avocado–a small stone in the middle surrounded by a large, soft external layer where a lot of activity takes place."

For network security teams, the Covid-19 crisis has exacerbated the challenges posed by this development as the edge of networks moved from business premises to homes. Phishing attacks have multiplied severalfold, says Mr Brown, because organised cyber criminals quickly grasped how to target remote and often isolated employees with well-masked emails, leading to a spate of denial-of-service, ransomware and other attacks.

IT teams also took a lot of risks in the early stages of the pandemic, adds Mr Brown. "Everyone had business continuity plans, but I don't think any of them assumed that almost all staff would have to shift to remote working within 24 or 48 hours." In many places employees are starting to return to offices, but Mr Brown believes that security teams have not fully addressed those risks. Although there is recognition of the need to invest more in cybersecurity, he says, many teams are waiting to see what type of future work regimes ultimately take root before making decisions about what to invest in.

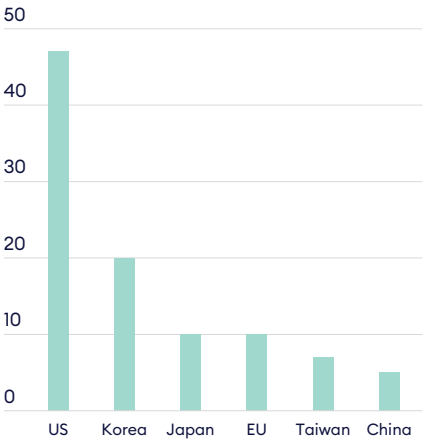
A likely feature of future security strategies is the adoption of a multi-layer approach. This will include recognising that, when it comes to cybersecurity, not all employees are equal. "Security teams may be relatively relaxed about a junior member of staff in a generic role working from home," says Mr Brown. "But if it's a senior executive in a commercially sensitive role, they'll need to adopt a defence-in-depth approach." This might involve installing a hardened SD-WAN (software-defined wide-area network) box in those people's homes so that their connections to the internet are controlled by established policies, says. "This is where organisations are shifting to now in order to realise a more sustainable method of enabling the hybrid workforce."

Chips are at the heart of the enormous advances in computing power the world has seen in the past 25 years.

Semiconductors

Semiconductor production may be described as the engine of the digital economy, in that chips are at the heart of the enormous advances in computing power the world has seen in the past 25 years. Semiconductors are essential components of almost all digital devices used today. Having grown at an average rate of around 3.9% per year since 2000, global semiconductor revenues might have been expected to flatline or contract during the pandemic, but conversely they grew at a faster pace in 2020–by 7.3%, according to Gartner.[23] Notwithstanding existing supply chain disruption, the Semiconductor Industry Association (SIA) expects global revenue to reach US$469bn in 2021, expanding again the following year to US$496bn.[24]

Figure 5: Global competition:
Top 5 countries with global market share of semiconductor industry



Source: Semiconductor Industry Association

Since the onset of the pandemic, global semiconductor supply has been unable to keep up with skyrocketing demand. The latter has been driven mainly by a surge in sales of home computer equipment as employees shifted en masse to remote working. Severe chip shortages (also caused by a drought which hit production in Taiwan) are the result, and have negatively impacted numerous producers of end-user devices, including automotive and consumer electronics firms.

According to Julian David, the shortages have thrown light on the inadequate resilience of technology sector supply chains. They have also underscored the extreme concentration of semiconductor production. Although US firms account for 47% of global sales, most exports originate from East Asia–namely Taiwan, South Korea and China.[25] Moreover, the most advanced generation of semiconductors is currently produced at scale only by Taiwan's TSMC and South Korea's Samsung.

This situation has led some device manufacturers and governments to explore means of establishing production capacity closer to home. Such efforts are unlikely to bring them any relief, believes Torbjörn Fredriksson. He points out that chip fabrication is extremely costly and relies on a plentiful supply of skilled engineers. For these reasons, he says, the existing concentration of market power among East Asian and US firms is unlikely to be reduced in the foreseeable future.

Section 03

Changing policy and geopolitics

03

Changing policy and geopolitics

Some facets of technology R&D and production have long been treated strategically by governments and been subject to policy interventions.

As digital has come to underpin more economic activity, however, its science and production have come to be the subject of proactive industrial policy in many developed (and some less developed) countries. This more active state role in digital technology development as well as the growing geopolitical rivalry between the US and China are impacting technology producers' supply chains and may shape future technology trade patterns.

Industrial policy

"Strategic public investments to shelter and grow champion industries is a reality of the twenty-first-century economy. We cannot ignore or wish this away." These are the words, spoken in June 2021, by Brian Deese, Director of the National Economic Council, which advises the US president on economic policy.[26] He voiced them as context in calling for the US to adopt a "national industrial strategy" to boost manufacturing of advanced technologies.

This is the latest manifestation of governments' penchant to proactively support domestic industries in the digital technology sector. While China's government has pursued this approach for several years, it is a new departure for Western governments, says Antonio Andreoni, Associate Professor of Industrial Economics at UCL. "This is a much more strategic type of intervention that we haven't seen pursued so explicitly in the past," he says.

Such efforts are driven by multiple policy objectives, the most important of which are: the desire to improve absolute levels of productivity in the economy; the desire to establish capacity in high value-add segments of the global supply chain; and the desire to gain autonomy in, or influence over, industries with strategic economic and security value.

Since 2008, 101 countries, representing more than 90% of global GDP, have adopted formal industrial development strategies,[27] and these focus mainly on supporting technology innovation and development of the digital economy. The trend is evident across development stages. Of the 114 post-2008 industrial policies identified by UNCTAD, 30 emanate from developed countries and 84 from developing ones.[28]

Although policy specifics vary from country to country, two broad approaches stand out. One is the use of support measures. These are largely direct or indirect transfers from government to the private sector in the form of, for example, tax cuts, grants, R&D funding or equity financing. China makes considerable use of mission-oriented R&D funding, while the EU tends to utilise undirected grants and equity financing.[29] Michael Nelson believes the US does a very good job of investing in the early development of AI and other advanced technologies.

> "Strategic public investments to shelter and grow champion industries is a reality of the twenty-first-century economy. We cannot ignore or wish this away."
>
> **Brian Deese**, Director of the National Economic Council

> The UK government has also joined the ranks of those devising a national strategy to support the growth of AI- and robotics-related R&D and commercial development.

Many of these initiatives have involved defence or security agencies, he says, but they are scattered across the federal government and are also undertaken by some state governments.

The UK government has also joined the ranks of those devising a national strategy (with accompanying funding) to support the growth of AI- and robotics-related R&D and commercial development. These are manifested in the UK's Industrial Challenge Fund and AI Sector Deal, launched in 2017 and 2018 respectively.

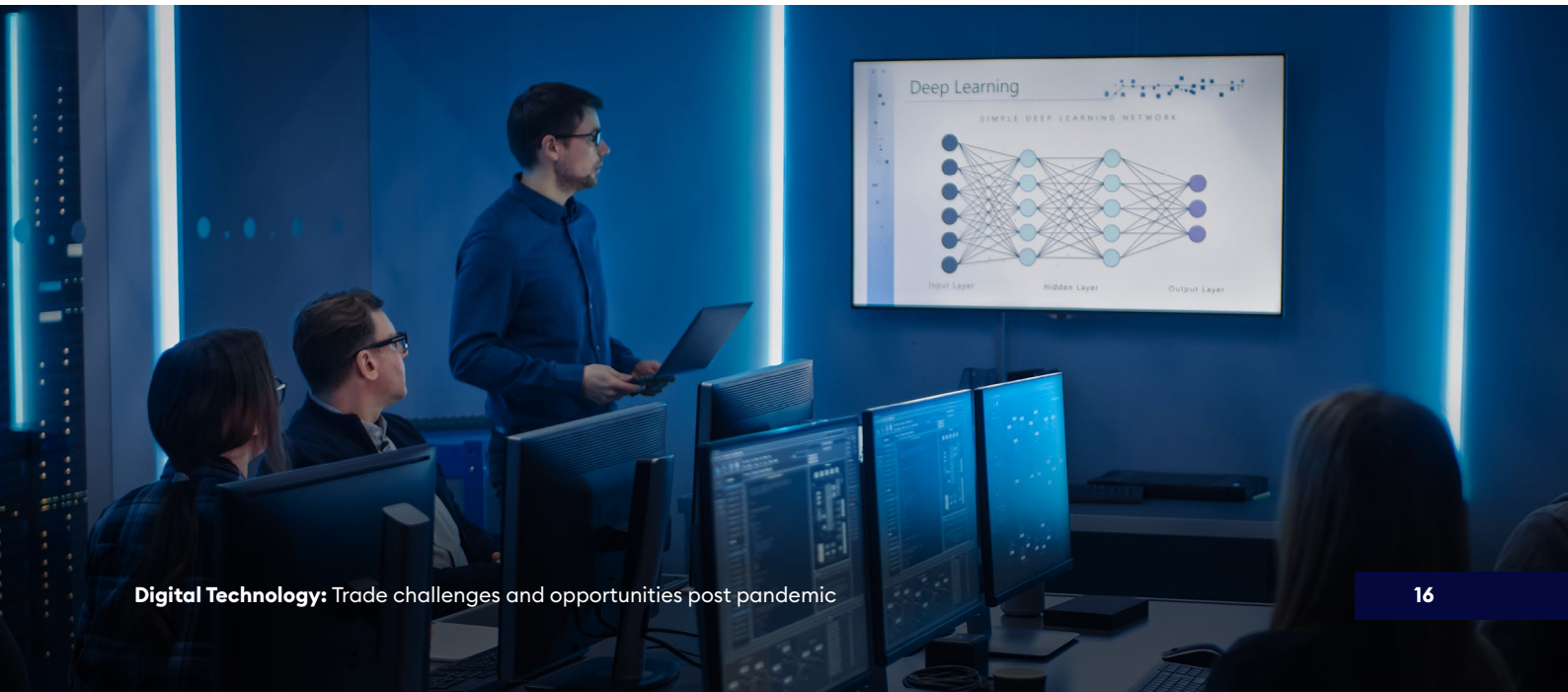
The other approach favoured by many governments is that of attracting overseas investment. This includes the establishment of special economic zones (as pursued by China, for example), creating immigration policies to attract high-skilled labour in technology (favoured by the EU and Singapore) or creating regulatory sandboxes (as in Singapore and the UK).[30]

Bifurcating supply chains

The rivalry between nations is not only happening at the frontiers of technology, points out Mr Andreoni. "It's not just a matter of who has the best science, or who has the most advanced emerging technologies, but it's also how you are able to manufacture it," he says.

This helps explain why the US-China rivalry is coming to impact the supply chains serving their own and other countries' technology companies. For example, US government attempts to shut Huawei, a Chinese telecoms equipment producer, out of 5G mobile markets in several countries have led mobile operators to begin removing Huawei gear from their networks and finding alternative suppliers. US efforts to cut off the supply of semiconductors to Huawei are likewise impacting chip producers elsewhere in Asia. Actions by both governments lead some experts to predict a bifurcation of global technology supply chains: one serving mainly Chinese technology companies and the other serving those of the US and Europe.[31]

Not all experts believe this will necessarily come to pass. Mr Nelson is one: "I'm optimistic that the US will continue to drive innovation and find new ways to use advanced technologies. And I'm optimistic that China will do the same." At the same time, he says, existing technology supply chains remain highly interconnected and resilient. "Dependencies can be reduced, but the notion of splitting this ecosystem in two is preposterous," says Mr Nelson. "At the end of the day, this ecosystem with lots of different suppliers–whether from the Netherlands, Taiwan, Japan, Silicon Valley or China–is too robust and produces too many efficiencies of scale to think something else will take its place."



Endnotes

1. Hard and fast definitions of digital technology are elusive, but ICT is commonly used in valuations of market size and international trade. The term takes in IT (information technology) and telecommunications hardware, software and related services, and includes technology fields that are a focus of this report, namely AI, semiconductors and cybersecurity software and services.
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Department for International Trade

The UK's Department for International Trade (DIT) has overall responsibility for promoting UK trade across the world and attracting foreign investment to our economy. We are a specialised government department with responsibility for negotiating international trade policy, supporting business, as well as delivering an outward looking trade diplomacy strategy.

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