# Digital Technologies and the Global Economy's Productivity Imperative (*)

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***Abstract:*** Global GDP growth has been propelled by two key factors over the past 50 years: growth of the size of the overall labor force, which doubled in the G20 countries as a result of brisk population growth, and rising productivity. Over the next half century, from 2014-2064, as a result of declining fertility rates, the working-age population is expected to fall in all G20 countries, and is already doing so in Germany, Italy, Japan and Russia. Given this demographic trend, the onus for future growth will be on productivity, whose growth in developed economies has been declining over the past decade. For the world to maintain the same GDP growth trajectory over the next half century, productivity would need to grow 80% faster than the already high rate of the past 50 years. This paper examines the extent to which digital technologies could help respond to this productivity imperative. In contrast to some observers, we do not expect a drying up of technological or business innovations to constrain growth; we also believe that technology-driven productivity is compatible with rising employment. Drawing on research by the McKinsey Global Institute (MGI) and McKinsey & Co.'s Operations and Hi Tech Practices, we outline the potential for digital technologies and business innovation to raise productivity and increase employment. We conclude with a discussion of the priorities for governments and policy makers as they seek to make use of the opportunities technology is creating.

***Key words:*** productivity, technology, employment, labor force, Cloud, Big Data, internet of things, business innovation, ageing, fertility rate, G20.

(*) Except where otherwise stated, the data in this paper are drawn from three recent MGI reports, "Global Growth: can productivity save the day in an aging world?" (January 2015); "The Internet of Things: mapping the value beyond the hype" (June 2015) and "Disruptive technologies: advances that will transform life, business and the global economy" (May 2013), as well as from the September 2014 study by McKinsey France, "Accélérer la mutation numérique des entreprises : un gisement de croissance et de compétitivité pour la France" ("Accelerating the digital transformation of companies: a source of growth and competitiveness for France").

## ■ Demographic trends and the productivity imperative

Over the past 50 years, the global economy expanded six-fold as the world's population and per capita income each grew at unprecedented speed. The global population more than doubled while average per capita income almost tripled to about $13,000 at 2012 purchasing power parity. Two factors powered this exceptionally fast GDP growth: a rapidly expanding labor force and rising average productivity.

Labor force growth accounted for 48% of the GDP growth in this period in the 20 countries we studied, the G19 countries and Nigeria. It was propelled by the brisk population growth – a reflection of high fertility rates, declining infant mortality and longer life expectancy – and by a rising share of those of working age in the population. The proportion of people between 15 and 64 years climbed from 58% in 1964 to 68% in 2014. Employment grew at an annual rate of 1.7% in this period, doubling the total labor force.

The other 52% of GDP growth was generated by rising productivity, which grew at an average annual rate of 1.8% between 1964 and 2014. A number of factors propelled this productivity growth. They include a shift from agriculture to more productive manufacturing and service-sector jobs in cities; the growing use of automation and more efficient operational practices in companies, and the increasing integration of the world economy, which led to more productive modern businesses gaining share from less productive ones. Today, the average employee generates 2.4 times as much output as he or she did a half-century ago. Over the past decade the global productivity growth rate has been driven by emerging economies; in developed economies, the annual rate slowed from 1.8% in the 1974-2004 period to 0.8% between 2004 and 2014.

While the average pace of productivity growth was brisk, there were significant differences in the rate of that growth among economies. In developed economies including the United States and Western Europe, labor productivity grew by between 1.5% and 1.9% a year from 1964 to 2014; the growth was above average in those countries which experienced important levels of immigration, including the US, Canada and Australia. The strongest productivity growth during this period was in South Korea and Japan, rising 4.6% and 2.8% per annum respectively and allowing these economies to narrow their aggregate productivity gaps with Western Europe and the United States. Among developing economies, the variance in productivity performance has been much wider. There is no typical rate of productivity growth in these economies. China's productivity grew at an

annual pace of 5.7% between 1964 and 2014, although that average masked a very sharp acceleration in the past 20 years; while productivity grew at a 3.9% annual rate between 1964 and 1994, the pace rose to 7.4% annually from 1994 to 2004 and to 9.3% between 2004 and 2014. In contrast, Mexico and Saudi Arabia clocked less than 1% annual productivity growth over the half-century. Overall, it is striking that the absolute gap between productivity in emerging and developed economies as measured in US dollars per worker has not narrowed. Productivity in developed economies today remains almost five times that of emerging economies.

The next 50 years look very different. The "demographic dividend" that helped to fuel global growth in the past half century has come to an end, and in some countries it has reversed course. Fertility rates have declined, and in many countries they have fallen below the replacement threshold needed to keep the population steady. Over the next half century, the working-age population is expected to fall in all G20 countries, and is already doing so in Germany, Italy, Japan and Russia. By 2024, it will also start to decline in China and South Korea. Of the 20 countries we studied, only Nigeria bucks this trend. Taking all the factors into account, we calculate that average employment growth will decline to 0.3% per year over the next 50 years, less than one-fifth of the 1.7% growth that we saw between 1964 and 2014.

Higher labor participation rates could help to compensate for a part of this shortfall, especially if more women and elderly people over the age of 65 join the labor force. But in the face of the demographic trends, the onus for continued global growth will fall far more heavily on productivity. If global productivity growth continued to rise over the next 50 years at its average rate between 1964 and 2014, the rate of global GDP growth would decline by 40% in the G19 and Nigeria – from 3.6% a year to only 2.1% (Figure 1).

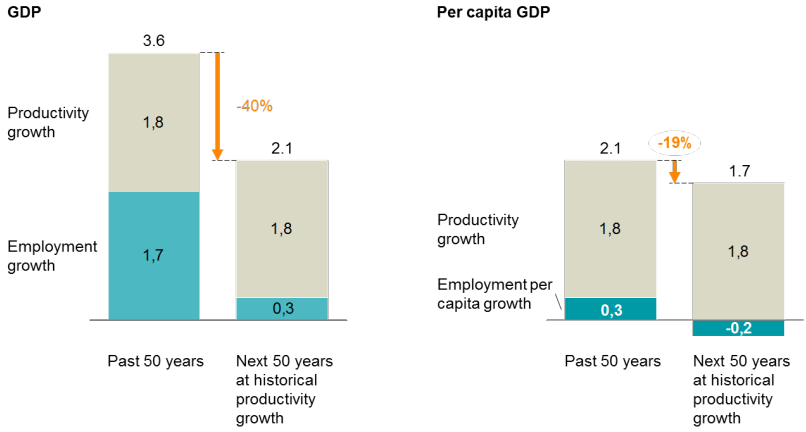
Putting this into perspective, average GDP growth over the next five decades would be one-third lower than it was over either the past five years of recovery from the global recession or the energy crisis decade of 1974 to 1984. Over the course of 50 years, such a slowdown in growth would add up to a significant shift in the world's growth trajectory. Having expanded six-fold in the 50 years from 1964, the global economy would grow only threefold between 2014 and 2064.

The impact on global living standards as measured by per capita GDP would not be as dramatic as that on GDP growth overall. The expected fall in the share of the prime-working-age population age implies a 19% decline in the growth rate of per capita income from the rate of the past 50 years. This

would mean the standard of living rising by 2.3 times over the next half century compared with an increase of 2.8 times over the previous 50 years. Nonetheless, at a time when people's aspirations globally have grown larger, even such a gap would be noticeable, and noticed.

**Figure 1 - At past rates of productivity growth, GDP growth would slow down by about 40% and per capita GDP growth by about 20%**

**G19 and Nigeria**
Compound annual growth rate, %




NOTE: Numbers may not sum due to rounding.

*SOURCE: The Conference Board Total Economy Database; United Nations Population Division; McKinsey Global Institute analysis*

The demographic transition and the changing age structure in a population have a far greater economic and social impact than simply determining the share of workers in an economy. The consumption and saving patterns of youthful populations differ from those of more mature age groups. [1] In France, for example, McKinsey research has found that by 2030 well over half of all households will be headed by someone aged 55 years or older. Mature households are set to become the largest and fastest-growing pool of earners and consumers. [2] Citizens aged 65-plus will account for almost half of additional consumption in the period to 2030 – but by virtue of

[1] For an overview of the academic research on the relationship between the age structure in a country and economics, see LEE & MASON (2011). On the broader societal and political implications of population age structure, see CINCOTTA (2012).

[2] *Meeting the 2030 French consumer: How European-wide trends will shape the consumer landscape*, McKinsey Consumer and Shopper Insights (2010, May).

their large numbers rather than their purchasing power, which will be under pressure. This has large implications for patterns of consumption. Older households tend to spend less on apparel and accessories, and therefore their share in the average consumption basket will fall. However, older households tend to be heavier consumers of financial services and the share of this category in the average consumption basket will therefore rise. In China, by comparison, a new generation is emerging, made up of youthful, middle-class consumers who were born after China started to open up its economy in the mid-1980s. McKinsey research has found that these members of Generation 2, or G2, are much more confident consumers than their parents and are more willing to pay a premium for the best products; indeed, they regard expensive products as better products. [3] They are happy to try new products and eager to experience new technologies. In 2020, 35% of total consumption in China is expected to come from these young consumers, who will be major purchasers of leisure, personal services, travel, and high-end hospitality.

Beyond such national differences, however, the global economy as a whole faces a productivity imperative. In order for productivity to fully compensate for the impact of the changing demographic trends, global growth would need to be 80% faster than the already high rate of the past 50 years. In terms of per capita income, productivity would need to accelerate by 22%.

Is such an increase in productivity possible? We believe the answer is yes. In contrast to some observers, we do not expect a drying up of technological or business innovations to constrain growth. To the contrary, we see considerable opportunity.

Over 25 years of MGI research on productivity and growth, we have learned that it is impossible to make sweeping generalizations about a country's productivity or prospects for its future economic performance, and that we can only arrive at macro-level insights through a granular examination of individual businesses at the industry, sector, and country levels.

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[3] *Demystify the consumption generation (G2) in China*, McKinsey Insights China (2013, February). This report is based on seven years' consecutive door-to-door consumer research, interviewing around 70,000 Chinese consumers across more than 60 cities and 100 product categories.

A detailed analysis of five sector case studies that we conducted, in agriculture, food processing, automotive, retail and health care, suggests that it is possible, albeit very challenging, to boost the annual rate of productivity growth to as much as 4% a year over the next decade. [4] That would be more than the 80% acceleration required to compensate fully for the demographic deceleration noted above.

A significant proportion of the potential productivity gains, approximately three-quarters, is achievable through a catch-up process, by which companies improve their productivity through the broad adoption of best practices. There are manifold opportunities in all sectors, from increasing the share of modern and on-line retail formats to improving operational efficiency in healthcare, reducing waste in food processing, raising the capacity utilization of auto assemblers and so on. Across countries, large productivity differences exist within the same industry. That indicates there is much room for productivity growth, not just in developed countries but also in emerging countries.

However, the adoption of best practices cannot by itself respond in full to the productivity imperative. We estimate that about one-quarter of the additional productivity growth required to compensate for demographic trends could come from technological, operational and business innovations that go beyond today's best practices, and which push the frontier of the world's GDP potential. The continued rapid advances in digital technologies, and their increasingly broad-based applications for businesses, governments and individuals, will be a substantial contributor to productivity growth going forward.

In the rest of this paper, we will seek to identify more closely how and where digital technologies could enhance productivity, what the implications could be for employment, and how governments, business leaders and other policy makers can ensure that the opportunities these technologies offer are best exploited.

[4] Details of the results in the five sectors are to be found in chapter 4 of the MGI report, *Global Growth: can productivity save the day in an aging world?* MGI reports are available on http://www.mckinsey.com/insights/mgi

## ■ Digital technologies as drivers of growth and productivity

The phrase "digital technology" is sometimes used as shorthand for the internet, and it is true that in a very short time the internet has transformed the way we live, the way we work, the way we socialize and meet, and the way our countries develop. Two billion people are now connected to the internet. Almost $8 trillion exchange hands each year through e-commerce. In some developed markets, about two-thirds of all businesses have a web presence of some kinds, and one-third of small and medium-sized businesses extensively use web technologies. [5]

Thanks to rapid advances in technological development, however, we see the internet as just one transformative digital technology among several:

- The internet's own evolution into the mobile internet has brought with it ubiquitous connectivity and an explosive proliferation of apps – including across businesses and the public sector, enabling more efficient delivery of many services and creating opportunities to increase workforce productivity.

- Cloud technology, through which any computer application or service can be delivered over a network or the internet, is enabling the explosive growth of internet-based services, and can also improve the economics of IT for companies and governments.

- Advances in artificial intelligence, machine learning, and natural user interfaces such as voice recognition are making it possible to automate tasks that have long been regarded as impossible or impractical for machines to perform. For instance, some computers can now answer "unstructured" questions, posed in ordinary language rather than precisely written as software queries, so employees or customers without specialized training can get information on their own. This opens up possibilities for sweeping change in how knowledge work is organized and performed.

- Big data, the ability to capture, communicate, aggregate store and analyze vast amounts of information, is increasingly being used by businesses to optimize performance and target consumers with relevant information. One powerful example is to be found in retail, where Amazon

[5] These statistics are from the World Bank, 2009; Garner, 2010; Eurostat, 2010; and a 2011 McKinsey & Company Internet survey of more than 4,800 small and medium-sized enterprises detailed in the MGI report: *Internet matters: the Net's sweeping impact on growth, jobs and prosperity*.

has leveraged technology to analyze ordering and shipping patterns, and uses advanced automation in its warehouses. This has enabled the company to reach 91% of U.S. consumers within a day, while reducing inventory by three to five days, compared with its peers.

- Finally, the internet of things – embedding sensors and actuators in machines and other physical objects to bring them into the connected world – is spreading rapidly. From monitoring machines on the factory floor to measuring the moisture in a field of crops to tracking the flow of water through utility pipes, the internet of things allows businesses and public-sector organizations to manage assets, optimize performance, and create new business models. This can help companies get far more out of their physical assets – improving the performance of machines, extending their lives, and learning how they could be redesigned to do even more.

Taken together, these technologies can impact productivity and economic growth in several essential ways. They dramatically reduce costs of many business operations. They heighten competition, by enabling newcomers to enter markets and sectors and rapidly build scale, or give incumbents who adopt them a competitive advantage. They provide multiple channels for producers to establish a direct relationship with consumers, and then tailor offers directly for them. They provide a mass of real-time information that can be leveraged, and used to speed up decision-making.

Overall, we estimate the potential global economic impact from these five technologies could be as much as $30 trillion in 2025. This estimate does not represent GDP or market size but rather the technologies' economic potential, including consumer surplus, which represents an important portion of the value created. [6]

These technologies are already having a significant impact across the value chain in manufacturing, from product design to production. For example, Toyota says that big data has helped it eliminate 80% of defects prior to building the first physical prototype of a new model. Some other manufacturers say they have cut new-model development time by 30% to 50%. We estimate that digital technology and services already represents 5.5% of France's GDP, more than agriculture or financial services. That is on a par with Germany, but behind the United States (8% of GDP), China

[6] For methodology and details of the calculation, see the McKinsey Global Institute report, *Disruptive technologies: Advances that will transform life, business, and the global economy* (2013, May).

(9.2%), the United Kingdom (10%) and South Korea (10.1%). [7] Looking ahead, we believe that the potential impact of digital technology on growth and productivity, far from having run its course, could further accelerate. Unlike some commentators, we also believe that technology-driven productivity can be compatible with rising employment (see Box, "Technology, productivity and jobs" on the following page).

The speed with which technology does accelerate growth and productivity is hard to predict, however. It will take time for companies to create systems that can maximize the value of the evolving digital technologies and, more importantly, for management innovations, organizational changes, and new business models to be developed and implemented. This could lead to a new "productivity paradox" – a lag between investment in technology and productivity gains that can be seen at a macroeconomic level. [8]

One parallel for the advent of digital technology may be the impact of computers two decades ago; the Harvard economist Robert Solow famously said that you can see information technology everywhere but in the productivity figures. Studies at the time showed that IT was only one of several factors at work in the productivity acceleration of the mid to late 1990s, and that innovation, competition and cyclical demand also played an important role. While IT did enable productivity gains, its impact was varied and complex, and depended on changes in business processes that differed from sector to sector. These could take time (McKinsey Global Institute, 2001; McKinsey & Company, 2002).

A number of studies that we have conducted focusing either on countries including France and China, or on industry sectors, including agriculture, food processing, automotive, retail and healthcare, indicate that digital technology today is also no "silver bullet" that will automatically translate into productivity gains, but that it will require time and changed business processes to achieve its full potential.

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[7] These comparisons are detailed in the September 2014 study by McKinsey France already cited.

[8] The productivity paradox was observed by economists Robert SOLOW and Stephen ROACH, who in 1987 noted that despite the widespread adoption of computers to automate office functions, there was no evidence of their impact on productivity. Subsequent research found problems in how government statistics measured the impact of computers and a lag between investment in technology and the organizational adjustments required to realize significant productivity gains. See BRYNJOLFSSON & HITT (1998); McKinsey Global Institute (2001).

**Technology, productivity and jobs**

The public debate over technology and productivity is often framed as one about employment. A critical concern on the minds of many economists is that technology-enabled automation is replacing well-paid, middle-class jobs at a rate never before seen, leading to higher unemployment and increasing a bifurcation in the labor market between a dwindling number of high-skill jobs and many low-wage and low-skill service jobs (AUTOR & DORN, 2013; MISHEL & GEE, 2012). In August 2014, the Pew Research Center reported in a survey of a large number of technology professionals and economists that 48% of respondents believed that new technologies would displace more jobs than they would create by 2025; 52% said they would not (SMITH & ANDERSON, 2014).

The concern about technology replacing jobs is not new. In 1930, the British economist John Maynard KEYNES coined the term "technological unemployment." [9] Since the industrial revolutions that started in Britain, spread to America, and then throughout Europe, machines have replaced workers, creating not only a productivity revolution but also a labor market that required new skills.

History shows that technology-driven productivity can be – and was – compatible with rising employment. In the US, more than two-thirds of the years since 1929 have seen positive gains in both productivity and employment (McKinsey Global Institute, 2011). The question is whether that relationship will continue to hold. Our analysis shows that it can – that the perceived trade-off between productivity growth and employment growth is a temporary phenomenon, and that long-term productivity growth is achievable without job losses. In more than 80% of rolling ten-year periods over the past half century, labor productivity and employment have increased at the same time. (Even looking at single years, more than two-thirds of the past 50 years have been ones in which productivity and employment both increased). There is no indication that this relationship between employment and productivity growth has shifted over time. When we conducted the analysis separately for each decade, the periods with most annual declines in either employment or productivity growth were in the 1970s and 1980s, coinciding with the oil crises and Latin America's "lost decade" in the 1980s. Since 2004, the share of periods with growth in both productivity and employment has been above the 50-year average.

[9] In his famous 1930 essay *Economic possibilities for our grandchildren*, KEYNES said, "We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come – namely, technological unemployment. This means unemployment due to our discovery of means of economising the use of labour outrunning the pace at which we can find new uses for labour."

While many technologies are adopted precisely because they reduce demand for labor, the income from these savings can create demand for other, new things. This creates a virtuous cycle that explains joint productivity and employment growth. One third of new jobs created in the U.S. in the past 25 years were types that did not exist, or barely existed, 25 years ago. They included computer programmers, computer-system analysts, fitness instructors and medical technicians. A 2011 detailed analysis of the French economy by McKinsey's French office showed that while the internet had destroyed 500,000 jobs in the previous 15 years, it had created 1.2 million others, a net addition of 700,000, or 2.4 jobs created for every job destroyed (McKinsey & Company, March 2011).

For example, a study by McKinsey's French office in September 2014 found that while a big majority of consumers has readily adopted digital technology, companies have tended to be slower to do the same. Almost half the 500 companies surveyed said they had been relatively slow to adopt digital technologies because of organizational difficulties; for example just 14% had received orders via the internet and only 65% had a web site. 31% complained about the difficulty of recruiting digitally savvy staff, and 28% ascribed their tardiness to a lack of interest or involvement by senior management. The study calculated that if the potential technologies were to be deployed fully, this would create 1,000 billion euros in economic value by the year 2025 in France alone, including consumer surplus. That is the equivalent of more than one-third of the nation's GDP.

We have found similar lags between consumers and business in China. China's internet has already given rise to a dynamic technology sector, thriving social networks and the world's largest e-commerce market; on the unofficial "Singles Day" holiday in China on November 11, 2014, Alibaba, the nation's biggest e-tailer, recorded sales of more than $9.3 billion, a world record. Yet the web is only now beginning to penetrate many Chinese businesses. A McKinsey survey of CIOs found that the typical Chinese company spends just 2% of revenue on IT, far below the 4% international average (McKinsey Global Institute, 2014a).

This apparent lag in the adoption by business of digital technology and processes stands in contrast to the potential productivity and growth gains that they promise. Our research shows that the intense and effective application of digital technology can have a considerable impact, even in sectors sometimes deemed as low-tech, such as agriculture. For example a combination of precision farming and big data could usher in a new era of productivity in agriculture as well as enhancing the quality and resilience of

production. MGI has estimated that using sensor data for precision agriculture could raise crop yields by 10 to 20% globally.

Small and medium-sized businesses, not just large companies, also stand to benefit from embracing technological change. A McKinsey survey of 4,800 SMEs in 12 countries found that those with a strong web presence grew more than twice as quickly as those that had minimal or no presence. [10] This outcome held true across multiple sectors of the economy. In addition, SMEs that took advantage of the internet reported that the share of total revenues they earned from exports was more than twice as large as that reported by others. They also created more than twice the number of jobs as others.

In the future, we expect some of the biggest advances will come through the internet of things (IoT), the digitizing of the physical world. For now, the technology is at an early stage, and the adoption of it by business is embryonic. Most of the IoT data collected today are not used at all, and data that are used are not fully exploited. For instance, less than 1% of the data being generated by the 30,000 sensors on an offshore oil rig is currently used to make decisions. And of the data that are actually used – for example, in manufacturing automation systems on factory floors – most are used only for real-time control or anomaly detection. A great deal of additional value remains to be captured, by using more data, as well as deploying more sophisticated IoT applications, such as using performance data for predictive maintenance or to analyze workflows to optimize operating efficiency.

MGI in 2015 conducted research on more than 150 IoT use cases across the economy, to get a better gauge of how the technology could be applied in several specific settings, such as homes, offices and factories. A key insight from analyzing the benefits of IoT applications within settings is the critical contribution made by interoperability among IoT systems. On average, interoperability is necessary to create 40% of the potential value that can be generated by the internet of things in various settings. We also see that making IoT applications interoperable – linking a patient's home health monitor to the hospital's health informatics system, for example – is a complex systems design challenge that requires coordination on many levels (technology, capital investment cycles, organizational change, and so forth).

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[10] The survey was carried out in May 2011 in Canada, China, France, Germany, India, Italy, Japan, Russia, South Korea, Sweden, the United Kingdom and the United States. *Internet matters: the Net's sweeping impact on growth, jobs and prosperity.*

Based on our use cases, we estimate that the internet of things has a total potential economic impact of $3.9 trillion to $11.1 trillion per year in 2025. On the top end, the value of this impact – including consumer surplus – would be equivalent to about 11% of the world economy in 2025. Achieving this level of impact will require certain conditions to be in place and overcoming technical, organizational, and regulatory hurdles. In particular, organizations that use IoT technology will need better tools and methods to extract insights and actionable information from IoT data, most of which are not used today.

The deployment of the internet of things and other forms of digital technology, and their overall impact on productivity, will thus depend on several factors. Foremost among them is a willingness and the technical knowhow of businesses to take advantage of the considerable innovation that is becoming available. But governments and policy makers also will need to adopt policies and strategies that will enable the spread of digital technology to feed through into the productivity gains that the shifting demographic picture has made so necessary.

## ■ Implications for government and business

Having ample opportunities to improve productivity does not guarantee that they will be realized. MGI first identified some of the productivity gaps that persist today more than ten years ago. Drawing on many years of analysis of productivity and growth, we believe several key enablers are needed to boost productivity growth and help to lift the world economy's long-term growth rate closer to its potential. They include:

#### *Crafting a regulatory environment that incentivizes productivity and supports innovation*

Countries vary in the way their business environments facilitate creative destruction, that is to say, innovation and change in their industries. One of the main reasons that productivity growth has been faster in the United States than it has been in Continental Europe or Japan is the difference in the rate at which more productivity businesses gain market share and create jobs, obliging the less productive to either improve or go out of business (BAILY & FARRELL, 2006; McKinsey Global Institute, 2002). In the U.S. retail industry for example, virtually all of the rapid productivity growth in the

1990s was caused by more productive new establishments displacing much less productive ones. [11]To catalyze productivity through competition, the regulatory environment should avoid unnecessary red tape governing labor and the use of land, set low barriers to entry for new businesses, and put in place transparent and efficient bankruptcy procedures. Government standards and incentives are an effective tool for obliging companies to innovate because they help to shape consumer demand.

***Fostering demand for R&D investment in innovative products and services***

To ensure that we continue to have a rich technology pipeline in the decades to come will require continued investment in fundamental research. Fortunately, the available evidence suggests that overall investment in R&D shows no signs of slowing. Between 1995 and 2010, global R&D investment grew at a compound rate of 4%. Developed economies have held their R&D investment as a share of GDP steady at around 2.5% of GDP in this period, while emerging economies have increased their investment share of GDP from 0.5% to 1.3%. [12]

Demand for emerging technologies from the public sector will continue to be an important catalyst for research and innovation. The case for direct public-sector intervention to foster basic research is strong when social benefits outweigh the private returns to the funder of the original research, as is often the case for early-stage, groundbreaking research (CZARNITZKI & HOTTENROTT, 2011). To continue to build a platform for sustained productivity growth in the decades to come, public-sector demand for emerging technologies and support of long-term R&D will be needed.

***Education and training initiatives to enlarge the pool of digitally-literate talent***

A significant constraint on realizing value from digital technologies is a shortage of talent. As already noted, one of the reasons companies give for not leveraging the internet is a lack of expertise, and as the technologies become more sophisticated, that lack could become an even greater disadvantage. Many more people with deep expertise in computer technology, statistics and machine learning are needed, but so too are

[11] Overall industry turnover includes within-company evolution of establishments, reflecting within-company reallocation of resources across regions. See FOSTER *et al.* (2002).

[12] OECD data.

managers and analysts who are digitally literate or know how to leverage their companies' operations using insights from digital technologies, especially big data. [13]

Governments can act in a variety of ways to help increase the supply of talent necessary. First, they can put in place education initiatives to increase the pipeline of graduates with the right skills. In the United States, for instance, there is a push at the federal, state, and local levels to support more science, technology, engineering, and mathematics (STEM) education. Most other OECD governments also recognize the need for more STEM graduates who are historically underrepresented in those fields, including women. However, the needs for deep analytical talent are more specific even than this – more graduates with advanced training in statistics and machine learning (a sub-discipline of computer science) will be necessary. A second way for governments to increase the supply of talent is to reduce barriers to accessing these pools in other regions, for example through remote work or the immigration of skilled workers.

The challenge of developing a large number of organizational leaders and analysts in business, government, and the social sectors who have basic understanding of analytical techniques is on a far larger scale. At a minimum, new knowledge workers already in the educational pipeline on their way into the workforce should be educated on these topics; a mandatory course in statistics/decision science, with a module on experimental design, should become part of the curriculum in fields such as business administration and other management disciplines.

***Ensuring access to data***

The global economy is beginning to operate truly in real time, with constant streams of data showing where consumers are shopping, ships are traveling, energy and money are flowing. Open data – the release of information by governments and private institutions and the sharing of private data to enable insights across industries – provides additional depth to big data applications and makes possible entirely new ones, such as the smartphone app that tells commuters when the next bus will arrive. Making

[13] An analysis by MGI of the United States market alone found that the demand for deep analytical positions in big data would exceed the supply by between 140,000 and 190,000 in 2018, and that 1.5 million additional managers and analysts who could understand the data and apply the lessons from it would be needed. McKinsey Global Institute (2011).

data more widely available, and in shareable formats, has the potential to unlock large amounts of economic value, by improving the efficiency and effectiveness of existing processes; making possible new products, services, and markets; and creating value for individual consumers and citizens.

Governments can set the tone for open data within a society, both by releasing data and shaping the policy environment. Public-sector agencies can be a key source of open data. An important first step is to set priorities for data release that are based on potential value. Agencies can establish clear rules to govern the type of data that should – or should not – be released, with particular focus on safety, national security, privacy, liability, intellectual property rights, and confidentiality. Government leaders can champion the focus on open data across agencies and help make sure that the default decision is to release data whenever possible. As primary sources of open data, governments at all levels can be leaders in developing easy-to-use platforms for accessing open data. They can also shape the legal and economic environment that maximizes the potential societal value from the use of open data, while addressing the legitimate privacy and intellectual property concerns of individuals and organizations. This may include policies on who can access information, the type of information that can be collected or used in certain functions, and protocols for notifying individuals when information about them is made available.

***Opening up economies to cross-border economic flows from trade in goods and services to flows of people***

Being open to global economic activity allows companies and economies to benefit from competition, the flow of ideas and better practices and personal connections. Over the past 50 years, one of the most potent enablers of growth was closer integration of regional and global markets of tradeable goods that have spurred scale benefits and increasing competition. The widespread adoption of free trade agreements, first between developed economies and later with emerging regions, has contributed to productivity and GDP growth since 1964. [14]

On average, the sum of imports and exports as a share of GDP rose from 13% in 1964 to 40% in 2012 in the G19 countries and Nigeria. In the United States, the share rose from 7% of GDP to 24%, in China from 7% to 47%,

[14] For an overview of the academic evidence on the impact of trade, see WACZIARG & HORN WELCH (2008).

and in India from 8% to 42%. [15] Overall, recent MGI research has estimated that cross-border flows of goods, services, finance, people, and data and communications contribute 15 to 25% of global GDP growth each year (McKinsey Global Institute, 2014b).

In the coming decades, ongoing efforts to reduce trade barriers in manufacturing – and to resist the temptation to increase protection – will continue to be important. There is much room to open services to broader international competition, as well as to invest in physical and digital infrastructure to integrate countries and regions that remain isolated today, as we discussed in the infrastructure section earlier in this chapter. More open policies toward foreign direct investment and a search for more consistency across national policies have also facilitated technology transfer and business process transfers across regions (McKinsey Global Institute, 2003). The cost of isolation can be high. MGI research has found that openness to global flows promotes faster GDP growth, accounting for 15 to 25% of global GDP growth a year, and that countries with more connections to other nations in global flow networks will benefit 40% more than countries on the periphery with fewer connections.

**References**

AUTOR, D. H. & DORN, D. (2013): "The growth of low-skill service jobs and the polarization of the U.S. labor market", *American Economic Review*, Vol. 103, No. 5, August.

BAILY, M. N. & FARRELL, D. (2006): "Breaking down barriers to growth," *Finance & Development*, Vol. 43, No. 1, March.

BRYNJOLFSSON, E. & HITT, L. M. (1998): "Beyond the productivity paradox," *Communications of the ACM*, Vol. 41, issue 8, August.

CINCOTTA, R. P. (2012): "Demography: A development perspective," in SPEAR, J. & WILLIAMS P. D. (Eds), *Security and development in global politics: A critical comparison*, Georgetown University Press.

CZARNITZKI, D. & HOTTENROTT, H. (2011): "Financial constraints: Routine versus cutting edge R&D investment," *Journal of Economics & Management Strategy*, Vol. 20, issue 1, spring.

[15] McKinsey Global Institute analysis using World Trade Organization and World Bank data. Also see KRUGMAN (1995).

FOSTER, L., HALTIWANGER, J. & KRIZAN, C. J. (2002): "The link between aggregate and micro productivity growth: Evidence from retail trade", NBER working paper, No. 9120, August.

KRUGMAN, P. (1995): "Growing world trade: Causes and consequences", *Brookings Papers on Economic Activity*, Vol. 26, issue 1.

LEE, R. & MASON, A. (2011): *Population aging and the generational economy: A global perspective*, Edward Elgar Publishing, 2011.

KEYNES J. M. (1930): *Economic possibilities for our grandchildren*. www.econ.yale.edu/smith/econ116a/keynes1.pdf

McKinsey & Company:
- (2002): *How IT Enables Productivity Growth*, November.
- (2011): *Impact d'internet sur l'économie française: Comment internet transforme notre pays*, ("The internet's impact on the French economy: how the internet is transforming our country"), March.

McKinsey Global Institute:
- (2001) *U.S. Productivity Growth 1995-2000, Understanding the Contribution of Information Technology Relative to Other Factors*, October.
- (2002): *Reaching higher productivity growth in France and Germany*, October.
- (2003): *New horizons: Multinational company investment in developing economies*, October.
- (2011a): *Big data: the next frontier for innovation, competition and productivity*, June.
- (2011b): *Growth and renewal in the United States: Retooling America's economic engine*, February.
- (2013): *Disruptive technologies: Advances that will transform life, business, and the global economy*, May.
- (2014a): *China's digital transformation: The internet's impact on productivity and growth*, July.
- (2014b): *Global flows in a digital age: How trade, finance, people, and data connect the world economy*, April.

MISHEL, L. & GEE, K.-F. (2012): "Why aren't workers benefiting from labour productivity growth in the United States*?", International Productivity Monitor*, No. 23, Spring.

SMITH A. & ANDERSON, J. (2014): "AI, robotics, and the future of jobs", Pew Research Center, August 6.

WACZIARG, R. & HORN WELCH, K. (2008): "Trade liberalization and growth: New evidence", *World Bank Economic Review*, Vol. 22, No. 2, June.