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The global economic impact of 5G.

Powering your tomorrow

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Executive summary

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The promise of 5G has been echoed throughout the business world for years. 5G's faster speed, lower latency and ability to connect vastly higher numbers of devices than previous generations of mobile technology offered executives a glimpse of a more efficient and productive future. By providing the basis for ubiquitous ultra-fast broadband, 5G opens up possibilities far beyond the reach of 4G or Wi-Fi 6. This promise has only grown more critical today, as leaders consider how best to repair, rethink and reconfigure their business for the post–COVID-19 world.

As 5G's adoption and rollout accelerate, we can begin to quantify the technology's potential impact in economic terms. Drawing on expert insight and using economic modelling, we started at the use-case level to assess what that impact will be. We focused on five industries—healthcare, smart utilities, consumer and media, industrial manufacturing, and financial services—that stand to benefit significantly from 5G technology and calculated what that benefit could look like through 2030.

As with any such analysis, the absolute figures can only be directional and are most interesting when looked at in relation to one another. More than 80% of the economic potential appears to lie in healthcare applications (projected to contribute US$530bn to global GDP), smart utilities management (an additional US$330bn), and consumer and media applications (US$254bn more). Smaller contributions from the other industries in our study bring the total estimated uplift to US$1.3tn. As leaders contemplate the decade ahead, 5G demands strategic attention—both to where and how it can create competitive advantages, and to the implementation and integration imperatives that must be met for it to generate value.

Introduction:

The next quantum leap

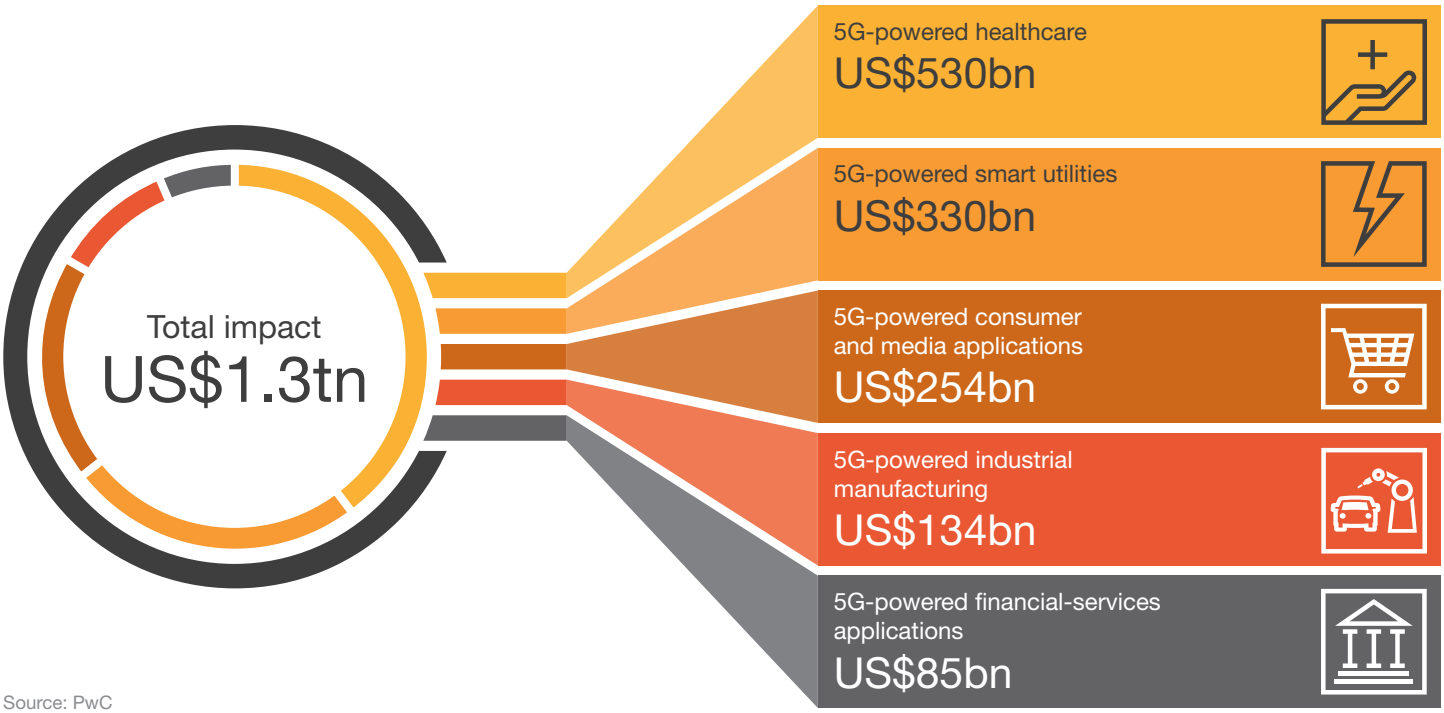
As 5G—the next generation of mobile connectivity—rolls out in coming years, it will create value in many industries and for society as a whole. Innovative uses of the technology show promise in a wide variety of settings: hospitals equipped with 5G devices that enable remote patient monitoring, and smart ambulances that communicate with doctors in real time; digital wallets that connect phones, wearables, cars and other devices to create seamless financial transactions; and 5G-enabled factories in which connections can be maintained among more sensors than ever before.

Such scenarios illustrate the economic impact of 5G mobile technology, which we measured through its ability to increase efficiency and productivity (see Methodology). This impact will be amplified by the fact that 5G isn't just a faster version of 4G or Wi-Fi 6 with wider reach. Besides offering up to 100 times the speed and 1,000 times the capacity of today's mobile networks, 5G will provide ultra-reliability, low latency, reduced energy use and massive connectivity both inside and outside of buildings. The result will be broadband that's not just superfast but ubiquitous. Moreover, when 5G is used in combination with AI, extended reality (XR), edge computing and the Internet of Things (IoT), it will enable business and society to realise the full benefits of these other technological advances.

The size and nature of 5G's economic impact will vary by industry and country. In healthcare, for example, in a single-payer, taxation-funded system, the effect may be to free up government resources to spend on other programmes and possibly lower taxes. In a private insurance–based system, the efficiencies of 5G could enable consumers to reallocate spending to other sectors.

When these effects are added together, the potential impact is huge. Healthcare will be far and away the biggest contributor to the economic gains from 5G: our model predicts that it could add more than half a trillion dollars to global GDP. But other industries also show significant potential, as 5G enables a vast wave of innovative solutions and use cases (see Exhibit 1). In this study, we analysed use cases, both new and established, in five sectors—healthcare, smart utilities, consumer and media, industrial manufacturing, and financial services—and found that, in aggregate, the adoption of 5G will add US$1.3tn to global GDP by 2030.

Exhibit 1: 5G boost to global GDP by industry by 2030 (US$, 2019 values)

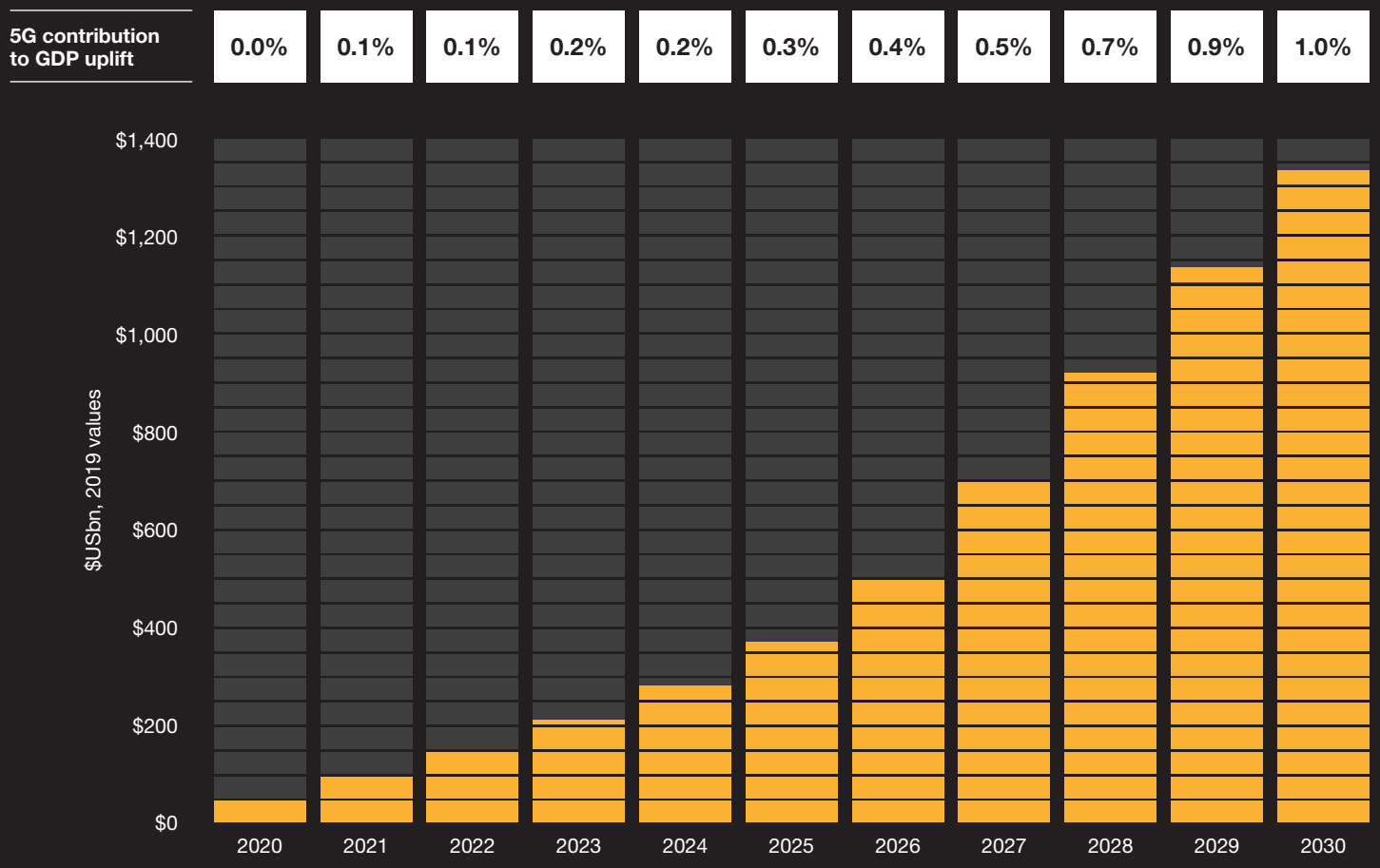


Source: PwC

These numbers quantify impact, but perhaps more important, our study findings reflect the value of 5G. The new levels of connectivity and collaboration that 5G enables will amplify and deepen the insight that organisations can gain from connected technologies. Companies will be able to see, attempt and achieve more, opening up new opportunities for growth as they rethink and reconfigure the way they do business in the post-pandemic world.[1] 5G will be a key part of their new operating environment and technology toolkit. By enabling new use cases and business models, 5G will result directly in the creation of higher value—for businesses, employees, customers and, ultimately, entire economies.

For the next five years, 5G's contribution to economic growth will be fairly modest, as telecom companies focus on infrastructure construction and rollout. But starting in 2025, we project these investments will have an increasingly energising effect on the global economy, as 5G-enabled applications become more widespread (see Exhibit 2).

Exhibit 2: Projected contribution of 5G to global GDP, 2020–30 (US$bn, 2019 values)

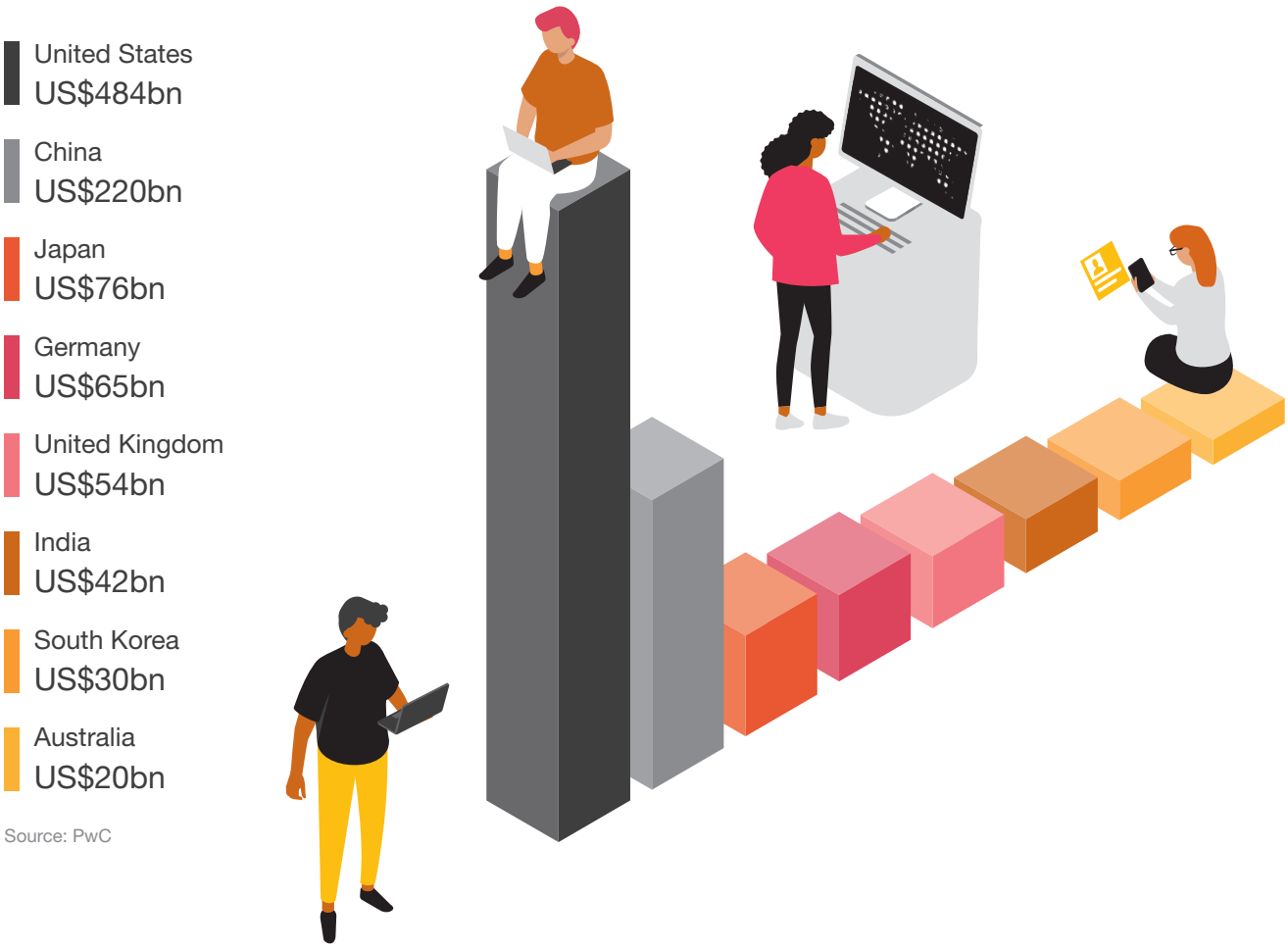


Source: PwC

1 Blair Sheppard, Daria Zarubina and Alexis Jenkins, "Adapting to a new world," *strategy+business,* 13 May 2020, https://www.strategy-business.com/article/Adapting-to-a-new-world.

At the regional level, North America will experience the biggest percentage uplift to GDP from 5G, followed by Asia and Oceania and then by Europe, the Middle East and Africa (EMEA). In absolute dollar terms, North America also will rank highest, and Asia and Oceania is projected to outpace EMEA because of its larger overall economy. (The scale of a national economy will influence its absolute impact on global GDP: a 2% increase in the US economy is about six times the size in dollar terms of a 1.3% expansion in the Japanese economy.) Among the countries analysed (see Exhibit 3), those with strong, modern industrial production sectors may benefit more than those that rely on service industries such as banking.

Exhibit 3: 5G's projected economic impact by country by 2030 (US$, 2019 values)



Source: PwC

Healthcare: Achieving better, faster outcomes

5G-powered healthcare applications will add

US$530bn

to global GDP by 2030

The rapid rise of telemedicine during the COVID-19 pandemic provides a glimpse of the future of healthcare, but remote care is just one area in which 5G can enable both cost savings and better health outcomes. For example, 5G will improve efficiency and productivity in hospitals through advances such as 5G-enabled tracking of medical devices and patient beds and the application of AI to 5G sensor data to trigger actions automatically and accelerate patient handovers.

We believe that the rising use of 5G—boosted by advances in robotics, IoT and AI—will enable the emergence of a new, connected healthcare ecosystem aligned with the concept of '4P' medicine: predictive, preventative, personalised and participatory. This ecosystem will use 5G connectivity to meet patient and provider needs accurately, conveniently, cost-effectively and at a massive scale.[2]

Our analysis reveals that 5G could enhance healthcare applications and generate higher economic value through the following four use cases.

Fewer and shorter hospital stays. 5G will vastly improve communication among doctors and with patients by enabling it to be continuous and real-time, both within and outside hospitals. This will allow doctors to use their time more efficiently, produce better patient outcomes and reduce the number and length of hospital stays.

Net contribution to global GDP by 2030: US$161bn

2 PwC, *5G in healthcare: How can 5G connect a post-COVID healthcare ecosystem?* 2020, https://www.pwc.com/gx/en/industries/tmt/5g/5g-in-healthcare.html.

Streamlined doctor–patient interactions. Mobile health platforms powered by 5G will enable faster and more accurate collection and sharing of health information both among health systems and between healthcare providers and patients. It may also enable doctors to use surgical robots or scanners controlled remotely over 5G to help them treat patients. Such applications will allow doctors to use their time more efficiently.

Net contribution to global GDP by 2030: US$89.5bn

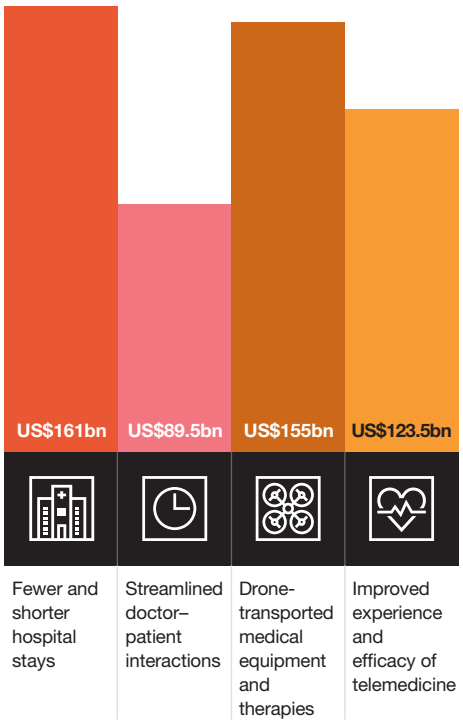
Drone-transported medical equipment and therapies. A defibrillator dispatched using a 5G-enabled drone could arrive at the patient's location four times faster than if it were brought by ambulance. Drones can also deliver medicines, blood and vaccines over long distances at high speed, or pick up and transport blood or tissue samples to a central laboratory for analysis.

Net contribution to global GDP by 2030: US$155bn

Improved experience and efficacy of telemedicine. Compared with previous generations of mobile technology, the combination of higher speed and efficiency with lower latency makes 5G better able to support remote, real-time interactions between doctors and patients. Healthcare providers will also be able to receive remote monitoring data from a large base of patients in real time, often through 5G-connected wearable devices and complemented by cloud analysis and processing (referred to as the 'Internet of the body'). These benefits mean 5G will expand the reach and effectiveness of remote health monitoring and telemedicine programmes, including in rural areas without easy access to hospitals.

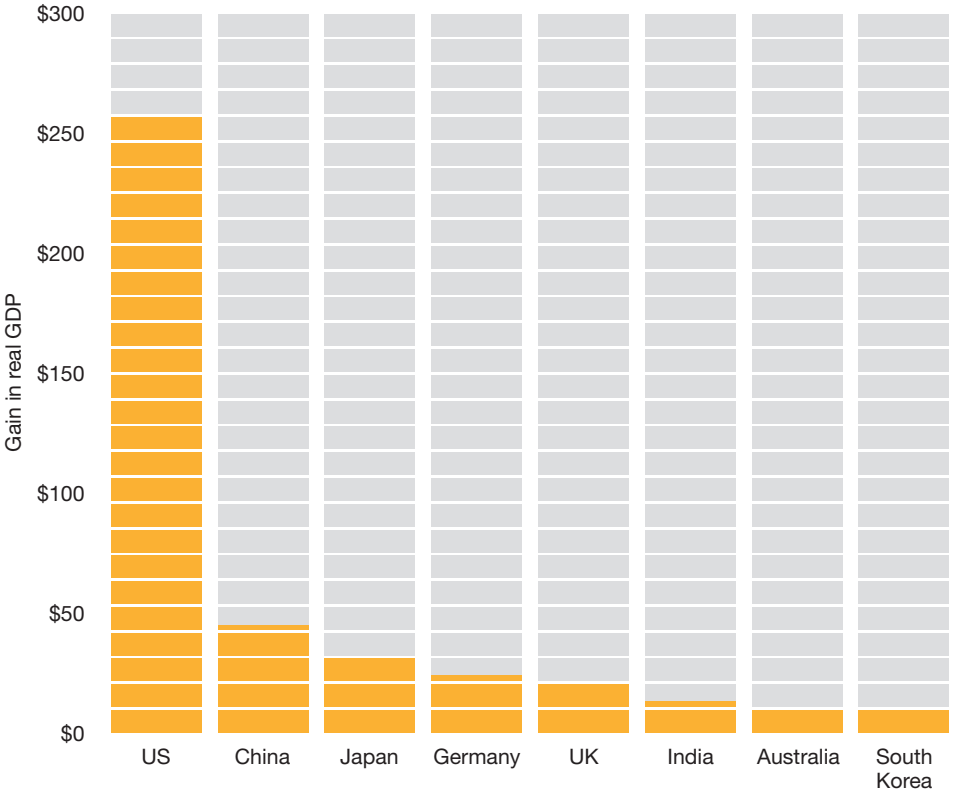
Net contribution to global GDP by 2030: US$123.5bn

Exhibit 4: Productivity gain from 5G applications in healthcare by use case by 2030 (US$, 2019 values)



Source: PwC

Exhibit 5: 5G boost to healthcare by country by 2030 (US$bn, 2019 values)



Source: PwC

Smart utilities: Creating agility and control

5G-powered smart utilities management will add

US$330bn

to global GDP by 2030

The global utilities industry is at the forefront of a sweeping energy transition that will radically alter business models and customer interactions. For example, in the new, lower-carbon energy landscape, electric utilities will need high levels of agility and control, including the ability to predict and manage contributions from a vast array of distributed, renewable energy sources. At the same time, consumers want the ability to track and minimise their energy use.

To ensure market competitiveness amid these demands, the world's 40 largest utilities[3] spent an estimated US$2.1bn on R&D and innovation in 2018—an 8% CAGR from a small base in 2013—but they will need to amp up this investment moving forward. One critical innovation has been the rise of smart utilities management: the use of leading-edge technologies to improve the speed, efficiency and responsiveness with which utilities manage their resources and services.

5G is well-suited to achieve these goals, given its ability to connect a massive number of devices and its low-power modes for long-term sensor applications. These same capabilities will help to make 5G a cornerstone of smart city applications worldwide, as its use by utilities will dovetail into the wider digitisation of people's lives through improvements in connectivity.

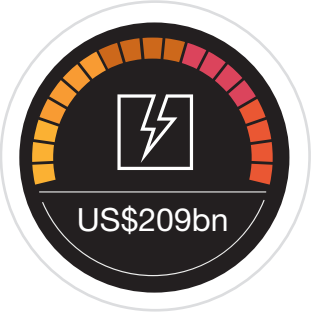
Our analysis reveals that 5G could enhance smart utilities applications and generate higher economic value through the following three use cases.

Enhanced smart meters and smart grids. Smart meters and smart grids enable electricity and gas providers to give customers a more detailed view of their energy use. 5G allows more efficient management of these tools, leading to energy savings as consumers make better-informed and more timely decisions.

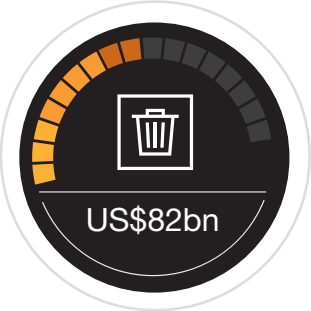
Net contribution to global GDP by 2030: US$209bn

3 Tom Flaherty, Tom Haddon and Amy Zhao, "Amping up innovation," *strategy+business*, 22 Sept. 2020, https://www.strategy-business.com/article/Amping-up-innovation?gko=78411.

Exhibit 6: Productivity gain from 5G applications in smart utilities management by use case by 2030 (US$, 2019 values)



Enhanced smart meters and smart grids



Better waste management and reduced solid waste

Reduced water leakage

Source: PwC

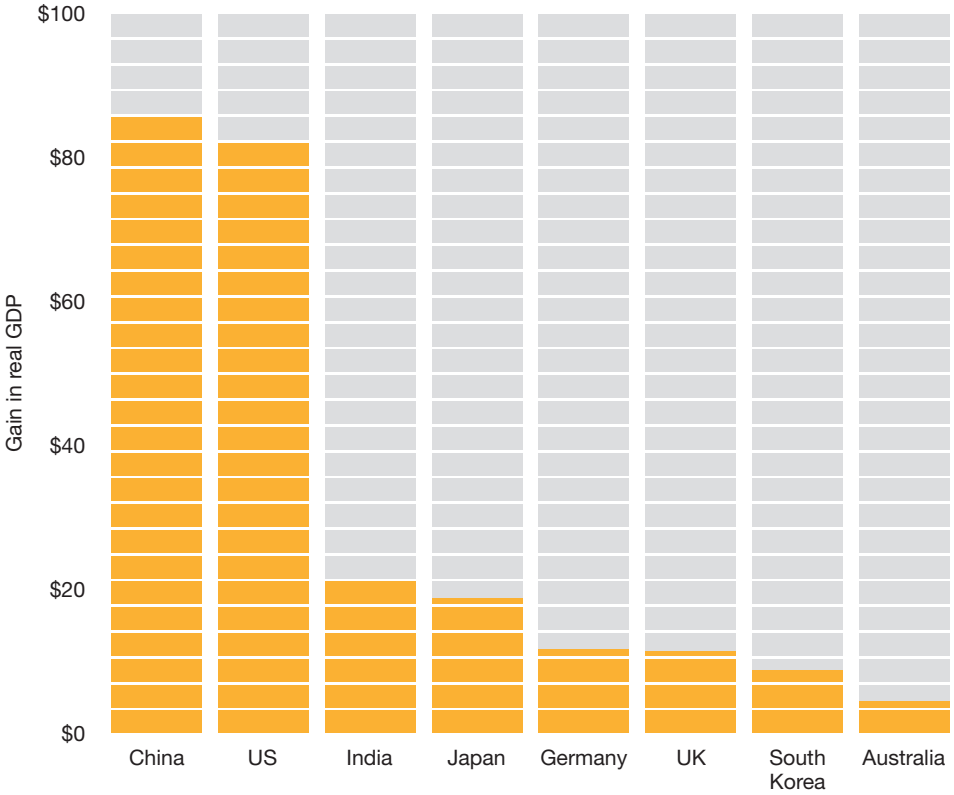
Better waste management and reduced solid waste. 5G will enable better use of applications such as pay-as-you-throw digital tracking. This involves monitoring and charging for solid waste disposal using digital technologies and can reduce the volume of solid waste per capita by 10% to 20%. Businesses and local authorities are also increasingly deploying sensors and analytics to help manage waste, especially in urban areas, and these tools can be operated more efficiently when connected using 5G.

Net contribution to global GDP by 2030: US$82bn

Reduced water leakage. By applying new technologies that incorporate 5G, utilities will be able to manage water resources more efficiently. For example, the deployment of sensors and analytics on water networks has been shown to cut water loss by up to 25%, and 5G will expand the potential for such gains.

Net contribution to global GDP by 2030: US$39bn

Exhibit 7: 5G boost to smart utilities management by country by 2030 (US$bn, 2019 values)



Source: PwC

Consumer and media: Transforming the at-home experience

5G applications in consumer and media will add

US$254bn

to global GDP by 2030

Even before the outbreak of COVID-19, mobile connectivity was playing an increasingly important role in the consumer and media industry. PwC's *Global Entertainment & Media Outlook 2020–2024*,[4] published in October 2020, found that the pandemic has accelerated ongoing shifts in consumer behaviour. This creates the potential for significant gains from 5G, which can enable consistent, high-quality content experiences wherever people are—at home or on the move.

When PwC reached out to consumers in its 2020 *Global Consumer Insights Survey*,[5] they confirmed the extent to which the pandemic has accelerated changes in consumer behaviours, with network speed a likely contributor. Moreover, the vast majority of consumers said they will retain these new behaviours after the pandemic. For example, 63% of survey respondents reported buying more groceries online since the onset of the pandemic, with 86% saying they are likely to continue this behaviour.

Consumers will use high-speed mobile data to access greater quantities of content and services, opening up revenue opportunities across sectors, including gaming, entertainment, music and over-the-top (OTT) video. And as 5G networks roll out globally, the technology's low latency and ultra-fast data transmission may result in more 'mash-up' entertainment and media business models, in which different offerings are combined to produce something new based on innovative and collaborative uses of data. For example, digital platforms are morphing into performance spaces, streaming recorded virtual reality (VR) music performances to replace concerts and festivals shuttered by the pandemic.

4 PwC, *Global Entertainment & Media Outlook 2020–2024*, 2020, https://www.pwc.com/gx/en/industries/tmt/media/outlook.html.

5 PwC, *The consumer transformed: Global Consumer Insights Survey 2020*, 2020, https://www.pwc.com/gx/en/industries/consumer-markets/consumer-insights-survey.html.

Our analysis reveals that 5G could enhance consumer and media applications and generate higher economic value through the following two use cases.

Real-time marketing and customer relations. As consumer adoption of 5G handsets grows, businesses will increasingly use the technology to capture and enhance consumer interactions, opening up vast new opportunities around sales and customer service. 5G will enable companies to capture and analyse data for customers or visitors in real or near-real time. Combining 5G with powerful analytics capabilities, AI and marketing automation will allow campaigns to be constantly optimised and tweaked. Consider a shopping mall: retailers will know which consumers have walked in and be able to push personalised ads or offers to their mobile devices. And when a repeat customer enters the store, retailers will be able to improve the shopping experience by guiding that customer to his or her favourite items and even adjusting the pricing to encourage purchase. Augmented reality (AR) over 5G will also improve the experience by enabling shoppers to see themselves in a garment without entering a fitting room.

Net contribution to global GDP by 2030: US$221bn

Delivery of online gaming and OTT media. When online or cloud gaming is delivered over 5G, the gaming hardware doesn't require as much processing power, and processing can happen closer to the user. Combined with 5G's higher speed and ultra-low latency, this edge computing concept means 5G will usher in a new era of ever more immersive gaming experiences that were not possible with 4G. OTT content streaming will also increase thanks to better, faster access on the move and to 5G's greater ability to support VR and AR experiences and simultaneous high-definition video streaming. And in the fast-growing e-sports sector, 5G's ability to run multiple virtual connections over one network—technically termed 'network slicing'—opens the way for providers to offer experiences such as personalised 3D augmentation, instant replays and 360-degree in-game views on mobile devices.

Net contribution to global GDP by 2030: US$33bn

Exhibit 8: Productivity gain from 5G applications in consumer and media by use case by 2030 (US$, 2019 values)

Real-time marketing and customer relations

US$221bn

Delivery of online gaming and OTT media

US$33bn

Source: PwC

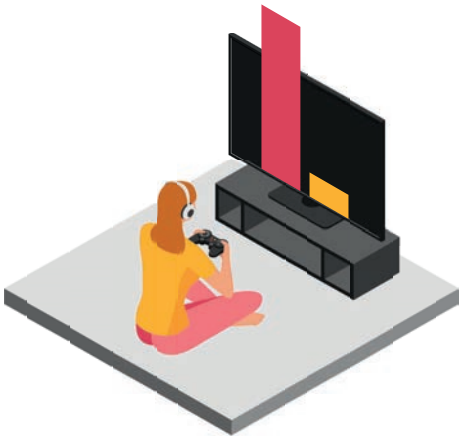
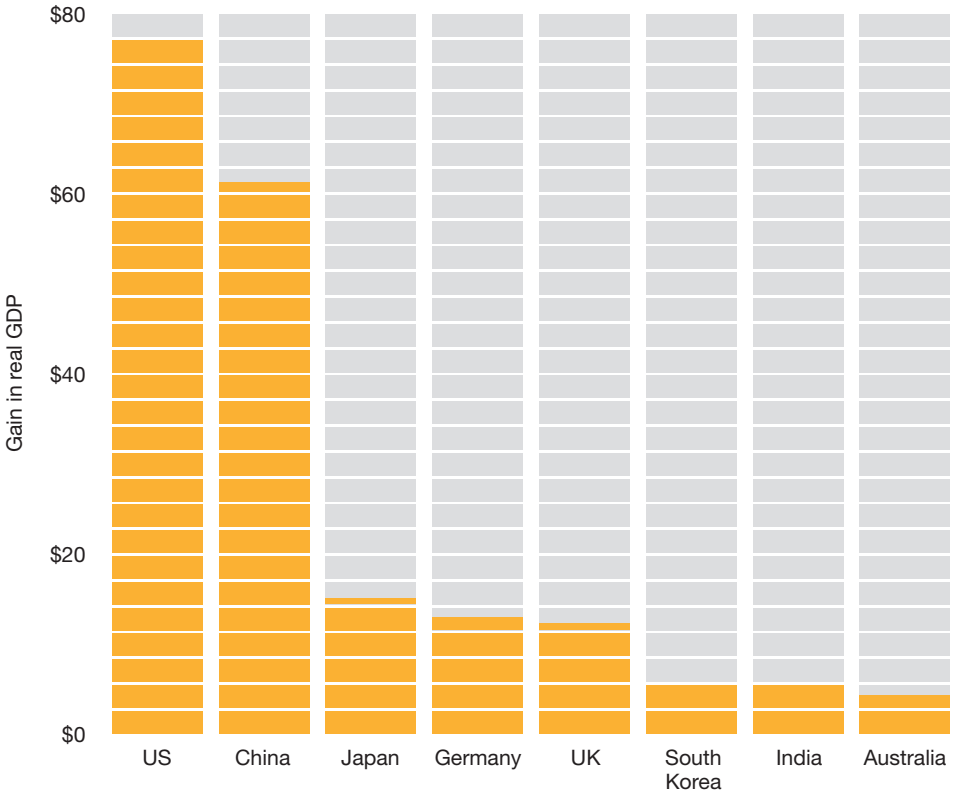


Exhibit 9: 5G boost to consumer and media by country by 2030 (US$bn, 2019 values)



Source: PwC

Industrial manufacturing: Building connected ecosystems

5G applications in manufacturing will add

US$134bn

to global GDP by 2030

In the manufacturing industry, digital technologies are increasingly pivotal to efficiency and effectiveness in production facilities and along supply chains. In factories, 5G can free up machinery from being tethered to a particular location by replacing cables with wireless connectivity, giving manufacturers a far greater degree of flexibility.[6]

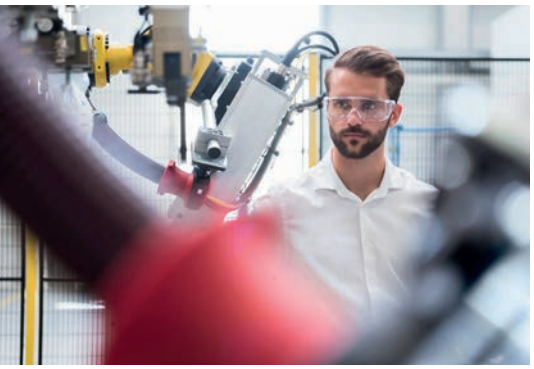
By paving the way to more adaptable and responsive production lines that can be reconfigured faster and with less effort, 5G will make it easier to customise products to meet specific requirements at higher quality, scale and speed, and at lower cost—including labour costs. Across supply chains,[7] 5G will accelerate the development of connected and self-orchestrating intelligent ecosystems that can quickly anticipate and address issues and opportunities.

For the purposes of this study, our research focused on one use case through which 5G applications could enhance the global economic contribution from the manufacturing industry. However, large benefits are anticipated from other applications as well—for example, benefits from production optimisation, preventative maintenance and supply chain integration, among others.[8]

6 PwC, *Smart manufacturing powered by 5G*, 2020, https://www.pwc.com/gx/en/industries/tmt/5g-in-manufacturing.html.

7 PwC, *Connected and autonomous supply chain ecosystems 2025*, 2020, https://www.pwc.com/gx/en/industries/industrial-manufacturing/digital-supply-chain.html.

8 Note: We also analysed direct productivity improvement from reduced defects, but this use case did not achieve a statistically significant contribution.



Autonomous robots and vehicles in industrial settings. 5G-powered IoT applications will allow industrial companies to realise the full benefits of the Fourth Industrial Revolution.[9] For example, 5G will enable robots and self-driving vehicles that use laser-based perception and AI to move safely through facilities without any need for fixed infrastructure. In addition to offering intelligent, safe, efficient and reliable transportation, the autonomous devices will work together with chargers, software and services to act as an integrated inventory movement and robotics platform within industrial centres. This, in turn, will reduce the need for labour to work in factory operations.

Net contribution to global GDP by 2030: US$130bn

Exhibit 10: Productivity gain from 5G applications in manufacturing by use case by 2030 (US$, 2019 values)

Autonomous robots and vehicles in industrial settings

US$130bn

Improved efficiency from reduction in defects

US$4bn

Source: PwC

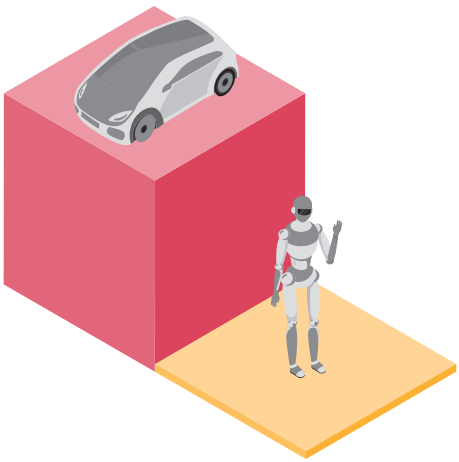
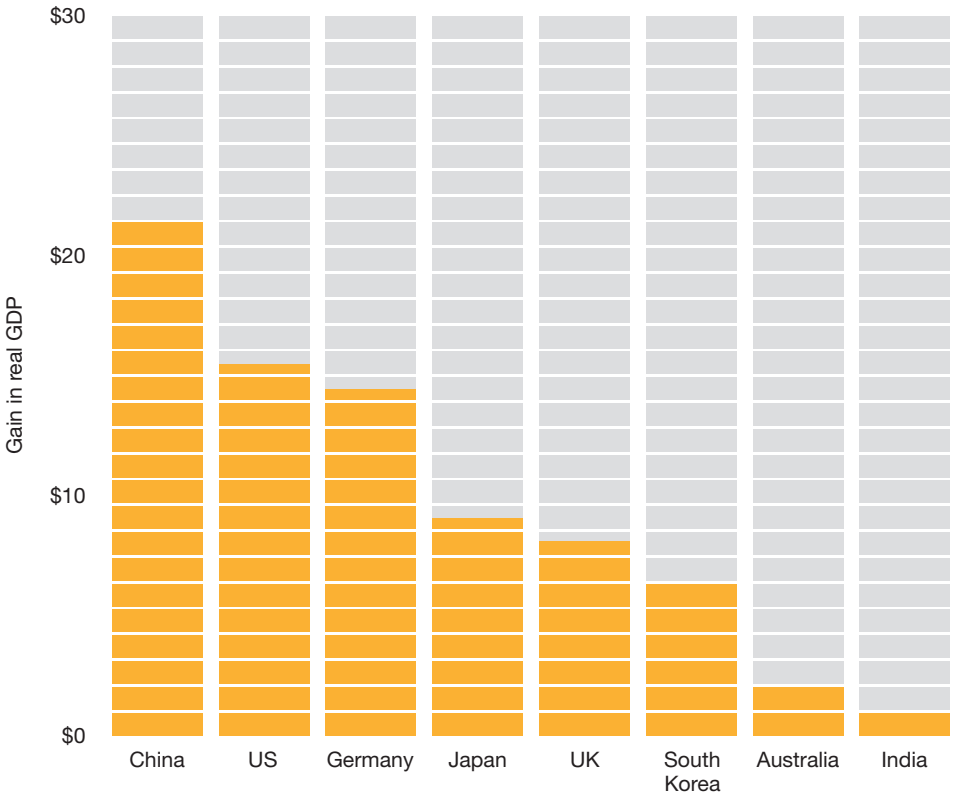


Exhibit 11: 5G boost to manufacturing by country by 2030 (US$bn, 2019 values)



Source: PwC

9 PwC, *The fourth industrial revolution: A recovery plan for today's economic storm*, 2020, https://www.pwc.com/us/en/library/4ir-ready/fourth-industrial-revolution-economic-downturn.html.

Financial services: Supporting virtual interactions

5G applications in financial services will add

US$85bn

to global GDP by 2030

The pandemic has had profound knock-on effects on the financial-services industry, including accelerating the migration to digital channels and interactions by both retail and institutional customers. Combined with the advent of 5G and improved telepresence, this rapid digital shift creates opportunities for firms to redesign their customer strategy and journey[10] around increasingly meaningful virtual experiences, which, in turn, enables them to reduce or eliminate costly physical channels such as bank branch networks.

Banking is not the only financial-services sector that will benefit from 5G. For example, the huge bandwidth and mass connectivity of 5G will support the delivery of AI-powered 'robo-advice' to a wide array of devices. This will provide an enhanced channel to customers not only for banks but also insurance companies and investment advisers. The use of 5G-enabled drones to inspect and monitor insured properties could improve and streamline claims management and help reduce fraud. Moreover, previous location accuracy was not refined enough to be used in insurance-based claims to determine fault. But 5G will improve the precision of mobile location by one or two orders of magnitude, depending on specific implementations—enabling location accuracy that could be leveraged to determine liability in auto and other related claims.

10 PwC, *The future of financial services: Securing your tomorrow, today,* 2020, https://www.pwc.com/gx/en/financial-services/pdf/pwc-the-future-of-financial-services.pdf.

Our analysis focused on the following two use cases through which 5G applications could boost the economic contribution from financial services.

Improved customer experience. Banks will be able to deploy highly sophisticated, 5G-enabled AI advisers in-branch that can converse with customers and help them with financial transactions. At the same time, smartphone data and the growing use of mobile technologies will make it easier to push marketing or advisory content to customers at specific moments of need.

Net contribution to global GDP by 2030: US$55bn

Reduced losses from fraud. For financial-services providers, 5G will help to facilitate advances in security, such as using facial recognition to verify customers' identity when they use ATMs and other devices. Such innovations will enable consumers to access their accounts quickly without having to use a card and will help to make transactions more secure, reducing the risk of fraud.

Net contribution to global GDP by 2030: US$30bn

Exhibit 12: Productivity gain from 5G applications in financial services by use case by 2030 (US$, 2019 values)

Improved customer experience

US$55bn

Reduced losses from fraud

US$30bn

Source: PwC

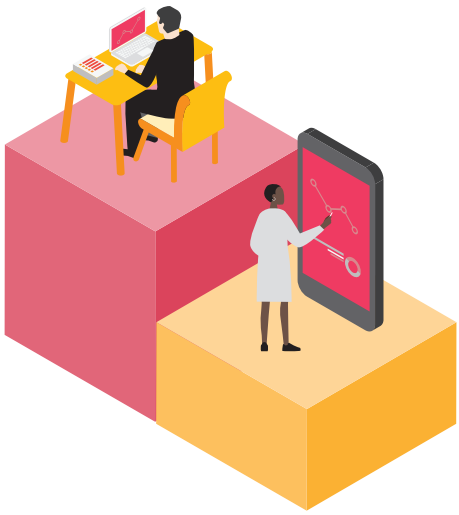
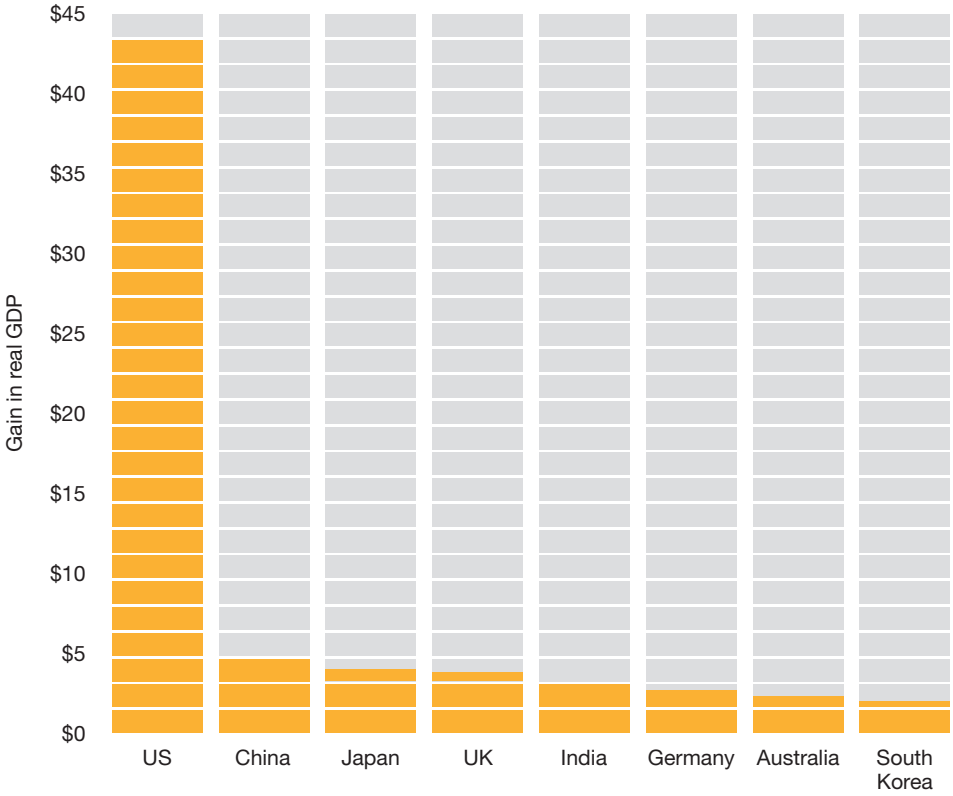


Exhibit 13: 5G boost to financial services by country by 2030 (US$bn, 2019 values)



Source: PwC

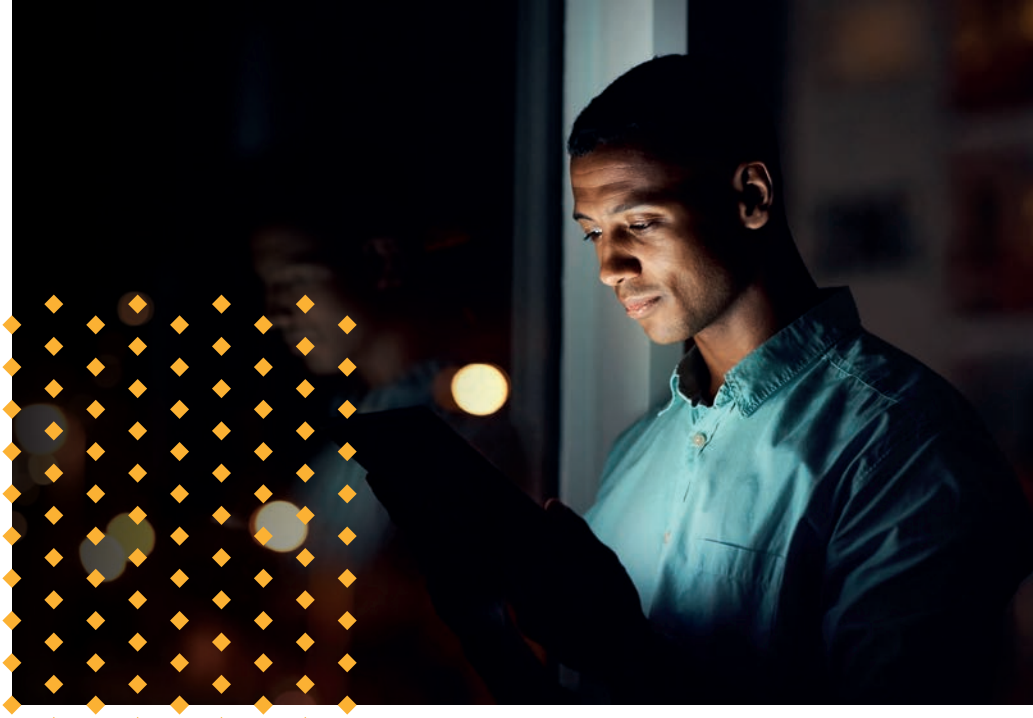
Conclusion: Reinventing your future with 5G

The 5G era is here, introducing the next generation of smart business applications just as organisations plan how to emerge stronger in the post-pandemic world. The potential for impact across industries is enormous, but to realise these gains, companies will need a strategic approach—one underpinned by a clear view of the use cases that will deliver the greatest value over time. This is true for both of the key stakeholder groups shaping the future usage of 5G: enterprises and policy-makers.

For enterprises, the imperative is to factor 5G into their technology road maps. Leaders will need to take stock of their business models and processes and consider how 5G can enable improvements and opportunities, many still unthought of. They'll also need to collaborate closely with partners in a wide array of industries, including technology, media and retail, and to combine 5G with other enabling technologies, such as AI and IoT.

For policy-makers and governments, the key is to regard 5G as fundamental societal infrastructure: a platform that, by providing ubiquitous, superfast broadband, will influence the competitiveness of nations' economies and their ability to develop their own sunrise industries and technologies. Policy-makers should look to encourage and provide incentives for 5G investments as quickly as possible.

As companies and countries look to their post-pandemic future, their 5G strategy should include the following four steps.



Repair what's been disrupted by COVID-19. 5G offers companies an efficient data platform over which they can offer new and existing services, helping to restore revenues and economic activity lost during the pandemic. With the effects of COVID-19 accelerating digitisation across all sectors, 5G can act as a catalyst, making the rebound even stronger. Regulators and policy-makers should set the scene by being open to a wide range of 5G use cases, such as telemedicine and self-driving vehicles.

Rethink the future to embrace new business models and use cases. With 5G, enterprises can take a fresh look at how they operate, reconsidering product offerings, go-to-market approaches, and even the industries and geographies in which they manoeuvre. Collaboration and partnerships will be key: as we highlighted in *Making 5G pay*,[11] 5G opens the way to a wide array of business and revenue models powered by collaborative relationships between telecoms and partners in other sectors. Again, a positive and willing attitude from policy-makers will be vital.

Reconfigure how your enterprise operates. In addition to being a powerful technology in its own right, 5G can bring together and turbocharge other emerging technologies, including AI, XR, edge computing and the IoT. All of these technologies work better and contribute more value when applied in combination with 5G, helping enterprises create a 'technology flywheel'—the pent-up power of which will be all the greater in the wake of the pandemic. On the telecoms side, as we described in a recent report,[12] this reconfiguration will see companies reinvent their business support systems and operational support systems to become more flexible, agile and connected to support 5G-based services. And all businesses will need to radically upskill their workforce[13] for a 5G-enabled world.

Report transparently about the creation of value from 5G. By reporting clearly and openly on their 5G strategy and how it's delivering economic and societal value, enterprises will open up new opportunities, build trust and improve their access to capital.

The 5G revolution is creating vast new productive potential: for the individual consumer, for enterprises, for governments and for the global economy. If you are ready to seize the opportunities it offers, they will power your tomorrow.

11 PwC's Strategy&, *Making 5G pay: Monetizing the impending revolution in communications infrastructure,* 2019, https://www.strategyand.pwc.com/gx/en/insights/2019/making-5g-pay/making-5g-pay.pdf.

12 PwC, *Transforming telecoms' internal ecosystems: How to rethink business support systems and operational support systems in the age of 5G,* 2020, https://www.pwc.com/gx/en/industries/tmt/5g/pwc-transforming-telecoms-internal-ecosystems.pdf.

13 Carol Stubbings and Nicole Wakefield, "CEOs need to take the lead on upskilling," *strategy+business,* 28 Sept. 2020, https://www.strategy-business.com/article/CEOs-need-to-take-the-lead-on-upskilling.

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Appendix

Methodology

PwC's UK economics team applied a four-stage approach to quantify the potential economic benefits from 5G for the global economy by 2030. The stages were:

- **Identifying areas of applications.** *Identifying the 'impact channels' through which 5G will affect the economy by analysing how it enhances previous capabilities and creates new use-case opportunities.* Our analysis includes economic impacts that, although not currently considered transformative use cases, will have significant productivity effects, such as impacts on global supply chains and compliance adherence across industries.
- **Mapping industry applications.** *Using global datasets to identify the industries in which 5G applications will affect the economy.* These first two stages enabled us to create a core list of use cases for 5G and determine how they map across industries.
- **Quantifying first round impacts.** *For each use case, applying a range of sources and techniques to estimate productivity impact, including researching external literature and engaging with PwC experts on use-case adoption and associated productivity improvements.* The final productivity shocks were categorised into 12 5G levers spanning five impact areas: provenance and traceability; securitisation and payment; identity and credentials; agreements, thresholds and disputes; and loyalty and rewards. These inputs were then transformed across countries and time based on an assumed 'S-shaped' adoption curve.
- **Assessing wider impacts.** *Using a computable general equilibrium (CGE) model to quantify the rippling impacts of the use cases across the rest of the economy, including on overall GDP and productivity.* The CGE model captures all economic interactions in the global economy, including trade and spending between firms on one another's goods and inputs; spending by consumers on goods; investment decisions; and dynamics in the market such as demand for factors such as capital and labour, trade, employment and wage effects.

Scope and assumptions

The projections in this study represent the net economic impact of 5G technology, taking into account displacement effects, such as certain economic activities becoming obsolete, and focusing on economic value added across value chains and throughout the economy, rather than only on the revenues of 5G telecoms businesses. Also, we have assumed reasonable uptake over time, with the quality of 5G products and services developing as forecast by experts across the PwC network. And we have made the judgement that COVID-19 will not have a material impact on 5G's longer-term economic contribution.

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