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How 5G will change your life

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16

Cover story
How 5G will change your life

The global 5G rollout has just begun, but behind the hype lies uncertainty and the potential for unintended consequences. This edition of Konzept seeks to answer many unresolved questions. First and foremost, we explain the tangible ways in which 5G will affect you, including the smartphone impact, the future of television, predictive maintenance, autonomous cars, smart cities and more. We also examine the geo-political disagreements, emerging market economics, and argue that the financial cost of distraction is greater than expected.

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Editorial

Given the average smartphone user touches their device upwards of 100 times a day, there is no question people are dependent on communications technology. Most assume the new 5G networks will only increase that dependency further. Yet dbDig primary research shows that smartphone users are rather ambivalent towards 5G, in developed markets at least. One problem is there is no 'killer app' ready and waiting for 5G in the same way that the roll-out of 4G networks immediately made streaming video mainstream.

Yet, the first 'killer apps' for 5G networks are not about smartphones. Rather, the Industrial Internet of Things will be the immediate beneficiary. In this issue of Konzept, we look behind the 5G hype and ask what does it mean for you? What do people mean when they promise a more 'efficient', 'flexible', and 'optimised' life? A great case study is Siemens. The company has developed smart IIoT services to utilise 5G and allow robots in car factories to wirelessly communicate with each other and move themselves around the factory floor in response to, say, a breakdown in another part of the production line.

From the consumer's point of view, IIoT and 5G will enable the 'digital twin' of their car to simulate the effect of specific factors, such as a high number of speed humps near the driver's home, and predict the need for maintenance on the suspension before the problem causes damage.

While the first applications of 5G may be in the industrial space, some of the most anticipated developments are those that will directly impact individuals. Autonomous cars, remote surgery, and virtual reality films are just three things in progress. Another is smart cities. Yet some experiments with smart cities have seen strong public push back. We ask who wants to live in one? And will they contribute to inequality as other technologies have done?

A separate article takes us to emerging markets and we follow a recent trek to the Himalayas which showed us just how the roll out of a new communications network provides a 'technology skip' for emerging markets that has engaged an enormous pool of previously-ignored consumers.

For all the fanfare about 5G applications, the discord behind-the-scenes is just as important. We look at the trade war between the US and China which has introduced a decisively political element into 5G development. We examine the effects for both superpowers and other countries. Separately, we make several suggestions to help Europe catch up to the 5G position already enjoyed by the US and China. We also take a walk through history to see how faster communications has aided economic growth. We then ask whether in the age of instant communications, 5G will actually lead to economic growth?

Against the political and technological backdrop, the impact of 5G on equity markets will likely be more nuanced. We examine how the 3G and 4G roll-outs showed that investors in various industry groups experience vastly different timings on their gains and losses. It will be interesting to see if these patterns repeat themselves for stocks with 5G exposure.

Next, we examine how 5G networks are shaking up the business models. We look at today's 'golden age' of television and ask whether the big spending on high-quality content is sustainable in the medium term. We also enter into the satellite versus online streaming debate and examine both the cost dynamics and the significant non-financial issues. Furthermore, there may be no debate more fraught than the state of news media. We predict five ways communications technology will change the industry and impact society.

Ultimately, it is the impact on individuals that really matters. So given that the average smartphone user touches their device 100 times each day, what is the impact of the distractive element of better communications? There is a small but increasing amount of evidence to suggest communications-based distractions have a bigger economic and social cost than many expect. Indeed, in the future, we may see more attempts by companies such as Atos Origin to go email free.

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Contents

Summaries

How 5G will change your life

The roll out of 5G networks is underway, yet dbDig primary research shows US smartphone users are relatively ambivalent. The issue is that unlike the 3G and 4G roll-outs, there is no 'killer application' for 5G smartphones yet. But 5G's biggest effects could be outside smartphones. It will enable predictive maintenance on cars, virtual reality films, autonomous cars, and other Smart City applications. And that is before considering the industrial Smart Factory applications that are already being built. In fact, the consumer internet industry will likely be a 'late cycle' beneficiary of 5G and we note that equity investors took time to warm to 3G and 4G.

Siemens case study

At the forefront of 5G's application to the Industrial Internet of Things is Siemens and its cloud-based MindSphere system. Integrating the 5G network into this system will make it possible to capture the data generated by one million sensors per square kilometre in factory complexes. To gain first-mover advantage, some clients are already adjusting their factories with a view to incorporating wireless robots that can move around a production line. The goal is a complex that can operate itself, learn and integrate with suppliers. It also enables 'digital twins' to provide predictive maintenance information directly to consumers.

The politics of 5G

In the middle of the geopolitical battleground between the US and China is 5G, and particularly Huawei. While the rhetoric has oscillated between hard and soft, both countries are considering how to build out industries that have been hit with restrictions, or are at risk. At the same time, the international clout of the US, and the increasing influence of China through its Belt and Road Initiative, have left other countries caught up in the dispute. Many are wrestling with the issue of how to take a side, or avoid it completely. But the issue is just as much about economics as geopolitics.

Europe needs to expand its digital infrastructure

Europe significantly lags the US when it comes to digital infrastructure and targets have been missed. It also sits behind China which is progressing with its "made in China 2025" strategy. The risk for Europe is that this underperformance becomes self-reinforcing as companies look elsewhere to invest. Compounding Europe's problems is the notable divergence in the digital infrastructure between different countries. We look at some of the reasons for this underperformance and posit some solutions. Given the government investment required, the final result will depend on political priorities.

Distraction economics

As 5G makes the world even more connected, there is a growing awareness that distractions are bad for the economy. In fact, slower productivity growth and GDP in developed countries has coincided with the rise of email and smartphones. Indeed, some suggest the US economy loses $1tn each year due to too much information and interruption. Feeding into the economic impact is the realisation of the mental health implications of over-communication. For example, studies show that people who are forced to work without email report increased collaboration with colleagues, significantly less stress, and, importantly, feel far more productive.

Peak speed and economic growth

The increased speed of communications has usually gone hand-in-hand with economic growth. But even though large quantities of information can now be sent instantly around the world, it does not mean slower growth. That is because the latest technology is allowing an unprecedented spread of communications. In particular, that is directly leading to increased education rates in developing countries. In fact, if current increases in education rates continue, the 200m additional educated workers that enter the workforce over the next three decades will compensate for most of the expected decline in the workforce in the more-developed world due to demographic problems.

Satellite vs streaming

Elon Musk's SpaceX is rapidly reducing the cost of launching a satellite into orbit. That is helpful for the traditional television industry as it deals with competition from streaming services. It is true that streaming is becoming cheaper. Indeed, if cost deflation continues at its current rate, a majority of global channels will be better off going online-only by the end of next year. The proportion is the highest in Europe. But still, satellite has its place. It is still the best way to access the greatest number of subscribers, the quality is easier to guarantee, and piracy concerns are lessened.

The emerging market technology skip

Our recent trek in the Indian Himalayas showed what an impact new communications technology is having on a huge swathe of the population that has, until recently, been largely excluded from the global economy. Smartphones have been the 'technology skip' – they are cheap and run on new, fast networks. They enable micro-entrepreneurship without the need for other, more expensive computing equipment. But despite there being a billion eyeballs now watching screens in India, the path towards monetising that viewership is diverging from that in developed markets. Content still needs to remain free or low-cost, making advertising key – a huge challenge for broadcasters and content owners.

The 'golden age' of television and its uncertain future

Our present day has been described as the 'golden age' of television with huge amounts of money being invested in original content by providers with very deep pockets. Some worry that 5G will stimulate even more competition and cause spectacular failures. But traditional television habits are changing and new models are emerging. As today's market fragments, more content providers are able to target specific audiences and still remain viable. In addition, both traditional cable and free-to-air networks are investing heavily in data and analytics to evolve their advertising models. Rather than being something to fear, new business models should be seen as an opportunity.

Who wants to live in a Smart City?

It is an intriguing paradox that while better data use can unquestionably improve people's lives, citizens are pushing back against their data being used by companies and governments. That has led to several Smart City projects, which will be reliant on 5G networks, to be delayed. That is just one of many reasons why pre-planned Smart Cities may have to be built from scratch. But if that happens, some worry the 'gilded cities' will widen the inequality gap. Yet, the technology-skill complementarity that has boosted top-end wages may weaken as several extraordinary one-off factors that have hurt low-paid workers in developed markets have recently diminished.

The future of news

Two decades ago, newspaper editors were told the internet age meant they had to give away content for free, create click-bait, and support it all with any advertising they could find. It hasn't turned out that way. Fears of fake news, the shift to quality, and the lack of patience for distraction has led to growing numbers of subscribers at some of the world's best-known mastheads. Yet, the shift is not complete. Communications and 5G technology are likely to have five impacts on the news media: the return of regional reporting with new funding models, less focus on speed, a reduction in the number of news sources people read, the acceptance of automation, and the return of television news, in a curated format.

How 5G will change your life

Amidst hype and high expectation, the 5G roll-out has begun. It recently launched in Korea, while the US, UK and others have commenced trial versions and China has said it will soon grant commercial licenses for its network. To take advantage, companies such as Samsung and LG have launched 5G smartphones. In total, $160bn is being invested annually in the construction of 5G networks according to GSMA, the mobile network operators' association. It expects 5G to contribute $2.2tn to the global economy in the coming 15 years, just a little less than the size of the UK economy.

Yet, for all the fanfare, many in the industry are quietly nervous. Among other things, one of the biggest concerns is that there is no 'killer application' ready and waiting to be unleashed that requires the 5G network. That trepidation stands in direct contrast to the 4G and 3G roll-outs. The former allowed good-quality streaming video and the latter photo sharing and other types of multimedia. Both were a boon for hardware, software, and network providers.

This is backed up by our dbDig primary research[1] which shows that in the US, only ten per cent of customers are prepared to pay $6 or more for 5G services and one-quarter of customers say they are not prepared to pay any extra at all. Yet when we look at China a different picture emerges. Indeed, two-thirds of Chinese customers are willing to pay for 5G if it means quicker uploads to social media or the ability to play mobile games with very low load time. That is double the proportion of US customers who are willing to pay for the same services. It seems part of the reason is that the Chinese are far more likely to report issues with signal strength when they are in rural areas. Given smart phones have become a crucial engagement tool in rural Asian areas (see our piece titled, 'The emerging market technology skip') the willingness of the Chinese to upgrade is not surprising. However, the future for 5G smartphone service in developed markets seems more uncertain.

On top of the concerns about user uptake are the voices of health professionals, environmentalists, and politicians who worry about radiation emissions. Take Brussels, for example, a city with very strict radiation regulations. There, a pilot 5G project was halted on health grounds with the environment minister proclaiming, "The people of Brussels are not guinea pigs." In Switzerland, authorities have commenced a 5G radiation monitoring programme. And all this comes before considering the stern political rhetoric that has accompanied the choice of Chinese suppliers for 5G infrastructure (see our piece titled, 'The politics of 5G').

So given that many smartphone users are wondering whether they should bother upgrading to 5G, the network providers cannot be blamed for wondering just how aggressively they should spend the money to roll out 5G networks. Consider that 5G works on a much shorter wavelength than 4G. Because of that, it cannot travel as far as the longer wavelengths of earlier networks. It also has more trouble penetrating the thick walls of buildings. To deal with this, network providers will need to install perhaps five times more base stations than they have with 4G, and some of those stations may be more costly to build. The extra cost, then, is significant and the initial roll-outs will almost certainly be confined to densely-populated urban areas.

1 dbDig is Deutsche Bank Research's Data Innovation Group. For the complete 5G data and analysis, please contact your usual Deutsche Bank representative, or write to the team at luke.templeman@db.com

So, is it a situation of "build it and they will come"? Will the roll out of 5G spur a frenzied development of 5G-specific applications in a similar way to how 4G catalysed a plethora of video-related products? Or will network providers need to see evidence of a demand for 5G and a willingness to pay before they can justify the expense of rolling out 5G beyond city centres? While we wait for the 'killer app' to be developed, the answer is it will probably be a bit of both until a virtuous cycle is established.

The thing is that unlike the move to 3G and 4G, some of the most important uses of the 5G network are unlikely to take place on a smartphone, at least for now. Instead, the initial uptake in 5G will likely be driven by the manufacturing industry and public utilities, not individual consumers. Some countries have made significant plans for this. Germany, for example, has reserved a 100 megahertz band between 3.7 and 3.8 gigahertz to be used exclusively by industrial companies for their local networks. German company Siemens is one of the companies at the forefront of 5G industrial applications (see our piece titled, 'Siemens case study').

Some call it the Industrial Internet of Things, others Industry 4.0. Either way, the story is the same. The IIoT is a network of intelligent industrial devices, that is, machines that have in-built sensors that collect data and communicate with each other. This allows them to adjust how they perform a task to what is happening elsewhere in the factory, or inform a human of a certain need to make the process more efficient. The idea is not new, but so far, 'smart factories' have been extremely limited. One key problem is the latency of existing 4G networks. Although it may be small,

just a second's delay for a precision manufacturing job can result in serious damage to the product. The 5G network with latency at the lower end of the millisecond range will go a long way to fixing that. For example, a robot arm will be able to stop itself immediately if a camera identifies a foreign object on the conveyor belt.

The very-low latency of 5G opens up the possibilities for using machines in remote locations or where it is difficult to lay cables. For example, industrial companies use IWLAN networks for the monitoring of power networks on islands or the identification of leaks in oil and gas pipelines.

Reliable wireless connectivity will also enable autonomous robots on the factory floor. These will be able to move themselves to where they are needed, particularly in cases where a breakdown or bottleneck occurs at one point on the production line. It is true that factories are currently configured for cable-connected robots and reorganising the factory to allow for autonomous robots will be expensive. But in time this will change as the design of many factories is currently very inefficient as they are frequently back-solved to account for the requirements of cable-connected robots. Not only that, but it will also allow for more mobile human staff in factories. Currently, most control panels are wired as they are generally deemed too critical to be left to a wireless connection. Reliable 5G connections will change that. Furthermore, ultra-low latency augmented reality applications will also be enabled for technicians.

Of course, industrial markets are just at the beginning of their digitisation journey. As factories begin to implement 5G, the network will grow. That will allow control to be increasingly decentralised. It will also allow for a link to be made with suppliers. This is great news for those that engage in just-in-time inventory processes, or wish they could. For example, if a supplier can be notified of a factory delay the moment a machine detects it, shipments from that supplier can be delayed to accommodate. This also trims energy costs and reduces throughput times.

Another application factory owners have long desired is predictive maintenance. Apart from the speed and latency benefits of 5G, the network is much better than 4G at handling multiple devices at once. In fact, 5G makes it possible to transmit the data generated by one million IoT devices per square kilometre in a factory complex. That should cover the complete production line of most factories and their associated temperature measurement and flow sensors. Indeed, by some estimates there will be 80 billion connected devices generating 180 zettabytes of data in 2025, 45 times the amount of data generated in 2013.

All that data allows for the strain on components to be better analysed and the cost savings can be significant. This is best illustrated with an example. Take a brewery which has thousands of valves that secure the smooth transfer of liquid through the machines. From time to time, one will break causing downtime or, even worse, a contamination of the product. To avoid this, the norm is to exchange all valves at specific intervals based on historic projections of breakage rates. In a 5G smart factory, sensors can measure the actual strain on the valves and alert the human controllers when a specific one needs to be replaced before it breaks and without throwing

away otherwise perfectly good valves.

Further down the road, 5G technology should accelerate the adoption of industrial and enterprise mobile internet use case beyond factories. One example is the opening up of new technology acceptance models for mainstream consumer internet companies to expand into enterprise solutions. In fact, given the potential applications, this will likely become a mega-trend. The US will likely lead the way. To put the figures in context, the technology software and services industry represents one-third of all US listed technology companies' market value. In North Asia by contrast, the figure is under ten per cent and it is difficult to identify many strong enterprise software companies in the region. That said, it will not be all one-way traffic from North America. China has strong ambitions to build stronger digitally-connected infrastructure and aims to become less reliant on foreign and overseas technology for enterprise software.

While the first applications of 5G may be in the industrial space, one of the most anticipated consumer-facing applications is the autonomous car. The necessity is the close-to-zero latency of 5G – critical if autonomous cars are to be linked together and make split-second decisions. Although the world is some way from widespread adoption of autonomous cars, they have the potential to offer safety and environmental benefits with 5G as the backbone. They will also likely be the most visible part of a smart city (see our piece titled, 'Who wants to live in a Smart City').

Other consumer-facing applications currently under development include remote surgery which requires very-low latency services. On the entertainment front, virtual reality films will require the high speed of 5G networks. Consider that a standard two-hour film streamed in high-definition on Netflix will consume four gigabytes of data. The same film in virtual reality will use ten times the amount.

To examine just the consumer and industrial benefits of 5G is to merely see one side of the coin. The other is which companies and industries will benefit and, crucially, when.

In the first instance, it is the hardware equipment makers that should benefit as they are the ones to construct the infrastructure to lay out the 5G network. Then it will be the turn of the software makers. History shows that the providers of content, such as video and games, have benefitted at this point as digital content tends to be more intuitive from a business model standpoint and thus has faster adoption. Following this are businesses that require more infrastructure support. With 3G and 4G, this included the e-commerce and food delivery industries.

The consumer internet industry is likely to be a 'late cycle' beneficiary of 5G technology. Internet companies tend to identify and release new innovative services and content once there is sufficient reach and penetration. Thus, a sufficiently installed 5G base is a likely pre-requisite for the consumer internet industry.

Yet, the industry will also note how market valuations reacted to the 3G and 4G upgrades in the past. At first, investors were pessimistic, fearing the unknown costs and worried about the extent of adoption of the applications enabled by the technology as well as cannibalisation. These fears weighed on market valuations early in the

cycle before becoming a tailwind later. This was particularly noticeable in Asia. During 2011 and 2012, major Asian internet stocks reached then-historic valuation lows in China, Japan, and Korea. In China, the market valuation of these large listed stocks remained flat in 2011 despite the jump of one-third in the underlying earnings outlook. In the more mature Japanese market, the aggregate sector's market value fell eight per cent despite a six per cent increase in earnings.

As the industry decides the extent of its initial roll-out, it will be cognisant of the lessons learnt from the transition from 3G to 4G. Then, streaming video was the 'killer application' that was ready to go as soon as the 4G network was installed, and customers were enthusiastic in their take-up. The net consequence was lower earnings for consumer internet companies as the increase in bandwidth and content procurement costs skyrocketed, relative to the periods where text and static image-based content consumption were mainstream. In other words, the early phase of improving network quality was a cost that wracked on the nerves of investors. It would be safe to assume telecommunication executives will use this experience and temper their enthusiasm for an immediate wide-spread 5G roll out.

But despite the nerves of suppliers, the concerns of health professionals, and the political complications, the tangible benefits of 5G networks, will likely become commonplace far sooner than many expect.

The early phases of prior network roll-outs saw extra costs for providers that wracked the nerves of investors.

Siemens case study

Imagine a car owner who lives in Islington, an area of London notorious for its speed humps. The car is still three months away from its annual service check but, out of the blue, the owner receives a message via the car's app that the suspension needs servicing. This is the kind of predictive maintenance capability car manufacturers are beginning to build thanks to 5G networks and the Industrial Internet of Things. >

At the forefront of creating the infrastructure for the Industrial Internet of Things is Siemens. The company has developed a cloud-based IoT operating system called MindSphere, which enables customers to link their machines and infrastructure to the cloud and communicate. This means manufacturers can analyse their production facilities and products during actual use and implement the insights from data analytics to continuously optimise the processes. Already, carmaker Volkswagen is on board.

The on-the-ground applications are significant. The 5G network, combined with MindSphere, will make it possible to transmit the data generated by one million sensors per square kilometre in factory complexes. This should cover all the connected sensors envisioned on a complete production line that incorporate things, such as temperature measurement, flow of product, and the like. Furthermore, as 5G allows for close-to-zero latency (or the time between the command being issued and the machine taking action), the cables that currently connect most factory equipment can be removed, meaning autonomous mobile robots can adjust their position on the factory floor.

The application of Siemens' systems within the Volkswagen universe is particularly complex. The MindSphere system is charged with networking the production systems and equipment at 122 Volkswagen plants. Once implemented, it will allow, for example, an autonomous vehicle fleet to transport goods or spare parts between delivery ramps, factory halls, and warehouses back and forth with timing that is precisely adapted to the production schedule.

The goal is a plant complex which largely runs itself and learns from itself, something that is particularly important when a breakdown or other unexpected event occurs to any machine in the production line. As a result of all the machines being connected via MindSphere, they can all be instantly notified of a problem with one machine. The others, then, can adjust their speed or divert work-in-progress goods to suit. When autonomous mobile robots are integrated on the factory floor, they can change their position to re-optimise the production line.

The result is a production line that can adjust itself to run at its peak possible operation even though it may be unexpectedly running at a lower capacity. That is a big step up from the past where a broken machine could easily result in bottlenecks or wastage. Furthermore, where a delay or shutdown are unavoidable, the machines across the factory can automatically adjust their settings to reduce power consumption during the repair time. In all, a more productive, reliable, and flexible factory.

In the long term, it is expected that Volkswagen's industrial cloud will also integrate its entire supply chain comprising 1,500 suppliers and partners at more than 30,000 locations. As suppliers and equipment providers will be connected, the knowledge gained from the data analysis of the sensors on the factory floor will make it possible to make micro-adjustments all the way along Volkswagen's supply chain in real time. A problem that causes a delay on one line can automatically inform a just-in-time supplier to delay or reduce their shipment for the next day.

Beyond making factories more efficient, Siemens' systems also enable more advanced use of 'digital twins', where an exact digital copy of an object is stored on an IoT system. As with our example of the car earlier, this is enabled by the multitude of sensors now possible.

Digital twins go beyond merely being able to simulate what a product might do in the future. Returning to our example with the speed humps, during the design and production phase, a digital copy of each individual car produced can be uploaded into a cloud-based system. Then, as the car is being driven each day by the owner, thousands of sensors can feed back data into that cloud-based system; information such as tyre pressures, engine revolutions, and the number of speed humps crossed. All this data is fed into the digital twin on the system in real-time. The system can then assess how the car is performing in its specific conditions and run simulations to see which components of the car may soon need repair, assuming either the same conditions continue or in a variety of scenarios.

It is true that, historically, the industry has been slow to adapt to new technologies. One reason is that reliability issues can matter more than generating new efficiencies. And that is before considering that substantial training will be required for the partners and suppliers that will form part of the network. Consequently, most customers will likely start small and gradually scale up their IoT capabilities. For the companies that are brave enough to pioneer systems such as Siemens' MindSphere, the gains could well give them a headstart.

In the long term, it is expected that Volkswagen's industrial cloud will also integrate its entire supply chain comprising 1,500 suppliers and partners at more than 30,000 locations.

The politics of 5G

Huawei. . .is it business or personal? >

If we are to believe the prognostications about its future impact, 5G certainly occupies a crucial geopolitical dimension. The ability to control the Internet of Things via vastly reduced latency and higher speeds is a serious weapon in the hands of an adversary. If one power can shut down or warp vital systems such as the power grid, autonomous cars, trains, robotics, manufacturing sequences, air traffic control, communications, or sensitive information, there seems scant need to invest in strategic bombers and missiles.

It is interesting to frame the geopolitics of 5G networks in the context of the goals and strategies deployed in the two years that the US-China trade dispute has been simmering. There have been suggestions of three possible, and progressively more expansive, main objectives of the Trump administration:

1. Balance bilateral trade. This plays off the riff that Trump is strictly transactional in his approach, looking for a somewhat advantageous but minimalist deal that he can tout to his political base. China would import more US raw materials, grains, and aircraft, so it would cease, as Trump has quoted, "taking $500bn a year from us". In this case, China, via internal directives, will simply have shifted its purchase of materials from elsewhere to the US. Some other countries will then have to run bilateral deficits or smaller trade surpluses with China, but the US current account balance might not change much. This would be relatively easy for China to deliver and could be dressed up as more than just a cheap victory by Trump if he were out to score domestic political points. But it is unlikely that this has ever been a real goal rather than just easy rhetoric.

2. Level the playing field. Economic demands have been pursued progressively more stridently as varying personalities in the Commerce Department, the Treasury, and the Office of the Trade Representative have successively captured control of the negotiations. The US position has been that China should end barriers to US exports, investment barriers, forced majority Chinese ownership of US direct investment, forced intellectual property transfer and theft, and state subsidies to exporters and import competitors. Until recently, this seemed to be the real goal.

Tough talk, however, and general tariff threats could have been designed to get either or both of these two potential objectives. After all, tariffs alone do not block trade (at least when set at 10 per cent or even 25 per cent). They shift it somewhat. The employment of tariff weapons alone in the bargaining process likely indicates that the negotiation is still strictly about business. So as attention centred on these issues, some kind of mutually agreeable compromise has generally been expected during the negotiation.

3. National security and geopolitical priorities. But tight quotas and embargoes—strict non-tariff barriers that close down markets completely—are about geopolitics and even blatant mercantilism. Existential threats to Chinese companies rather than stiff but reasonable fines for corporate transgressions are about geopolitics[1]. This is strictly personal. China's blocking of soy beans is about US electoral college calculations, but since the EU uses the same tactics in protectionist retaliation, this is not such a great departure.

1 Huge US and EU fines on, e.g., Volkswagen and Google, respectively, though painful, have not been intended as fatal.

Nowhere has this security dimension been more salient than in 5G, which is perhaps the key to the control of future technological communications development. Blocking China's leading company in the global 5G roll-out is *raison d'état*, a serious response to a "Death by China" worldview. Pulling the rug from under China's key technology companies is a neat parallel to China's ban of Google and Facebook for internal security and mercantilist reasons in favour of now highly-competitive local champions.

From what now seems to be an increasingly bi-partisan US perspective, the Chinese state-supported companies Huawei and ZTE blatantly thwart US laws and restrictions. They are believed to be acting not as private firms but rather as instruments of the Chinese state. This opens the door to blocking inputs of vital US hardware and software, creating potential short-term disaster for these firms and slowing down their global 5G roll-out, while also hitting even their mature product revenues such as smart phones. Even if the US relents somewhat, as it has done in operating system updates for Huawei phones already in the hands of consumers, the writing is on the wall for consumers of future products since the US can always strike again to undermine the usefulness of their consumer durables. Indeed, an exodus from their products has already begun.

China's natural response will likely be to accelerate the development of its own chip and operating system production. If successful, this would attack US dominance in this dimension and cause long-run harm to US technology companies. But, meanwhile, Huawei revenues would seriously suffer, so this response would become a costly race against time. It has been argued that China could retaliate by blocking rare earths exports as it has previously done with Japan. But this response likewise would work only briefly. An emergency would likely be declared in the US, initiating a crash program to develop existing rare earth deposits in the West. In turn, that would break China's near-monopoly.

China could also strike in yet another dimension by harming US firms in China, keeping them from the vast domestic consumer market, but this would be followed by an exodus of such firms and a wipe out of inward US and other foreign direct investment to China. Both China's own gross and net international investments are larger still, and these can likewise be harassed and seized as hostages[2].

Why is 5G the hill to die on?

The principal suppliers of 5G equipment currently are Huawei, ZTE, Samsung, Nokia, and Ericsson. However, these are dependent on US firms for many key components and software, which is the crux of the current blockage of Huawei. That is key as Huawei has a pricing and technical advantage, having engaged extensively in 5G development and investment for some years. The US argues that the price advantage arises from Huawei's close relationship with the Chinese government, its large guaranteed internal market, subsidised credit, and favoured position in the Belt and Road Initiative. For the recipient countries in the BRI, the deployment of Huawei 5G is nearly irresistible.

2 Our 2014 retrospective on the evolution of Bretton Woods II reprises the function of China's reserves as collateral to its trading partners against a geopolitical upheaval. Reserve acquisition was by far the dominant form of capital export that China used to finance its current account surpluses. In the last five years, however, China has exported capital much more as FDI and other non-reserve instruments, so these investments would also serve as hostages in a show-down, although perhaps harder to isolate and freeze. See Dooley, Folkerts-Landau, and Garber, "The Revived Bretton Woods System's First Decade", 2014, pp. 17-19.
https://etf.dws.com/AUT/DEU/Download/Research-Global/89ac3939-4664-425f-b2e8-84e73ecc9ccb/Special-Report.pdf

The US is basing its case for shunning Huawei hardware on claims that it is an instrument of the Chinese government, and on the consequent security threat that Huawei may engage in massive surveillance of data transmissions or even act via access to the Internet of Things. Huawei denies the allegations and the US has not been completely successful in persuading even some of its allies in blocking the use of Huawei products. Timing is becoming critical. While South Korea was the first country to roll out 5G on a large scale in April, many countries have set up small scale demonstration networks and will soon be ready to deploy fully operational systems.

The recent step of the US to put Huawei on the entity list is evidently much more effective – vital component inputs into Huawei's products will be blocked. If strictly carried through, this might be fatal to Huawei just as it would have been to ZTE had not Trump relented. It will slow Huawei's 5G implementation by the months or years it will take for China to produce the components itself. It seems the US is willing to accept the price of squeezing the profits of its own technology company component suppliers, unless this is simply some bargaining tactic to achieve a lesser goal in the trade negotiation. Indeed, this may be as much a slap at various EU countries as it is at China since it moves beyond just trying to persuade US allies not to side with Huawei to arbitrarily blocking them.

From one point of view this strategy makes sense – just as a country that equipped its military with Soviet weapons during the Cold War put it solidly in the Soviet camp, using Chinese 5G will bind a country to China. The rosters of who is going with Huawei and who is not is defining the membership of the world's opposing camps going forward, just as did Comecon versus Marshall Plan membership in 1947. Strictly blocking vital Huawei inputs would be a major act of economic warfare, far beyond the current effort to limit the territories that take up Huawei. Where the tariff barriers imposed by Trump are as much about economics as geopolitics, this non-tariff barrier is mostly about geopolitical dominance.

Where the tariff barriers imposed by Trump are as much about economics as geopolitics, this non-tariff barrier is mostly about geopolitical dominance.

Europe needs to expand its digital infrastructure

In the race for digital infrastructure and leading positions in digital markets, Europe and its companies lag their US competitors by a significant margin. They also lag China where competition is augmented by the country's digital market which protects domestic companies. And that is before considering that Chinese companies are striving to become global leaders in robotics, automation, and other sectors, and can rely on government support. This all forms part of China's "Made in China 2025" strategy.

Europe is faced with three major risks in the area of digital transformation. First, European companies are at risk of falling even further behind in those core areas of technological change where they have already lost significant ground to their US and Chinese competitors. This particularly applies to platform economics and digital ecosystems. Second, in the relatively new field of artificial intelligence, Europe is massively underinvesting compared with the US and China, which are engaged in a neck-and-neck race. That leads to the third risk, that is, where European companies have developed good or leading positions in areas, such as robotics and automation, industry 4.0, connected mobility, and smart energy networks, they risk being attacked, overtaken or squeezed out of the market.

Digital infrastructure is a necessary condition for the development of digital markets

Digital infrastructure (fixed and wireless networks, antennae, data centres etc) is a necessary but not sufficient condition for the further development of the European digital economy and for Europe's international competitiveness. Of course, without the sufficient availability of infrastructure, the issue is a non-starter. A recent survey by German Bitkom Research showed that 93 per cent of all interviewed companies expect that 5G, the fifth generation of mobile communication networks, will enable the deployment of further digital technologies. 84 per cent expect that 5G will increase the productivity of German companies. So to really develop Europe's digital economy, considerable investment is necessary.

Numerous ambitious goals set by the EU

It is true that over the last few years, policymakers have set themselves quite ambitious goals to invest and improve the digital infrastructure in the EU. To better understand the political ambitions, it is important to look at a number of past plans. Back in 2010, the "Digital Agenda for Europe" formulated targets for broadband access in the EU; this agenda was updated in 2012. The three targets were:

- to bring basic broadband of up to 30 megabits per second to all Europeans by 2013;
- to provide all Europeans with this speed broadband by 2020;
- to ensure take-up by at least half of European households to ultra-fast broadband of over 100 megabits per second by 2020.

In 2016, the European Commission updated and extended its digital infrastructure goals:

- By 2025, all major socio-economic drivers (such as schools, transport hubs, the main providers of public services or highly digitalised companies) should have access to connectivity of at least one gigabit per second.
- All urban areas and all major terrestrial transport paths should have uninterrupted 5G coverage by 2025.
- All European households should have access to internet connectivity of at least 100 megabits per second, upgradable to gigabit speed.

Considerable investment necessary across Europe

It is worth bearing in mind these prior goals given that upgrading digital infrastructure is an expensive endeavour. While the estimates of the actual funding requirements differ depending on the time horizon and the size of the planned investments, they often come to a three figure billion amount. The European Commission believes that €515bn will need to be invested over ten years to achieve the targets for 2025.

In principle, private-sector companies are responsible for both the provision of the necessary digital infrastructure and the provision of telecommunications and internet services in the EU. Nevertheless, the government may subsidise infrastructure works, for example in rural areas, where the low population density or an unusual settlement structure render the necessary investment unprofitable. In fact, depending on these issues, public-private cooperations are in many cases the best option to provide the necessary digital infrastructure. The EU has created several programmes and funds to finance the past and future upgrading of the digital infrastructure network.

Progress lags behind the targets

During the last few years, there has been some progress in reaching the goals for digital infrastructure improvements in the EU. The target of providing basic broadband coverage has been (largely) reached. In 2017, 99.6 per cent of all EU households had access to some type of broadband connection. Fixed broadband services reached 97.4 per cent of EU households although the ratio was a little lower at 92.4 per cent in rural areas.

However, the target of providing all EU citizens with broadband connectivity of more than 30 megabits per second by 2020 will probably be missed. In 2017, only 79 per cent of EU households had access to such connections (up from just over half in 2013). Moreover, there are still considerable differences between the individual EU countries. In France and Poland, for example, the share of households with internet connectivity of more than 30 megabits per second was still below 60 per cent last year. Despite their progress in the last few years, these countries are very unlikely to reach the target of (almost) 100 per cent by 2020.

The third target of the EU Commission, having at least half of EU households actually using ultra-fast broadband by 2020, will probably be missed as well. As with the other two targets, there has been some progress in this regard. The European Commission estimates just 6.7 per cent of all fixed broadband connections provided ultra-fast access by mid-2014. By mid-2017, this had risen to 20 per cent. One issue is that people do not automatically use fast internet access even if it is available. Demand for high-speed broadband services depends on numerous factors, including the income, age and use by consumers and price. Of course, demand for high-speed internet influences, in turn, the pace with which the digital infrastructure is improved.

Numerous reasons for infrastructure deficiencies

There are economic and regulatory reasons for the insufficient progress of digital infrastructure improvements. The first is that providers continue to focus on copper infrastructure instead of optic fibre networks. In addition, competition is lacking. Furthermore, (state) financing bottlenecks, particularly in rural areas, have delayed investment.

The two major reasons, though, for why the improvement of digital infrastructure takes so much time are tight public funds and a lack of profitability of the projects. While this is true across Europe as a whole, it particularly applies to rural areas. Indeed, the European Investment Bank calculates that half of the expenditure which would be necessary to reach the broadband targets for 2020 will have to be spent in rural areas, where just one-fifth of the population live.

Of course, private sector companies only invest in (potentially) profitable ventures. In the absence of a profit motive, public sector subsidises are needed. This does happen. In fact, the government is often the most important investor in rural areas. Still, governments have proved reluctant, or unable, to finance the investments needed to reach the infrastructure goals for 2025. In any case, the medium-term financial planning for the EU as a whole and its member states does not foresee such investment.

Demand for ultra-fast internet (still) too low

Away from the supply-side, there are also demand-side reasons for the slow progress with broadband deployment. First, there is a discrepancy between the availability of broadband connections and the actual demand for ultra-fast internet. If customers were more interested in fast internet access and willing to pay for it, the digital infrastructure upgrade would be a more attractive investment for private-sector companies. Yet, it seems many households are quite content with slower but cheaper internet access, and this is likely to remain the case for the foreseeable future. Households' reluctance to pay for faster internet access may be due to the fact that the number of attractive digital applications is still too small.

To some extent, this is a chicken-and-egg problem. Demand will not increase as long as there are few attractive digital services, and if demand remains low, it does not make sense to upgrade the infrastructure. At the same time, data-intensive digital applications can be offered (and used) only if the network capacities are adequate. Still, both supply and demand will certainly rise in the coming years, perhaps just more slowly than originally envisioned.

Numerous measures against infrastructure bottlenecks

Any measures taken to ensure quick and efficient broadband deployment will need to address both the economic and the policy/regulatory problems mentioned above. Still, it is necessary that the regulatory framework for the telecommunications sector gives incentives for investment and stimulates competition. Competition, in turn, helps to exploit potential opportunities for cost-cutting. Just how state regulation promotes competition depends on the individual market area. If an area is commercially viable, several providers may establish parallel networks. From a macro-economic vantage point, this solution may not be ideal if one single network is sufficient. However, if several parallel networks make economic sense for the providers, they can establish a healthy degree of competition.

Suitable regulation can help build competition in the telecommunications sector even in regions which are not commercially viable. This is particularly important given that if governments really want to achieve the stated goals, they should support only gigabit-capable technologies. One of the most important tools is a tender procedure for assisted areas, which are allocated to the provider, and can offer the desired service at the lowest cost. The so-called open access regulation makes sure that competition does not end with the tender procedure. For example, state support for infrastructure deployment may depend on the winner allowing alternative providers access to the network once it is completed. In this way, open access helps to prevent (temporary) monopolies.

It is, of course, of upmost importance to exploit efficiency potentials. Economies of scale can be achieved by creating optimal assisted areas. Larger assisted areas will improve the chance of getting private providers interested in deploying their own network and of reducing state subsidies due to the higher number of potential customers and degressive fixed expenditure. This may also help prevent private investment from being crowded out by state subsidies. Cooperation along the value chain can also result in economies of scale. Since a large share of total infrastructure expenditure will be used for earthworks, it makes sense to cooperate with other network operators, including electricity, gas, and water suppliers.

Ultimately, governments will probably have to provide more money and raise spending as data traffic increases. In this way, at the end of the day, paving the way towards a gigabit society is a question of political priorities.

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Distraction economics

It may take several generations, but when people reflect on work in the early part of the 21st century, they may see Thierry Breton as being ahead of his time. In 2011, the chief executive of French technology firm Atos Origin announced his desire for a zero-email company. It did not quite work out but the company did reduce its email volume by two-thirds over the next three years. At the same time, operating margins increased one percentage point to 7.5 per cent, administrative costs fell a quarter to ten per cent, and the company's stock price jumped by half.

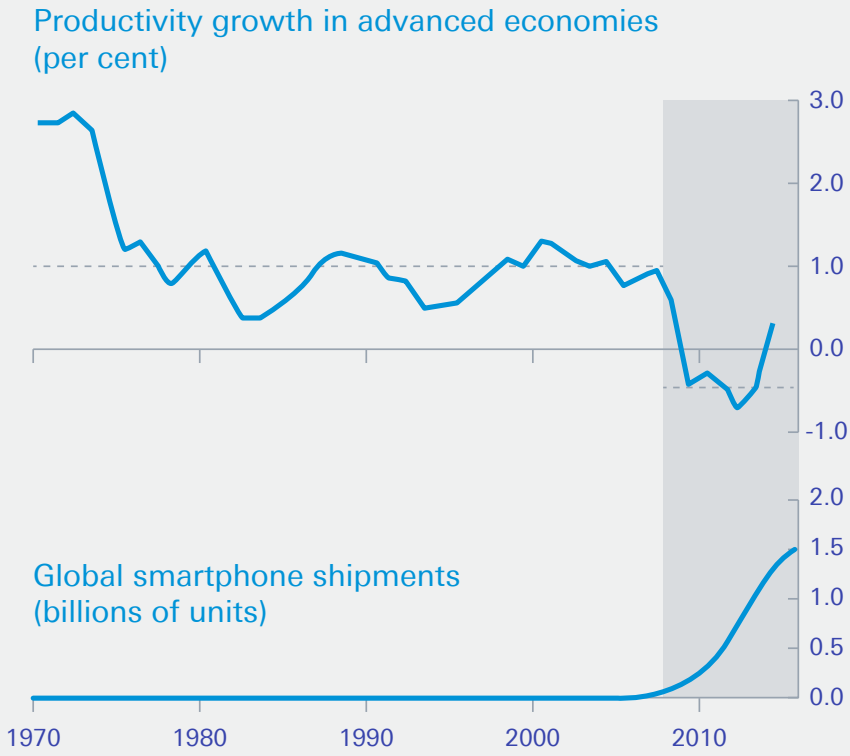
It is hard to say this exceptional financial performance was all down to less email, but it does offer anecdotal support to the abstract notion many workers have felt for some time; that is, technology has reached a point where unlimited information, and the zero cost of communicating it, has made instant communication, such as email, too quick, too easy, and too distracting.

The problem stretches across all levels of an organisation. As Fed chairman, Ben Bernanke was reached at edward.quince@frb.gov, a pseudonym to avoid "extraneous emails." Warren Buffett reportedly shuns email altogether. But email is just one example of how the instantaneous nature of modern communication causes unproductive distraction. The other big one is the smartphone. Various surveys suggest the average user touches their device upwards of 100 times a day. Indeed, people spend one hour each workday on social media, says the US Chamber of Commerce. Meanwhile, a third of millennials spend two hours or more each work day looking at their phones for personal activities according to Udemy's Workplace Distraction Report.

Ultimately, the question revolves around the extent to which the tangible and obvious benefits of instant communication outweigh the frequently-intangible and less obvious costs. Here, an increasing body of evidence suggests the costs are bigger than most people think.

Economists and industry analysts are just beginning to realise the extent of the problem. Researcher Jonathan Spira estimated that $1tn is lost to the US economy each year from too much information and interruption.

The link between the decline in productivity and the increase in extraneous communication is also one that is being increasingly explored. One McKinsey study found that 'interaction workers', such as those in professional jobs that are difficult to automate, spend just over one-quarter of their time reading and answering emails. Of course,



Source: Penn World Tables database, Statista, Bank of England

some of this enhances an employee's productivity but an increasing body of evidence spotlights the negative effects. The correlation on the above chart does not necessarily imply causation, but it certainly raises eyebrows.

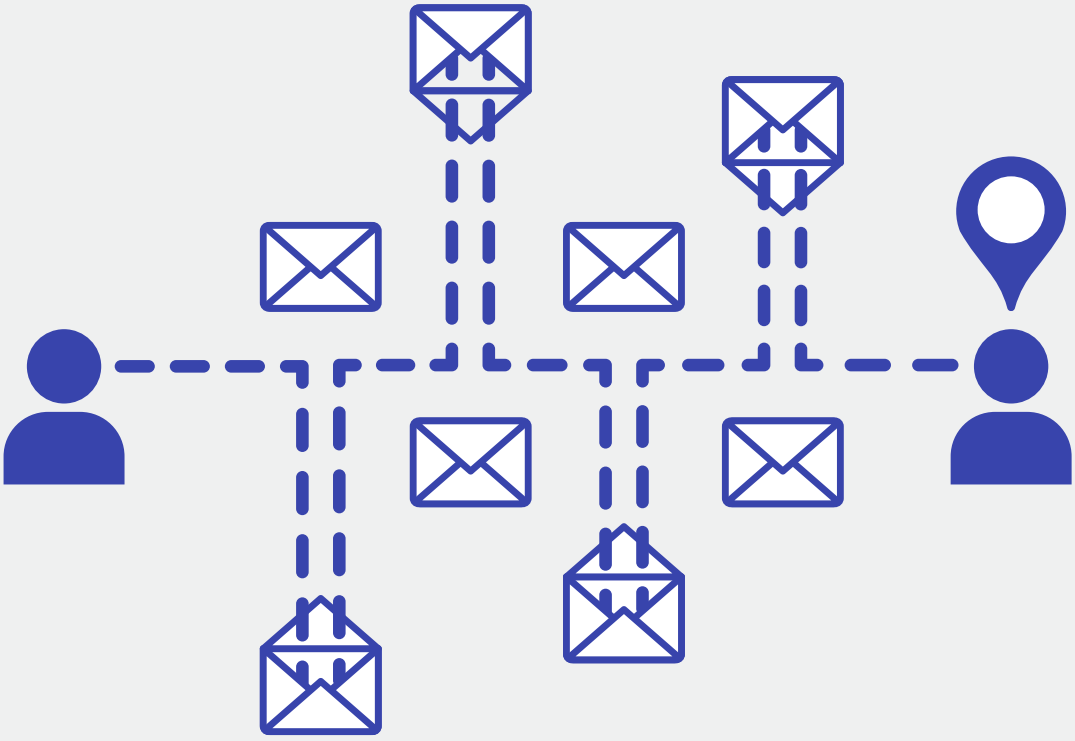
One contributor to any communications-based drop in productivity is the way it forces people to multi-task. One study looked at 'media multitaskers' that is, those who conduct multiple conversations and have numerous tabs open. It found that heavy media multi-taskers perform worse on tests of task-switching ability. This is likely due to their reduced ability to filter out interference from those tasks which are irrelevant. Bear in mind, it can take 25 minutes to recover from a distraction. There is also evidence that being distracted is habit forming. In other words, people who are distracted by external stimuli are more likely to go on and 'self-interrupt'.

The effects of the reduced productivity through distraction have also been illustrated in IQ terms, by the Bank of England. It points out that being distracted by phone calls and emails can reduce a worker's IQ by ten basis points, equivalent to losing a night's sleep. And it is not just equivalent sleep that distracted people lack but also the real thing. Indeed, even adjusting for social demographics, people with higher social media use have significantly greater odds of having a disturbed sleep.

Beyond the economic expense, the cost to mental health of communications distraction is only just beginning to be understood and companies should pay attention. Much stems from social media and the brain's dopamine response, or lack of it, which accompanies the feedback to an individual's postings, often seen purely in quantified terms, such as the number of 'likes'. Indeed, young adults who use at least seven social media platforms have an increased chance of depression and anxiety symptoms. Some studies have connected the use of social media with body image issues and eating disorders. The recent addition of applications in some devices to monitor and limit screen time are, at least in part, a response to this understanding.

Given that smartphones and email are still relatively new, the way people manage communication distraction is in its infancy. Because of that, the corporate response has so far been limited. In 2012, Volkswagen set up its servers so that emails were not sent from half an hour after the end of an employee's shift until half an hour before the beginning of the shift. Rival Daimler set up emails so that they are automatically deleted while an employee is on holiday. Federal legislation has also been enacted although the results are hard to test. In France, the 'right to disconnect' was established in 2016 giving workers the legal right to not answer work emails outside their normal hours. Some boosters argue that this is part of the reason for the high rate of productivity in France and it may be no coincidence that employees who are forced to work in a no-email environment (usually for the purpose of studies) report increased collaboration with colleagues, significantly less stress, and, importantly, feel far more productive.

So will the workers of the future look back on today's workers who currently spend one-quarter of their day on email and wonder if ditching it would mathematically increase productivity by one-third? Indeed, economists will note that US economic output would also be one-third higher today but for the mysterious productivity slowdown that started in 1971 – coincidentally the same year that Ray Tomlinson, the developer of email, hit the very first 'send' button.



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Peak speed and economic growth

It is a sad fact that although the Treaty of Ghent ended the War of 1812, the news took so long to reach the battlefield that, two weeks later, the Battle of New Orleans took place. In this case, the speed of communication, or the lack of it, was the difference between life and death for over 2,000 soldiers. The chance of such a situation being repeated fell to almost zero later in the century as transatlantic cables were laid and communication times fell from weeks to minutes.

Fast forward to today and almost anything can be instantly communicated anywhere in the world. Indeed, the plummet in time taken to send a message has led to enormous economic gains. A 2009 study found that ten more mobile phones per 100 people increases growth by 0.6 per cent points in developed countries, and in developing countries by 0.8 per cent. Other reports suggest a doubling of mobile data use increases growth by half a percentage point while a ten per cent increase in mobile penetration increases total factor productivity in the long run by 4.2 percentage points[1]. The following chart shows the correlation, if not causation, between communication time and economic growth over the last thousand years.

What is intriguing is that if we zoom in on the most recent iteration of communications development, that of the 3G and 4G network roll outs, it coincides with significantly slower economic growth as shown on the following chart. Even if the financial crisis years of 2008 and 2009 are excluded, the last two decades have been below average.

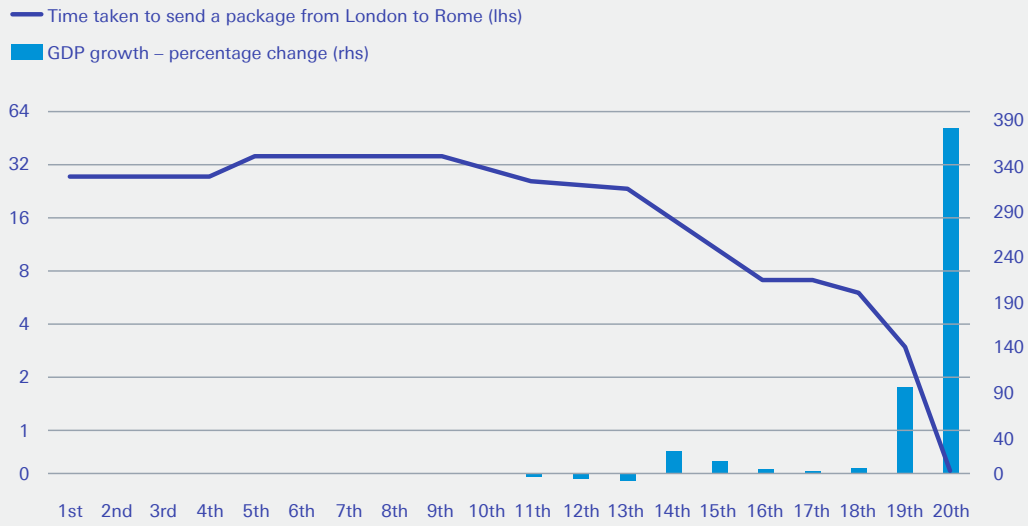
With this in mind, the current roll-out of 5G networks makes for a curious event. After all, throughout history, the idea of improved communications, and the growth that it precipitated, meant increasing the speed at which a message could be sent. But since email became ubiquitous in the 1990s (in developed markets at least) almost anything can be communicated in an instant. That has left some economists wondering where, or even if, incremental economic gains will be produced by more advanced communications technology, or whether existing gains will merely be redistributed. (See our piece, 'How 5G will change your life').

In essence, does peak speed mean the economic benefits of advances in communication technology are over? We do not believe so. It is true that many of the speed-related factors that have historically boosted economic growth do indeed appear to be gone but there are some unusual factors about the current wave of communications technology that allow for economic gains in ways the world has not seen before.

To understand how communications-related economic benefits will be derived, first we must review how communication developments have fuelled economic growth through eliminating inefficiencies and opening new markets. In the past, advances in communication have sometimes been the same thing as advances in transportation but not always. Consider that an ancient smoke signal can very quickly send a message, perhaps the need to prepare for battle, but it cannot convey much more than a predetermined and very simple message. Similarly, the electric telegraph in the 1800s could send a simple message across the Atlantic in minutes but the ten-day ship crossing was still necessary for anything more detailed.

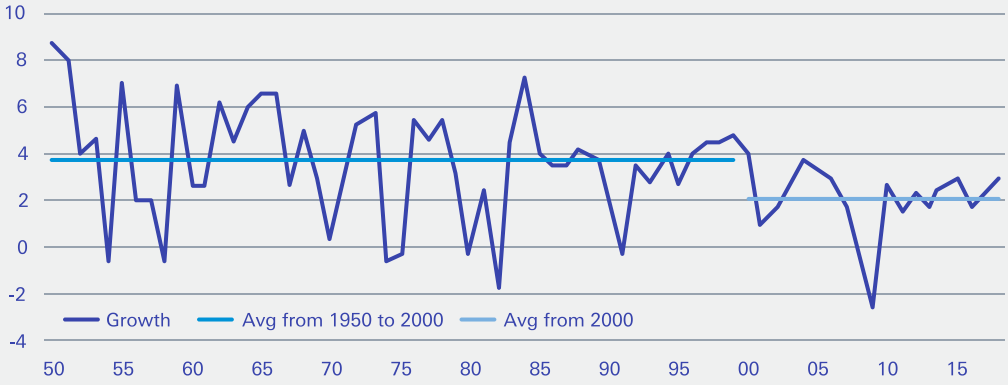
1 http://pubdocs.worldbank.org/en/391452529895999/WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

Time taken to send a package from London to Rome (days in summer) and GDP growth by century during the second millennium



Source: Museum of London, Cordeiro based on DeLong (2000) and Maddison (2007), orbis.stanford.edu, Deutsche Bank

US economic growth – percentage points



Source: Haver Analytics, Deutsche Bank

For that reason, when we discuss communication in this piece, we err towards the ability to send large, complex messages – equivalent to, say, a package of documents. That means that, at times, the development of transportation will directly impact the timing of the communication of such a message.

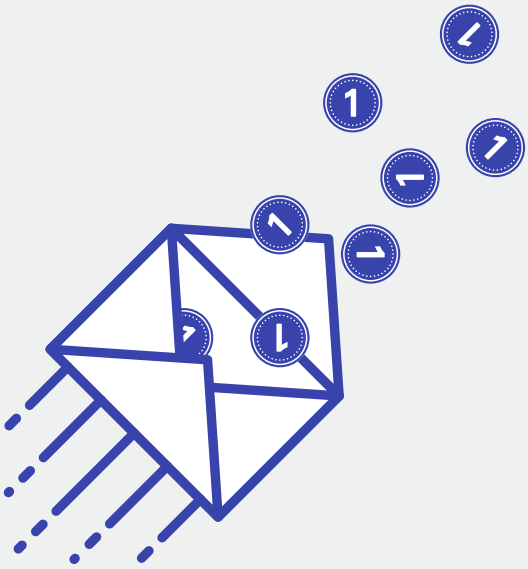
Indeed, transportation has been the limiting factor in communications until very recently. In Egypt, which developed the first postal system in about 2400 BC, and Rome, which built out its road network at scale, the transportation of messengers was critical for understanding the economy in various parts of the empire and thus implementing and collecting taxes.

Following the dark ages and Renaissance, the advances in ship building technology in the 1800s allowed for quicker communication over long distances. It is true that visual beacons, semaphore networks, and the electric telegraph were in use before this time, but it was clipper ships that allowed large packets of information (both written and in people) to be sent at much faster speeds. The quickest ships were given the most profitable contracts and shipped grain, spices, wool, and other commodities, particularly between Europe, South-East Asia, and Australia. Indeed, before Australia was connected with the rest of the world via the telegraph in the 1870s, the *Thermopylae* managed the trip from London to Melbourne in just 61 days, compared with the nine months it took ships to sail the same distance just 50 years earlier. The steam ships that followed boosted these benefits further.

Back on land, the development of commercial steam engines allowed packages to be sent in hours rather than days on horseback. Over that time period, freight rates dropped to just one-tenth of their original price and market access increased. Better transportation also changed the economy. One study found that access to railway stations increased local employment growth, while also changing structural patterns of employment, with a lower share working in agriculture and more in technology-related employment. It also played an important role in the growth of suburban living.

The development of the telephone and then mobile and smart phones produced their own economic gains as discussed earlier. In particular, each additional increase in wireless roll-out has been a step up. One report estimated that a ten per cent substitution from 2G to 3G penetration increased per capita economic growth by 0.15 percentage points.

More broadly, the development of the internet led to a significant boost in economic growth. One study found a ten percentage point increase in fixed broadband penetration increased the growth in gross domestic product by 1.2 percentage points for developed countries and 1.4 percentage points for developing ones[2]. Other studies have backed up this relationship albeit with different growth estimates.



This run through history shows how the increased speed of communications helped fuel economic growth. So it is no wonder that some people look at the slower growth of the last two decades and note that it occurred right at the time that the world reached peak speed in communications.

Of course, many economists have explored the reasons for the slower growth of the 2000s. The explanations include: China's rise, low productivity, the difficulty in recovering from the financial crisis and many others. No explanation, though, is conclusive, which leaves the door open to considering that growth has been lower because the support formerly provided by speedier communications technology is no longer there.

Yet, it does not automatically follow that economies are experiencing a 'communications stagnation' or that they will continue to do so. Indeed, history provides a clue as to how communications can help fuel economic growth in the future through the wider *spread* of communications rather than the mere speed.

One example comes from the Renaissance when the printing press was commercialised in Europe. It is true that a version of the printing press was invented in China just after 1000 AD, however, it is in Europe where the economic effects can be

2 http://pubdocs.worldbank.org/en/391452529895999/WDR16-BP-Exploring-the-Relationship-between-Broadband-and-Economic-Growth-Minges.pdf

more easily analysed. Research shows that cities that adopted the printing press in the 15th century grew 60 per cent faster in the 16th century than the cities that didn't adopt the technology.

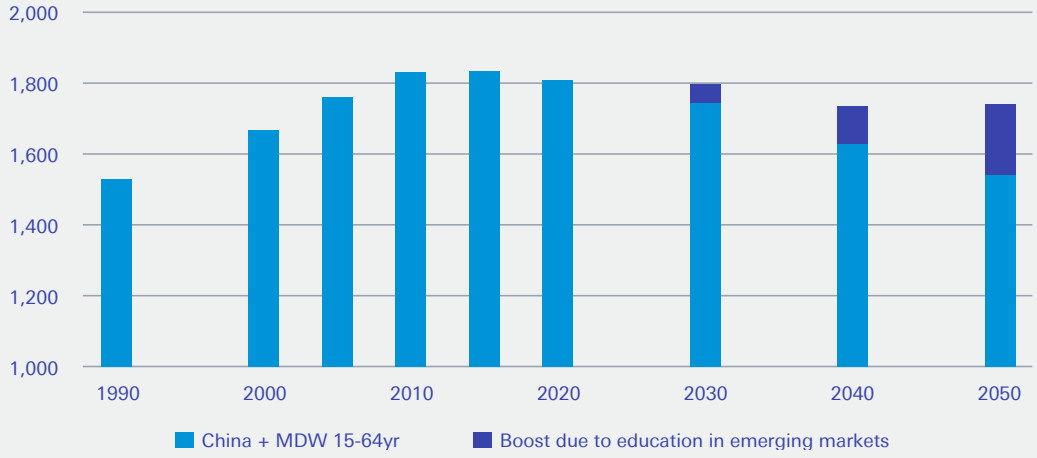
Of course, the spread of any communication technology is hardly a new phenomenon. But there is a key reason why the spread of the current round of communications technology should benefit economies more compared with the spread of other technology in the past. The reason is the 'technology skip' that was not available in the past (see our piece, 'The emerging market technology skip'). This shows how a much higher proportion of people, particularly in developing economies, can now take advantage of freer trade, higher incomes, and the ubiquity of smartphones to 'jump' over the technology stage that requires a more expensive desktop computer and broadband connection. This gives them the opportunity to interact with the global economy in ways that prior communication advances have not. This also aids the convergence between the economic performance of advanced and emerging economies and, importantly, will be of benefit to both.

One of the most important factors that will start in emerging markets and flow to developed markets is education, particularly for girls. Many studies confirm the link between the spread of communications and education. One UN-backed study cited the example of how in Bangladesh, greater availability of the internet has helped promote education in regions where qualified teachers have been scarce. It also points to a UN programme that used computer and mobile-based literacy programmes to reach 10,000 girls and women in Senegal, and 60,000 in Nigeria. The widened access to information ensures "more effective learning and more effective service provision."

When we consider that only a little over 16 per cent of the population in low-income countries use the internet, the potential is clear. Already, a greater spread of communications in the form of the internet is boosting education rates in developing countries and, particularly in those that have experienced a historical gap between education rates for boys and girls. Take, for example, the ten countries in the world where, ten years ago, girls were five percentage points less likely to be in secondary education, based on UN data. Today, that gap has shrunk in nine of those countries and girls comprise an average of 40 per cent of secondary students, up from 35 per cent a decade ago. This has neatly coincided with the increased spread of broadband access in almost each country. Indeed, the proportion of the population with access to the internet in low-income countries is just 20 per cent but the growth rate is exponential.

The benefits to society of closing the gap between the education of boys and girls are tremendous. So too are the economic benefits of increasing the rates of education for all children in countries where it has historically been lacking. Indeed, if we take the number of children under the age of 15 in all the countries that have a literacy rate for children of less than 90 per cent,

Workforce in the more-developed world plus China (m)



Source: Deutsche Bank, UN population division

and assume the current rate of growth in education rates continues (but is limited to 95 per cent) we can expect to see an additional 200m educated workers enter the workforce over the next three decades. That will compensate for most of the expected decline in the workforce in the more-developed world due to demographic problems.

Beyond education, the unprecedented spread of affordable communications is helping increase the consumer surplus, particularly in poor areas of emerging economies. Whereas some consumer goods were previously only available in small package sizes (which are relatively more expensive than larger sizes), now the critical mass of mobile technology in poor areas means markets have emerged that are easier for companies to identify and justify servicing. Other applications, such as job-matching follow from this, not only in emerging markets but also in developed ones, and boosts transparency and competition. We have written in past editions of Konzept (*From concentrate-America's diluted competition, June 2015*) about the long-term decline of competition. A boost from better communications is therefore very welcome.

Despite the astonishing growth of communications over the last two centuries, it is dangerous to assume that development in both the speed and spread of communications will only progress forward. Indeed, there are a number of precedents for modern societies moving away from interconnectedness. These can be grouped into three buckets.

The first reason for a 'communications regression' is a change in politics. Take, for example, the Roman postal service, the *cursus publicus*, which crumbled following the fall of the empire. Communications across Europe stagnated in some areas and ceased almost completely in others. Similarly, the French Revolution initially saw a proliferation of newspapers but as the revolution rolled on, the media became increasingly restricted and censored. This trend continued under Napoleon.

Experience today also echoes the past. Following the Easter bombings in Sri Lanka this year, the government banned social media including Facebook and WhatsApp. In the Arab Spring, perhaps the first revolution where social media played a major role, the Egyptian government blocked Twitter and Facebook as protests took place against President Hosni Mubarak.

Worryingly, Reporters Without Borders noted in its 2019 report that "the number of countries regarded as safe, where journalists can work in complete security, continues to decline, while authoritarian regimes continue to tighten their grip on the media."

The second reason communications can regress is accidental or deliberate sabotage of infrastructure. An example occurred in 2017 when the undersea internet cable that links Southeast Asia with Western Australia was cut three times. Meanwhile, an incident last year, put down to a routing error, led to internet traffic being sent from Europe and North America to Australia being diverted via China over a six-day period.

Of course, times of defined war inevitably lead to a loss of communications infrastructure. The blockades of the American Revolutionary War and Civil War, and infrastructure bombing during the Second World War are just two examples. In this regard, given that modern communications are generally based on cables that cross international jurisdictions or waters, or satellites in space, today's communication infrastructure is arguably more fragile than ever.

The final reason for a communications breakdown lies with unforeseen natural events. These go beyond the hurricanes, floods, and volcanos that have caused localised communication disruption over the last couple decades. Rather, big events can cause widespread chaos. In 1859, a solar storm known as the Carrington Event saw northern lights witnessed in Cuba and led to sparks flying from telegraph equipment. Such an event today would cause a serious loss of communications and economic output. A taster example occurred in 1989 when solar flares halted the Toronto Stock Exchange while a solar storm led to blackouts in Quebec.

No matter which way economists view the past gains from communications, it seems relatively certain that the gains from the next round of new technology, including 5G networks, will be derived in different ways to the past. Given that much of the wealth from the latest round of communications development has accrued to a small number of shareholders, it is reassuring that the 'technology skip' that is enabling an unprecedented spread of connectivity around the world appears set to benefit those in emerging economies that need it the most. And a happy side effect is they may just help balance the labour declines in developed economies as well.

Beyond education, the unprecedented spread of affordable communications is helping increase the consumer surplus, particularly in poor areas of emerging economies.

Satellite vs streaming

Every time Elon Musk launches a new rocket and talks about reducing the cost of placing satellites into orbit, there are some who see it as a sign that traditional satellite television is here to stay with constant cost reductions maintaining the industry. >

But this is not necessarily the case, particularly with the roll-out of 5G networks. This infrastructure appears set to reduce the cost of providing streamed television channels in an 'over the top' environment. It will also increase coverage and accessibility on mobile.

In fact, the 5G roll-out may accelerate current trends. Indeed, the economics of the industry are changing such that even without 5G, there is a risk that a large number of satellite television channels will move online in the short term.

It is true that at present, the use of satellites to deliver television is generally cheaper than streaming for the majority of channels. That is because satellite delivery has a fixed cost irrespective of the number of viewers. As such, there is little risk of any major payTV platform or large distributor moving to an online-only format. It just does not make sense given their large subscriber base.

Consider that a standard definition television stream uses 500 megabytes per hour. If we assume the average user watches three hours each day, that equates to 1,095 hours per year, thus consuming 548 gigabytes of data. Given that it costs a content delivery network €0.004 per gigabyte to transfer the data, it will cost €2.20 per viewer annually. So, for 10,000 viewers the cost is €22,000. When we consider that it costs €250,000 per year to broadcast a standard definition television channel via satellite, we can calculate the breakeven number of viewers at about 125,000.

The results for high-definition channels are a little lower but not too dissimilar. While HD channels use four times the amount of data as a standard definition channel, the cost of broadcasting HD via satellite is only 2.5 times higher than broadcasting SD. That places the breakeven at about 75,000 viewers. In other words, if a channel expects viewership over 75,000, it is better to pay the upfront cost of broadcasting via satellite.

Given the millions of people who watch popular shows such as *Game of Thrones*, it may seem safe to assume the major broadcasters are safe from the transition to online streaming. On top of this, some factors indicate that although streaming costs are falling, the rate of deflation is slowing. In particular, fixed line networks have a habit of becoming clogged with video traffic. In fact, during peak times, Netflix and YouTube alone consume one-third of downstream traffic in Europe.

Yet digging deeper shows that advances in streaming architecture are inevitable and can unexpectedly accelerate. In fact, the cost to transfer data via streaming has almost halved over the last three years and is falling at 15-20 per cent each year. The upshot is that, assuming this rate continues, the threshold for 'over the top' services being cost efficient relative to satellite will double every three to four years.

If we look across regions, we can examine how many channels are likely to see an imminent impact. In the UK, four-fifths of channels have under 125,000 viewers (the breakeven for a standard definition broadcast). That compares with the US where just over one-third of channels fall below this threshold. When we look across each of the world's key continents, two-fifths of channels fall below the 125,000 viewer threshold, leaving them at risk of moving to online-only.

Looking forward, if cost deflation continues at 20 per cent each year, a majority of global channels will be better off going online-only by the end of next year based on the economics. The effect is most acute in Europe where 85 per cent of channels could move to streaming. Elsewhere in the world, a little over half of channels will be more cost effective as streaming channels.

This may seem like the beginning of a rapid descent for satellite television but there are other issues besides cost that are working in the favour of these broadcasters.

The first is access. For a major broadcaster to move to streaming, they have to be very sure that their subscribers have a suitable broadband connection. This is not always the case in non-urban regions even in developed countries.

The second reason is quality. An increasing part of the business model of many large broadcasters is to upgrade customers from standard definition to high definition. For that, a reliable broadband connection is not enough; a fast one is necessary to eliminate the buffering and bandwidth problems that will frustrate customers.

Next, issues of piracy and security persist despite advances in anti-copy technology. It simply remains that transferring a digitised version of, say, a film provides a more convenient target for those who wish to pirate and redistribute the content, compared with satellite.

So while satellites may become less influential for broadcasting in the near future, they are unlikely to be completely cast aside. Their cost continues to fall. Aside from the reusable rockets that hit the headlines, a better understanding of how to place satellites in low-earth orbit is reducing the expense of broadcasting via this method. In any case, the average lifespan on a satellite is about 15 years, so for those that have been launched recently, much of their cost is sunk. Broadcasters, then, should look forward to a future where streaming is the norm. But they should be reassured that although it seems inevitable that satellites will eventually become a niche broadcast technology to remote areas, the shift may be more gradual than many think.

The emerging market ‘technology skip’

Makkhan Singh (aka Mac) was the intrepid, 20-year old guide on my recent trek to Har Ki Dun in the Himalayas of northern India. He stays in Sankri, a town where the nearest functioning mobile network is 30 kilometres away. And yet the first question Mac asked me when I took a photo was, “Sir, will you post this to your Instagram account?” Mac is far more tech-savvy than I. He has set up a website and uses WhatsApp to conduct his business which successfully competes with a more established adventure travel company based out of Bangalore.

The only reason Makkhan can do this is due to the rapid growth of affordable 4G networks in emerging markets over the past two to three years that has led to an explosion of mobile data consumption. While 5G may have a significant impact in developed countries, it is the more recently-rolled out 4G in emerging markets that has really been world changing. In India itself, the average 4G subscriber uses ten gigabytes of data each month, a ten-fold increase on the amount used just over two years ago. A similar picture can be seen elsewhere in Asia. Malays use 11 gigabytes per month, a five-fold increase, Indonesians use 4.5 gigabytes and Thais uses 11.5 gigabytes, both four times higher over the same period.

This rapid increase in mobile data usage is going hand-in-hand with the idea of personalised screens. Indeed, the overwhelming majority of homes in India that have a television have just one television. As a result, content consumption has always been a shared experience and a ‘battle for the remote’ is common each evening. But with smartphone subscriptions approaching 400m and generous data bundles available, almost half a billion people now have their own screen to explore and satiate their content cravings. Indeed, in India and other Asian nations, the smartphone has become the ‘first screen’ as viewership shifts away from the television. Content has gone from being a tool to drive data consumption to a critical pillar for subscriber retention. Facebook, WhatsApp, Line, and YouTube are the stepping stones as these subscribers build their connections. With 4G, video is the ‘killer application’ and accounts for four-fifths of data consumption.

Taken together, the data explosion combined with individual screens are enabling a ‘technology skip’ that is helping people like Makkan in

emerging markets to interact with the global economy in ways that were previously impractical or unaffordable. He has been able to immediately piggy-back on the advancements in the software, business, and economic infrastructure that took developed countries ten years to develop as they moved from 3G to 4G. Indeed, some emerging markets are showing signs of leapfrogging developed markets in terms of the advancement in their content consumption, and use of e-commerce and social media.

The rapid rise of mobile usage and 4G networks is changing content consumption as well as content creation. Take, for example, the most downloaded app in India – Tik Tok. This app makes it easy to create short-form video with real-time rendering of effects and filters – essentially Snapchat on steroids. Crucially, this app is ‘mobile-first’ and ‘mobile-only’.

While it is good news that millions of otherwise poor Indians can now interact with the local and global economy via their phone, it is also good news for the network and content providers, if they adapt themselves to their customers’ needs. Among these is the desire to pick and choose content. Consequently, the number of ‘over the top’ applications have mushroomed with content owners, broadcasters, telecom companies, and aggregators all battling for eyeballs. Content owners and broadcasters are seeking strategic partnerships with telecom companies as they ‘follow’ their viewers to their mobile screens. In both developed and developing markets, consumers are witnessing similar strategies from telecommunications companies as they transform their apps from the basic functionality of prepaid recharges to walled gardens with live television, streaming music, and high-value video content such as Netflix and Amazon Prime. Just a few examples are Singtel’s Cast and Starhub’s Go in Singapore, and Airtel TV and Jio TV in India. The key goal is to induce habit-forming behaviour for their apps, maximise time spent, and monetise the viewership.

Despite there being a billion eyeballs now watching screens in India, the path towards monetising that viewership is diverging from that in developed markets. In developed markets, meanwhile, the subscription-driven model of paid-for television is likely to slither to

mobile screens with consumers having the ability to pay for content. As a result, 'subscription video on demand' will likely become the dominant monetisation model. In contrast, consumers in emerging markets have lower levels of affordability and thus content will need to remain free or low-cost. Consequently, PayTV will likely remain significantly funded by advertising – just one example is YouTube. As such, the shift to mobile presents content owners and broadcasters with a huge challenge. In India at present, most 'over the top' apps are subscription-based. Just a few examples are Amazon Prime Video, Netflix, HotStar, Iflix, and HooQ. The direct-to-consumer operated by these platforms is a challenge given the low base of high-value customers.

Some alternatives are emerging with a business-to-business-to-consumer model. Telecommunication companies are the preferred partners due to their close billing relationship with their subscribers. In this way, as 'over the top' apps wean away viewership from television, they will reach a tipping point where an advertising-supported model will become more valuable than the subscription-only model which is currently prevalent. This shift of advertising from television to mobile phone in emerging markets is a difficult one for providers to make given the change involved, however, it is certainly the largest strategic opportunity available in the coming years.

Ultimately, the 'technology skip' that current technology is enabling will go a long way to bridging the gap between aspiration and achievement – beyond the glitzy metropolitan cities and into the deeper corners of India. Semi-urban and rural India will neither remain anonymous nor distant. The new smartphone users are simultaneously consuming and creating content. They are shopping and building businesses. The Chinese example is encouraging. Manufacturing has helped to lift 400m people out of poverty and has created a middle class with the collective consumption power to rival many developed countries. India, on the other hand, is a services-led economy in which 4G connectivity has become akin to electricity. This makes it a force multiplier which is unleashing micro-entrepreneurship. As a result, it seems likely that this 'technology skip' will flatten the historical advantage enjoyed by those in urban India and allow aspiration to compete with privilege.

PS. Makkhan Singh is now thinking of starting a trek-equipment shop on Amazon or Flipkart.

India is a services-led economy in which 4G connectivity has become akin to electricity. This makes it a force multiplier which is unleashing micro-entrepreneurship.

The ‘golden age’ of television and its uncertain future

Our present day has been described as the ‘golden age’ of television. For the consumer, the choices seem endless. For actors, directors, and writers, the huge amount of money being invested in original content has shaken up the industry. Many people regard modern television series to be the ‘novels of today’. >

But just as the golden age of rail led to a huge but unprofitable supply of track, some worry that the golden age of television is luring too many competitors, which will inevitably drive financial returns lower, and even push some players out of the business. Aside from industry behemoths Netflix and Amazon Prime, Disney is starting its own service this year, as are Apple and AT&T's Warner Media, while Facebook has dipped its toe into European football. They are all looking to compete with the many other over-the-top and traditional networks in each respective country. And that is before considering that 5G networks will greatly increase network capacity, aiding the shift to streaming.

Yet, while it is true that many new entrants are spending a lot of money on their television aspirations, it is too simplistic to view the market as one finite pie being fought over by many competitors.

To understand how the industry is changing and can accommodate at least most of the current players, first consider the traditional television business model. In the past, households had one or perhaps two televisions in Europe and three in the US. There were a finite number of channels and everyone watched programmes at their scheduled timeslot. Ratings grew in a predictable manner as did advertising and subscriptions. Simple.

Today, subscription streaming services, over-the-top platforms, and advertising-supported video on demand all compete with traditional free-to-air television networks and pay TV distribution companies. As a result, consumers have, for several years now, begun 'cord cutting' and merely subscribing to the specific services they desire. While cord-cutting has contributed to the drop in television viewing, the larger driver has simply been a shift in consumption, even among pay TV customers, toward streaming platforms and services. In the UK, viewers now watch just under three and a half hours of television each day, down over half an hour since 2012. Millennials have been a big part of this shift. Meanwhile, television penetration has also fallen from a peak of 85 per cent, to 80 per cent today.

While the trend of customisation has certainly established itself this decade, what has been less well predicted is how television business models would either adapt or fragment. So far, it appears that the latter is occurring. It should continue to do so and we can forecast the implications for each of the models in the medium term.

First, consider that many of the firms entering the market, such as Apple, Amazon and Facebook, are among the world's largest companies and carry sizable balance sheets. For them, television can be a loss leader for their other products, and their cash flow can easily subsidise the creation of original content. Alternatively, it can help diversify their income streams by adding subscription revenue.

That is not to say that companies without a large balance sheet cannot compete. Netflix, for example, is cash flow negative due to heavy investment in original content. Yet it has built a strong subscriber base and has proven it can raise prices and still retain customers, the numbers of which have doubled over the last four years and tripled in the last six. Indeed, Netflix expects its revenue per user to grow in the mid-single digits per annum in the future. Its content has also been very successful, with nominations and awards for various films: the 2018 film *Roma* won three Oscars, while *The Crown* won the Golden Globe for the best dramatic television series in 2017.

In contrast with the large spending on original content of some streaming services, there is no growth (in aggregate) in this for traditional television networks, and the return on investment on original content is generally lower than it has been historically. Instead, they are invested in non-scripted programmes such as sport and news. Indeed, over the last two decades, sports have experienced the most resilient ratings (particularly

compared with scripted content) and even if there has been a lull in some categories over the past two years, this appears to be a short-term blip. Encouragingly, NFL viewership grew in the US over the past year.

Yet even here, models are changing. This coming Premier League season in the UK, Amazon has the right to broadcast 20 matches, which will be free for Amazon Prime members. Facebook also has the rights to broadcast La Liga games to the Indian subcontinent.

The infringement of streaming services into the domain of sports also impacts how network owners will operate in the medium term. Sports are the number one reason why people pay for television and sports can provide the backbone that supports other cable networks. Beyond this, network owners are investing in unscripted content, with Discovery’s $15bn purchase of Scripps Networks making it the global leader in this category.

Both cable networks and free-to-air networks are also investing heavily into data and analytics in an effort to evolve their advertising models. They are using information gleaned from a host of data providers beyond the viewing data they’ve historically obtained through Neilsen, to produce insights that can be used for more targeted advertising. However, the TV advertising ecosystem is complex, with legacy infrastructure and industry organisation that makes it difficult to pursue coordinated efforts toward a more effective advertising model. Targeted advertising through these channels is only in its infancy and will undoubtedly form a key part of future business models for industry incumbents.

Going forward, the next iteration of over-the-top services is ‘advertising-supported video on demand’. Already some established players are here, including some traditional channels. Taking this one step further, YouTube Premium allows customers to pay to remove advertisements.

These various business models being adopted and adapted prove that technological change that leads to fragmentation is not to be feared but accepted as an opportunity. And as there is no question that the future of television will revolve around customisability, having so many players in the market does not necessarily mean there is too much competition. Rather, it is recognition that there is not just one market for television anymore but several that can support many providers. The key thing for television executives is to accept this fact and decide exactly which new market they wish to target.

Who wants to live in a Smart City?

The antennae and boxes, about the size of a handbag, have become more visible in New York over the last few years. They sit atop street lights, buildings, and other convenient locations. They are part of the ShotSpotter system and they listen for gunshots. When a shot is fired, the sensors can triangulate its location to within 25 metres. It then immediately sends an audio file to a support team. A review takes place using both machine learning and human input to determine if the sound was a real gunshot or something else that sounds similar, such as a firework. If determined to be real, the police are notified. They can then arrive at the location already knowing how many shots were fired and whether the shooter is moving.

The system operates in many cities through the US and it appears to be achieving its aim. The company quotes the mayor of Miami as claiming that since the programme was introduced in 2014 there has been a one-third reduction in the homicide rate.

This is the type of technology that advocates of smart cities love – sensors delivering data to improve living standards. They argue that 5G technology will only turbo-charge smart city applications. The very-low latency of 5G, combined with its ability to simultaneously transfer very large amounts of data between many devices means some technologies are now possible. One of the most visible is autonomous cars. To fulfil the promise of super-safe transport, cars should ideally be connected to each other and able to communicate in a split second.

Yet in real life, plans to imagine cities "from the internet up" are stalling. There are several examples. Just one is Toronto's Quayside precinct, which was hoped to be built by Sidewalk Labs, an Alphabet subsidiary. The project has become mired in controversy as activists and many politicians have voiced their concerns about data collection and privacy. A vote to give it the green light has been delayed. Another example is the old Mexican town of Santa Maria Tonantzintla, where residents have fought against their home becoming a smart city, or *Barrio Smart*, experiment on cultural grounds.

Despite the protest on the ground it would be hard to find anyone who does not agree that there are smarter ways to use data to improve cities. The question is whether societies need to find ways to retrofit existing cities with smart infrastructure that residents are happy with, or whether completely new cities will need to be built.

On balance, it seems that a truly smart city will have to be built from scratch, in the absence of some, as yet, uninvented technology. It is interesting to note that, through history, humans have gone through waves and troughs of being city builders. Following the town and city development in the US, Africa, and Australia in the 1800s, the last century of so has been a trough.

Some will argue, then, that city building is a thing of the past. After all, the 1800s was a time of development of regions where Europeans had not been. Today, there are no 'undiscovered' or 'unpenetrated' land masses. In addition, the mechanisation of agriculture has driven people to the cities which now have a critical mass that makes their allure very hard to replicate.

Yet new technology has usurped many businesses from seemingly invincible positions. Indeed, every one of the original 12 stocks in the Dow Jones Industrial Average have fallen out of the blue-chip stock index.

The new 5G networks could be the technology that shakes up the 'market' for cities and provides the incentive to build new purpose-built metropolises. The first reason is that it is very difficult to retrofit an existing city to become truly smart. For starters, there are not enough batteries (at least with current technology) to power the, perhaps, one trillion sensors that are predicted to be needed in smart cities over the coming years. These sensors will need wireless power. Of course, this technology is in progress and has already been deployed in mobile phones and some other applications. However, deploying wireless power over long distances for smart city applications seems a long way off.

Following on from this, the power systems for smart city applications will have to be much more reliable than the power supplies in current cities, particularly if lives are at stake, as they are with

autonomous cars. They will also have to be far more tamper proof than existing services.

Second, consider how difficult it is to upgrade the existing infrastructure in cities. London struggles to simply maintain leaky pipes from the Victorian era. Most other large, old cities struggle with similar issues. It seems wishful, then, to expect cities to efficiently deploy a sprawling network of connected sensors in a fully-infrastructured smart city.

Third, smart cities have very different physical needs from existing cities; needs that most cities will find all but impossible to fulfil. Take, for example, autonomous cars. The technology to operate them is advanced enough that they could easily operate in a specifically-designed city with specifically-designed roads and building spacings. But the technology is a very long way away from being able to operate in complicated, ancient cities such as London or Rome. Safety in these cities is not necessarily the issue. Rather, it is efficiency. For example, it is physically impossible to drive through some small, windy London streets without doing things that are technically illegal or break guidelines (such as crossing a centre line). Those who create the algorithms that control autonomous cars will be loath to open themselves to the consequences of programming a car that can do anything that is not strictly and technically correct.

As an increasing number of smart city applications are developed, they will undoubtedly be more sophisticated and thus even more difficult to retrofit into our existing cities.

Building new cities solves many of the problems with retrofitting existing cities for smart technology. Power systems can be integrated into infrastructure which, itself, can be pre-planned. Roads and buildings can be planned to allow for autonomous cars to operate under ideal conditions.

New smart cities could also help solve other problems. The first is house prices. In some of the western world's biggest cities, the average house price is six times household income. This is almost double the price of four decades ago. One contributor is the move to urbanisation. Smart cities will help in two ways. First, they will boost the supply of housing. Second, they will allow for much more efficient public transport that allows people to live further out of the city centre without compromising on commuting time as much as they do in existing cities.

Many will argue that a pre-planned smart city cannot be funded, particularly by budget-conscious western governments. Perhaps the proof-of-concept funding does not need to come from government but instead from wealthy individuals. Consider the billions of dollars being ploughed into personal space programmes. What if a smart city became the new trophy asset for the uber-wealthy? Given that so much of the world's wealth has generated by technology entrepreneurs, investing private money into the creation of a smart city could make business sense as well as being a social contribution.

But will smart cities indeed make a social contribution? On the one hand, there is an increasing number of ideas about how data can be used to fight inequality in cities based on social demographics. Yet, there are some reasons to suggest that smart cities may, in fact, make inequality worse.

A widening of inequality could be driven by the same phenomenon that has driven the increase in wealth for educated people over the last four decades – the period of the third industrial revolution, that of the computer age. The US National Bureau of Economic Research points out that between 1979 and 1995, workers in the top income decile saw their income grow from being 266 per cent higher than that of workers in the bottom decile to being 366 per cent more.

It is interesting that skilled workers have been earning so much more given the large increase in the supply of skilled labour that has hit the job market. The reason is that the technology-skill complementarity of the computer age has meant that improvements in technology have favoured those workers with skills. In contrast, that technology has replaced the tasks previously

performed by unskilled labour. Because digital technology has complemented people with skills, the large increase in educated workers over the last few decades has reinforced the profit motive behind the development of these tools.

Given the trend of the last four decades, it is easy to argue that smart cities may only widen inequality. Assuming that budding smart cities are first populated by those with skills (most likely those in the technology industry) the technology-skill complementarity could easily be amplified, making smart cities an even more extreme version of the most exclusive suburbs in major cities. It is hardly a stretch to see increasingly-powerful smart cities growing to have a disproportionate say in economics and politics. Those with dystopic tendencies will fear the re-emergence of city-states and a future as seen in *Mortal Engines* or *Elysium*. Of course, city-states are not new. Even in a Westphalian world, many cities have significant control over their affairs, including education, welfare, and taxation. So it is not hard to see smart cities merely extending this advantage.

Despite the concerns that smart cities may lead to widening inequality, one factor may override the advantage of skilled workers and narrow the gap between rich and poor. It relates to the type of industrial revolution into which the world already has one foot.

Consider the industrial revolution of the 19th century. This was a time when technology created machines that were designed to *replace* skilled workers, not complement them. The profit motive worked such that the abundance of unskilled labour could be used to operate the machines that replaced the relatively small number of skilled, expensive artisans. That contrasts with the computer age where technology replaced many mundane, unskilled tasks.

The fourth industrial revolution that has just begun is one of artificial intelligence that powers smart city developments all supported by 5G networks. Given that these robots are beginning to automate cognitive tasks rather than physical ones, at least some skilled labour is destined to be eliminated. The problems for skilled labour could be exacerbated by the significant increase in the supply of educated workers over the last four decades.

We have argued in the past that automation and artificial intelligence will not destroy people's jobs (*Tomorrow's robots and economic history – Not a job killer: Konzept June 2018*) but history shows it can certainly reorganise the structure of the labour market. Already, developed economies are seeing a hollowing out of middle-skill jobs – those that are easy to automate, while low skill (and high-skill) jobs have both seen wage increases. The risk is that as artificial intelligence becomes more advanced, an increasing proportion of high-skilled workers will be automated out of their existing job and into a lower-skilled job operating the machines – akin to the 19th century artisans.

While some at the top-end of town may see their wages fall, those at the bottom end are about to experience some positive news. That is because three extraordinary one-off (non-technological) factors that have supressed wage growth, particularly for low-income earners, are dissipating. Specifically, between 1980 and 2015, China re-emerged into the global economy, the Soviet Union collapsed, and India liberalised its economy. The combination of these three things integrated over a billion cheap workers into the global economy, increased labour competition and, on balance, pushed wages lower.

Perhaps the most discussed on these three factors is the size of the Chinese workforce that was unleashed onto the world economy. The impact of this in suppressing wage growth in developed markets is now largely complete. In fact, over the coming decades, China's demographic overhang means its workforce will shrink by 250m. The result is that lower paid workers in developed countries will begin to regain their bargaining power. The current automation revolution may only benefit their position relative to the current crop of higher earners. The end result is not a complete proletarianisation of the workforce, but a narrowing of the gap that has been worsened by a conflux of one-off factors.

That brings us, finally, to the ultimate question: Who wants to live in a smart city? Assuming the privacy and data collection issues that have plagued Toronto's Quayside project can be worked out, the answer is that smart city builders are incentivised to attract a proportional mix. In an era when wages for the low-skilled are rising relative to the high-skilled, that will ensure the necessary supply of workers for various jobs.

Perhaps, though, the factor that will ultimately determine who decides to live in a smart city may be how people derive, or change, their own sense of self. Since the weakening of the class system, nationality has been perhaps the primary driver of people's identity and attempts to dilute that through increased connectedness have been met with resistance. Beyond Brexit, Catalonia, Scotland, Western Sahara, and others all have independence movements. The rise of the smart city, then, may end up being less about technology and inequality, and more about how it forces people to question just how connected they wish to be. Just perhaps, what national identity was to the 20th century, connectedness may be to the 21st.

The rise of the smart city, then, may end up being less about technology and inequality, and more about how it forces people to question just how connected they wish to be.

The future of news

We discuss five ways that we think communications technology will change news media. >

The day after Donald Trump was elected president, a group of journalists at the New York Times sat around a table and tried to work out why they didn't see it coming. Their conclusion, that they hadn't paid enough attention to non-metropolitan areas in the US, was a startling mea culpa. Such a failing was not limited to the New York Times. London-based newspapers did the same soul searching after they predicted a 'remain' vote in the 2016 Brexit referendum. This deprioritisation of regional news plays out in the statistics. Since 2005, some 245 local news titles have closed in Britain. The cause, of course, is the plummet in advertising revenue. Indeed, the Pew Research Center estimates that this revenue in US print newspapers was just $18bn in 2016, down nearly two-thirds over the prior decade.

This is the background behind our first prediction for how news will change – that is, the return of regional reporting. The catalyst will be three changes to the funding structure. First, wealthy individuals will allocate some of their philanthropic giving to revive and support regional newspapers. The most well known example is Jeff Bezos, although the Washington Post is not a regional title. A small Facebook trial to fund regional reporting may also lead to bigger things. These will be seen as just the beginning of the trend towards the wealthy owning or supporting the press, particularly in regional areas.

The second and third methods of funding are based on the maxim that if news is a public good then it must receive public funding. First, governments will allow regional newspapers to be tax-deductible charities. Exploring journalism-as-a-charity has often been talked about but little material progress has been made although some small steps have been taken. Earlier this year, the BBC proposed a charitable structure called the Local Democracy Foundation to fund reporting on local council meetings and other regional activities. In addition to providing tax incentives, western governments will allocate more direct funding for regional media themselves. This will be driven by a desire to counter the influence of Russia, China, and the Middle East which have boosted funding to their own media organisations and begun to have influence abroad. Finally, a license fee system will be implemented. This will raise a levy from the public that bypasses government influence with the amount payable based on usage proxies, such as data consumption.

The second way the press will change is illustrated neatly in the tag line of a new publication called *Delayed Gratification*, which proudly claims to be the world's first 'Slow Journalism' magazine. Its *raison d'êtr*e is to review news stories several months after they occur to present those stories with the type of cool head that only a retrospective outlook can provide. Of course, the speed of delivery of news will always have its place. However, the premium that has traditionally been ascribed to timeliness will shrink given that smartphones and Twitter have made it possible to deliver news instantly to almost anywhere in the world. With this in mind, the gap between mere factual reporting and analysis will widen and, for the latter, readers will prioritise quality over speed.

An acceptance of a slower speed of some news dovetails neatly with our third prediction – that people will reduce the number of news sources they read and, importantly, will be willing to pay for them. This prediction can be seen in stark contrast to the prevailing thought in the early 2000s when online news services really began to gain traction. At that time, futurists told editors that the new business model was to give away content for free on the web and support it with online advertisements. The theory went that in the age of unlimited information, no one would pay for news when they could find it somewhere else on the web for free.

It has not turned out this way. Unlimited information has turned into unreliable or untrusted information. As a result, more people are subscribing to news services they trust. Indeed, in the final quarter of last year, The New York Times added 265,000 subscribers, the largest increase since President Trump was elected. Similarly, The Financial Times recently welcomed its record one millionth paying subscriber. As foreign powers, domestic lobby groups, pranksters, and hackers become more sophisticated at using 'news' on the web for nefarious purposes, people's willingness to pay for news will only increase.

The fourth way news will change relates to what is reported and how it is done. Already automation is taking over some aspects of journalism. The Associated Press has for several years used intelligent software to write the news stories for standard company earnings reports. AP can churn out over 4,000 of these reports each quarter, more than ten times what it could manage when human reporters did the job.

Some of the journalists who used to crank out corporate earnings stories have now left the profession. The best have adapted. And they will adapt further as machine learning and artificial intelligence become more widely used by media outlets. Journalists will engage in higher-value work, changing media outlets into something more resembling research houses. In part, this will be driven by the decreasing cost of sensors and the 5G networks that allow for their increased connectivity.

Finally, the future of news will see the return of the news bulletin. It seems incongruous that young people watch almost two hours of online video each day, and seek the overwhelming majority of their news online, and yet 90 per cent do not watch a television news bulletin. Instead, the over-65 age group is the main demographic still in the habit of sitting down for a half-hour broadcast. This will change. Media outlets will become more sophisticated at learning what news topics interest individual consumers and tailor news bulletins to those interests. There are signs this is beginning to happen. Reuters is looking to launch a video news service curated by an algorithm. As media organisations implement more technology of this ilk, the once all-powerful news broadcast will re-emerge.

These five recommendations are staunchly positive about the future of news, a stark contrast to the predictions of many, and indeed, much of the evidence on the ground. Yet, it is important to note that there is no shortage of demand for news. The internet has not done away with it. Rather, it has been ruthlessly informative. It has told editors that their traditional content and delivery are not what people want. Slowly, editors are learning and as the current crop of journalism graduates are a firmly-entrenched as digital natives, this will only add the digital heft to news organisations. So when media historians look back on the two decades to 2020, they may see them as the period that shook up the industry for the better rather than signalling its decline.

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Konzept discusses the thematic issues that affect the world from a financial, social, and environmental point of view. In this edition, we examine how 5G networks will impact the world. Particularly, we look at how the increased spread of communications is enabling the education of girls in developing countries and why this is not just a social benefit but an economic one too. In addition, we examine how faster communications in emerging markets are enabling those in rural areas to engage with the global economy. Furthermore, we discuss the issues around inequality that are driving the debate over Smart Cities. Together with our other articles, we hope this issue of Konzept will contribute to the conversation as 5G networks are rolled out across the world.