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How new technologies could accelerate growth

March 2020

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Emerging technologies offer the promise of faster growth in productivity and incomes. This would be a decisive break from the experience of the past decade when weak productivity growth became part of the 'new normal'.

In this section we explore the economic changes potentially prompted by these technologies and how different sectors might fare in what is sometimes referred to as the 'second machine age'. We expect the greatest impacts to be felt in:

— **Transport and logistics**, with the advent of electric and autonomous vehicles transforming automotive, transport and insurance;

— **Manufacturing**, where 3D printing, the internet of things and industrial robotics will transform production;

— **Financial services**, where artificial intelligence (AI), machine learning and digital business models offer new ways to provide financial services.

While a number of emerging technologies are competing for attention, in this section we look in particular at five technologies we expect to have a significant impact on these sectors and the broader global economy:

— **The internet of things** – the addition of sensors and internet connectivity to machines, warehouses and other physical infrastructure, enables tracking and automatic verification and responses;

— **Machine learning and AI** – it is increasingly possible to automate decision making, as well as some of the tasks that are currently performed by humans; radiology and accounting[1] are just a few examples of professions at risk of automation;

— **Industrial robotics** – even more highly automated manufacturing will enhance both productivity and the flexibility of manufacturing;

— **3D printing** – objects built up from materials on site enable benefits such as local production of more complex part;

— **Autonomous vehicles** – this is a specific but important application of machine learning.

[1] See WEF, The Future of jobs Report, 2018.

Transport and logistics

Technological advances in transport and logistics could evolve as the result of sequential developments across related and complementary technologies:

— Electric vehicle (EV) adoption;

— Autonomous vehicle (AV) adoption;

— The development of mobility-as-a-service (MaaS).

Given that human error is the cause of at least nine in ten road accidents[2], such advances have the potential to significantly improve road safety. Other benefits include improving the efficiency of public transport and freight services[3], and enabling cleaner cities with more green space and room for recreation activities.

The overall economic impacts of this technology could include:

— lower cost passenger transport and logistics;

— significant transformation of some sectors' business models, including motor insurance, car servicing, and fuel stations;

— reduced demand for labour in the sector.

Large-scale investment would be required to facilitate a shift to new energy source, and public investment may be needed to fund the early phases of developing new infrastructure. Further investment, for example in 5G telecoms infrastructure, will be necessary for the full implementation of AV technology to go ahead.

Electric vehicle technology

Cost continues to be the main obstacle to the widespread adoption of EV technology, with batteries accounting for the most significant element of overall vehicle cost. KPMG estimates that in terms of total ownership cost – the cost of acquiring and operating a vehicle – we will reach parity between EVs and vehicles with traditional combustion engines in the early 2020s, with further cost reductions subsequently.

Another challenge is range of travel (which is related to the cost of battery), where EVs do not currently match conventionally fuelled cars. Widespread adoption will also require significant investment in charging infrastructure, with some public subsidy potentially needed in early stages.

The benefits from EV adoption range from a cleaner environment to falling vehicle servicing costs as a result of fewer engine parts.

The shift will require a change to the current model of the after-sale care market and prompt a gradual reduction in demand for conventional fuels, accompanied by increased demand on the electricity network.

[2] See a summary by Bryant Walker Smith from Stanford Law School on http://cyberlaw.stanford.edu/blog/2013/12/human-error-cause-vehicle-crashes.

[3] See https://arrival.com.

Autonomous vehicle technology

Automation could drastically reduce the cost of moving goods and people around. However, automation technology is expected to gradually emerge in distinct stages, unlocking novel economic applications (see Chart 22).

While the final phase of full automation may still be some way off, substantial operational cost savings and safety benefits are available from earlier phases. We are already between stage 1 and 2 of adoption, enjoying benefits from vehicles that provide 'lane assistance' and that can perform some manoeuvres such as parking. More advanced technologies are at various stages of testing and preliminary deployment in different countries.

The benefits from wide-scale adoption of autonomous vehicle adoption could include:

— improved safety and reduced insurance costs;

— the potential transformation of public transport, enabling providers to move from fixed-route, fixed-timetable bus services to on-demand autonomous alternatives, providing a more efficient and effective way to take people from door to door;

— increased efficiency in transport and logistics, thanks to ideas such as platooning, where one human-driven vehicle leads a convoy of autonomous ones, reducing air resistance and saving fuel;

— enabling public authorities to track and optimise the flow of vehicles.

The adoption of autonomous vehicles would lead to the gradual elimination of human input in the transport and logistics sector, and falling demand for drivers. There is also likely to be a gradual shift of the insurance burden to the manufacturer for the responsibility of driving, which will require changes in the motor insurance industry.

AV could herald a new era of vehicles that are in use 24 hours a day, rather than mostly sat idle. This will mean fewer vehicles are needed, capital can be deployed more efficiently and roads infrastructure will suffer less congestion during peak times.

It could also influence where people choose to live and spend their leisure time, with less accessible places becoming more popular. This could ease pressure on housing within cities' green belts, as well as make more remote places attractive.

Mobility-as-a-service

In the UK, mobility-as-a-service (MaaS) is expected to generate a shift in the ownership model for vehicles, with people summoning vehicles as and when they need transport rather than keeping their own car. Uber and other mobile platforms offer a preview of what MaaS could enable and there is already some evidence of lower vehicle ownership and driving licence uptake amongst younger people.

Taking EVs, AVs and MaaS together, we could see:

— less capital tied up in vehicles and logistics infrastructure;

— lower costs of transport and logistics;

— less labour required for this sector;

— a reshaping of the urban and suburban landscape, with regions beyond large urban centres benefiting from increased demand for second homes and short breaks.

Chart 22: Stages in AV adoption

Stage 1 **Driver assistance**	Stage 2 **Partial automation**	Stage 3 **Conditional automation**	Stage 4 **High automation**	Stage 5 **Full automation**
Limited improvements in safety and efficiency in specific contexts.	Further improvements in safety and efficiency in specific contexts.	Potential improvements in fuel efficiency due to platoon driving on highways. Further potential safety improvements in specific contexts.	Potential for safety improvements, potential reduction in human involvement due to remote driver intervention. Insurance burden shifts away from driver and onto car manufacturer.	Fully automated logistics, higher utilisation rate for vehicles, lower costs of transportation.

Source: *KPMG, Connected and autonomous vehicles – The UK economic opportunity.*

Manufacturing

Many technologies already available have the potential to impact on multiple stages of the production cycle. The term ‘Industry 4.0’ is often used to describe these technologies and their impact collectively.

The many value-additive opportunities offered by these technologies span multiple stages in the manufacturing process, from design and development to after-market servicing. We consider three stages of the value chain.

Research & development and planning

Traditionally, this is the stage of production with some of the highest margins in the entire value chain and new technologies could improve these further. There is the potential to enhance both productivity and efficiency, reducing the cost of conducting research and the time required to take a product to market.

For example, in the pharmaceuticals sector, algorithms can help identify the most promising chemical structures before they are tested and used to develop new drugs.[4] In the building industry, real-time location data can help planners observe and analyse how people use public spaces so that designs take their needs into account.

In addition, big data analytics can play a role in optimising the manufacturing process, particularly as the development of the internet of things makes it possible to observe and track the workflows across the shop floor.[5] It is already possible to create ‘digital twins’ of assets or components[6], which can be used to improve the reliability of real assets, enhance production and reduce maintenance costs. As further advances are made, these technologies are likely to become more widespread and will impact a large proportion of existing value chains in the production sectors.

Buy and make

Increased automation of manufacturing processes is already progressing apace. At the beginning of 2020, the Industrial Federation of Robotics reported that there were 2.4 million industrial robots already operating in factories around the world.[7] These help to improve productivity, but also drive improvements in quality and quality assurance processes during production.

Additionally, increasing the use of 3D printing could lead to the development of new products that can be customised for end-users, and make it viable to produce items in smaller production runs. Hearing aid manufacturers, for example, are using 3D printing tools to manufacture each aid to better fit the user, improving the efficiency of the device.[8]

3D printing represents a radical break from traditional production processes and offers:

- reduced loss due to material wastage as parts are built up;
- lower production lead times as once prepared, the 3D printer can manufacture any part, regardless of complexity or shape;
- relatively fixed variable costs for each part produced as the only cost is material and printer time.

We expect 3D printing to become more widely used as new materials become available and the capital cost of 3D printers declines. The cost structure of the 3D printing process makes it relatively more attractive to small production runs, particularly for the production of custom parts shaped to users’ preferences.

[4] See Francesca Lake , ‘Artificial intelligence in drug discovery: what is new, and what is next?’, Future Drug Discovery 2019 1:2.

[5] See Yingfeng Zhang, Fei Tao, ‘Optimization of Manufacturing Systems Using the Internet of Things’, Academic Press, 2017.

[6] See GE, Digital twin, accessed from: https://www.ge.com/digital/applications/digital-twin.

[7] See IFR, 2020, accessed from: https://ifr.org/ifr-press-releases/news/facts-about-robots-worldwide.

[8] See Christian G. Sandström, ‘The non-disruptive emergence of an ecosystem for 3D Printing — Insights from the hearing aid industry’s transition 1989–2008’, Technological Forecasting & Social Change, 2015.

Logistics, sales and aftersales

Autonomous vehicles could drastically reduce the costs of logistics and delivery, especially as drones can be used to make last-mile deliveries. Amazon is already actively seeking to develop drone technologies to make deliveries using its 'Prime Air' service[9], which in future could be used to make deliveries to customers.

The biggest impact on the after-sale market is likely to come from increased use of sensors and the internet of things.[10] Rather than offering a reactive service following a failure of a device or part, by embedding sensors and monitoring performance; failures in components could be diagnosed and prevented before they occur. This opens new opportunities where manufacturers could offer to lease parts and components for fixed number of operating hours, with technology enabling an efficient execution of these contracts.

With a wide range of potential applications and a variety of different uses, the overall impact of these technologies may take decades to be fully realised and will have a significant impact on productivity.

Financial services

Developments in financial technology (fintech) – especially those powered by new developments in AI – could have a significant impact on activity in the financial services sector. While a number of different applications are already in use or can be envisaged, we expect the largest impacts to come from widening access and reducing the transactions costs of existing financial services.

For example, consider the M-PESA mobile payment service launched on a pilot basis in October 2005 in Kenya. The service gives mobile phone users without access to a bank account many of the benefits of financial services, including the ability to transfer money and make payments. Some estimates suggest this system has lifted 2% of Kenyan households out of poverty.[11]

Elsewhere, financial services companies are making better use of data in order to enable lending to some borrowers who lack collateral. This is the model used by Ant Financial in China[12], which analyses data on previous transactions and bill-paying behaviours when considering loans to small- and micro-businesses, rather than demanding collateral they are unlikely to possess. Access to finance is an important enabler for these businesses, which in turn drives positive effects for the broader economy.

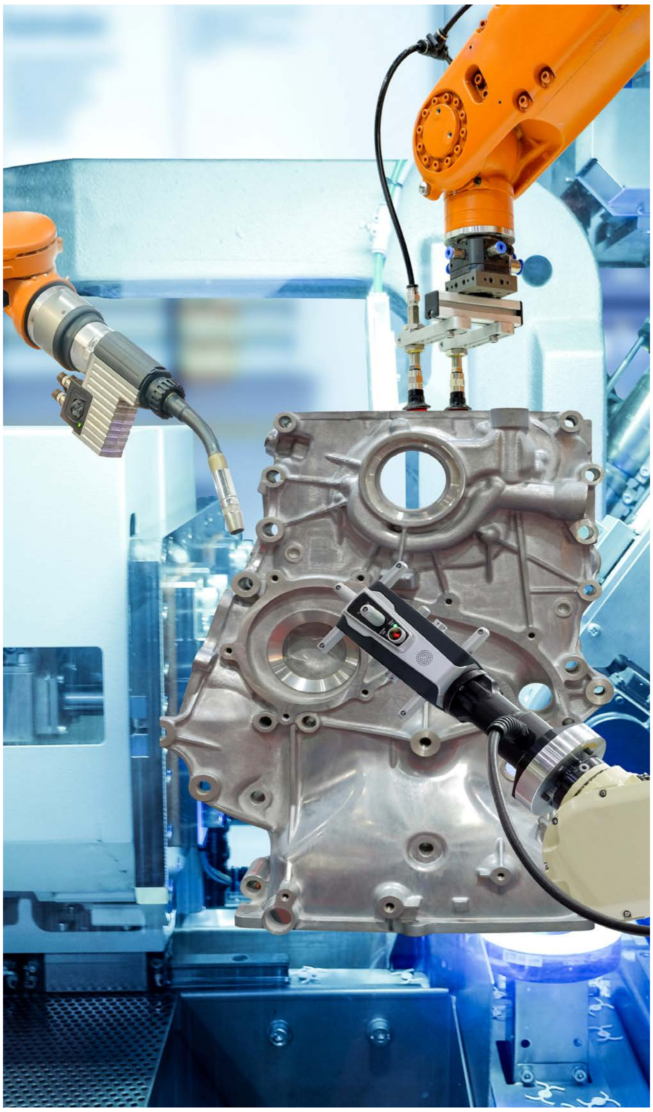
In general, the impacts of fintech can be separated into two groups: some technologies reduce costs and improve efficiency for existing users; while others provide new ways to ensure access to financial products and services for customers who were previously excluded.

[9] See Amazon Prime Air, accessed from: https://www.amazon.com/Amazon-Prime-Air/b?ie=UTF8&node=8037720011.

[10] See Harvard Business Review, 'How Smart, Connected Products Are Transforming After-Sales Service', 2015.

[11] See Tavneet Suri, and, William Jack (2016). "The Long-run Poverty and Gender Impacts of Mobile Money". Science. 354 (6317): 1288–1292.

[12] See International Finance Corporation, Leveraging Big Data for Lending in China Case Study, World Bank Group.



Conclusion: dealing with change

As the majority of technologies on the horizon have a bias towards increasing the capital-intensity of production, there are question marks over whether demand for labour can be sustained. Technological unemployment may become a reality if the job-stealing effect of these new technologies is not mitigated by simultaneous and robust growth in other labour-intensive tasks. This may attract significant level of public attention.

The greatest challenge may lie in the need to equip workers with the skills to work with constantly evolving AI technologies. An increasing emphasis on lifelong learning is essential as the expected pace of change will be much faster than traditional educational systems can support.

Equally, regulation, particularly on the way data is used and owned, is an essential pre-condition to wider adoption. Without regulation that secures public trust, acceptance will be difficult and hostility towards these technologies will increase.[13]

There is also a pressing need for flexibility because the full impacts of these emerging technologies are not yet clear. Some authors have pointed to the limited nature of these technologies compared to the enormous changes that took place during the 20th century[14], inferring that the likely boost to productivity growth would remain small. Others are more optimistic and argue that since new technologies require a period of investment and adoption, current low pace of productivity growth is temporary and is set to accelerate in the near future.[15] Our response will need to evolve as the picture becomes clearer, but at the moment new technology in the pipeline looks promising.

[13] See KPMG, 'How the UK can win the AI race', 2018.

[14] For example, Robert Gordon, 'The Economics of Secular Stagnation', American Economic Review: Papers & Proceedings 2015, 105(5): 54–59.

[15] For example, Brynjolfsson, Erik, Daniel Rock, and Chad Syverson. The productivity J-curve: How intangibles complement general purpose technologies. No. w25148. National Bureau of Economic Research, 2018.

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CREATE | CRT124765 | March 2020