



June 2021

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Automation

The pursuit of efficiency

From early mechanisation towards fully automated smart factories and homes, automation is gathering speed

Automation's manufacturing roots have extended into transport, healthcare, finance, utilities and retail

Automation is one of nine big themes identified by HSBC Global Research and the main point of discussion during HSBC's Automation Week (14-18 June 2021)

This is an abridged version of a report by the same title published on 10-June-21. Please contact your HSBC representative or email AskResearch@hsbc.com for more information.

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Executive Summary

Automation: multi-dimensional efficiency

Automation is, in its broadest sense, the pursuit of increased efficiency. This typically involves reducing or replacing the human involvement in a process, be it the production of an individual part or component, the upgrading of a production line or the streamlining of entire systems, processes and organisations across a wide variety of sectors from manufacturing to consumers to IT and finance. The impact of automation can be felt vertically and horizontally, from the factory floor to the boardroom and across supply chains, logistics and utilities.

Automation is strategic and keeping abreast of developments is crucial

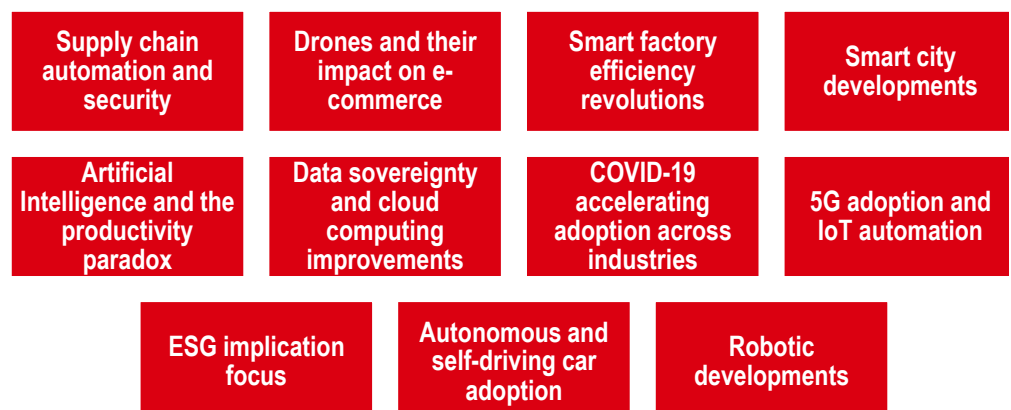
Automation can impact both capex and opex investment trends in many sectors and is often cited by companies in their M&A strategies (bolt-on or otherwise). It can affect competition, capital intensity and operational efficiency and therefore can have a bearing on both profitability and returns. But automation doesn't stop there. Its effects can be felt in ESG issues such as energy usage, climate change, and social trends as it remoulds workforces while generating data, the ownership of which may not always be clear.

Current trends: from Automation to Autonomy

Where are we heading?

Automation is, in its broadest sense, the pursuit of increased efficiency. The impact of automation can be felt vertically and horizontally, from the factory floor to the boardroom and across supply chains, logistics and utilities. It has been evolving for centuries and with Industry 4.0, 5.0, 5G, AI, robotics and autonomy all in sight, we need to keep abreast of developments in Automation.

As we enter into a new age of technological innovations, competition is growing and adoption of new automation technologies is expected to increase across industries in a post COVID-19 environment. The trends we expect to see in 2021 are listed below and will be discussed and presented by industry experts and companies at HSBC's Automation Week (14-18 June 2021). For more information on the event as well as how to register to attend, please contact your HSBC representative for details.



Source: HSBC

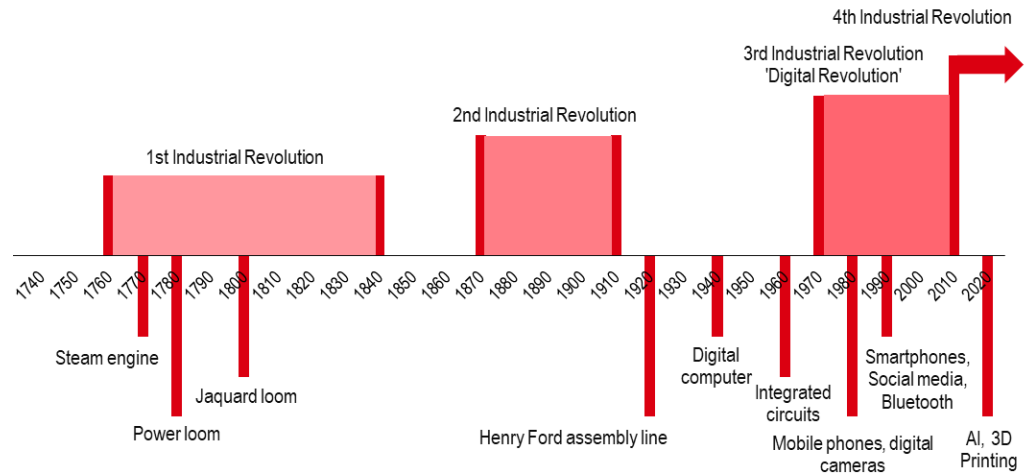
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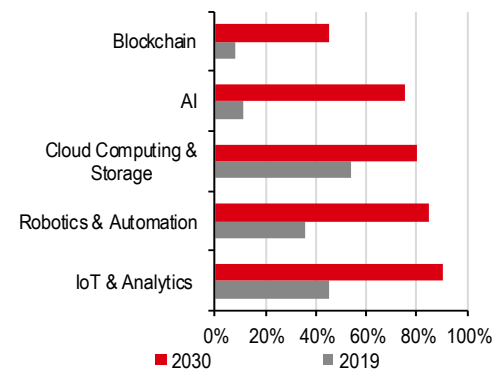
Automation in five charts

Automation timeline



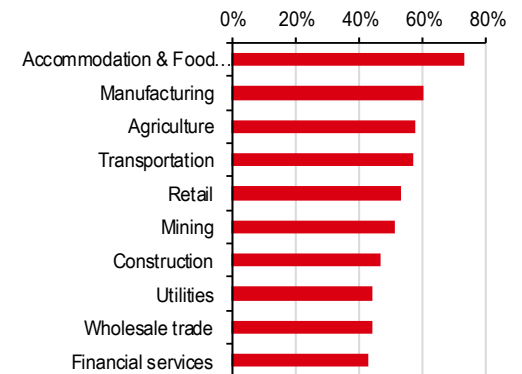
Source: HSBC

Warehouse automation technology adoption (% of organisations)



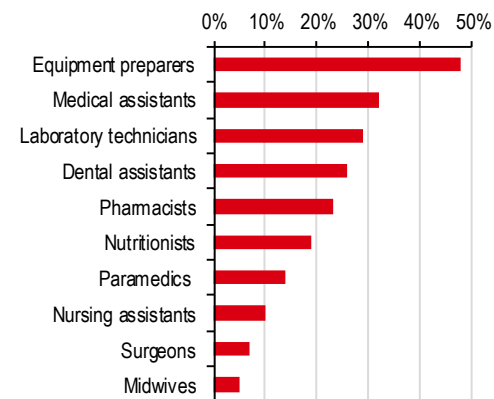
Source: LogisticsIQ

Top 10 industries for automation potential % (2017)



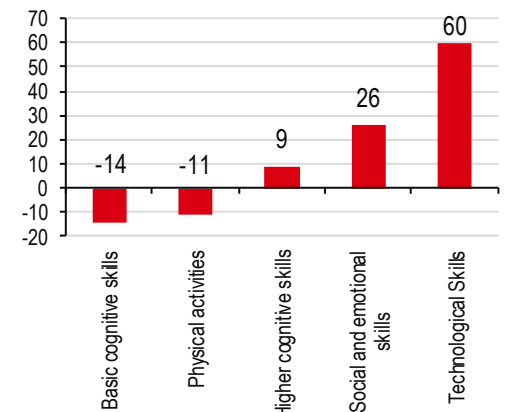
Source: Fortune

Share of hours worked in healthcare occupations that could be freed-up by automation via AI by 2030



Source: HSBC, mClinica, Note: Data from selected European countries: France, Germany, Hungary, Italy, Portugal, Sweden and UK.

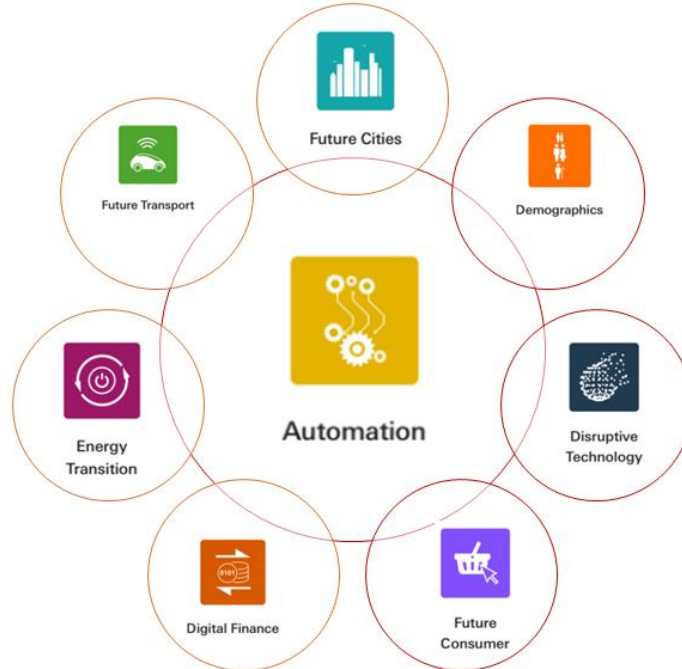
Change in hours worked per week in the United States due to automation and AI between 2016 and 2030 (%)



Source: HSBC, US Bureau of Labour Statistics (BLS)

Automation and HSBC's nine big themes

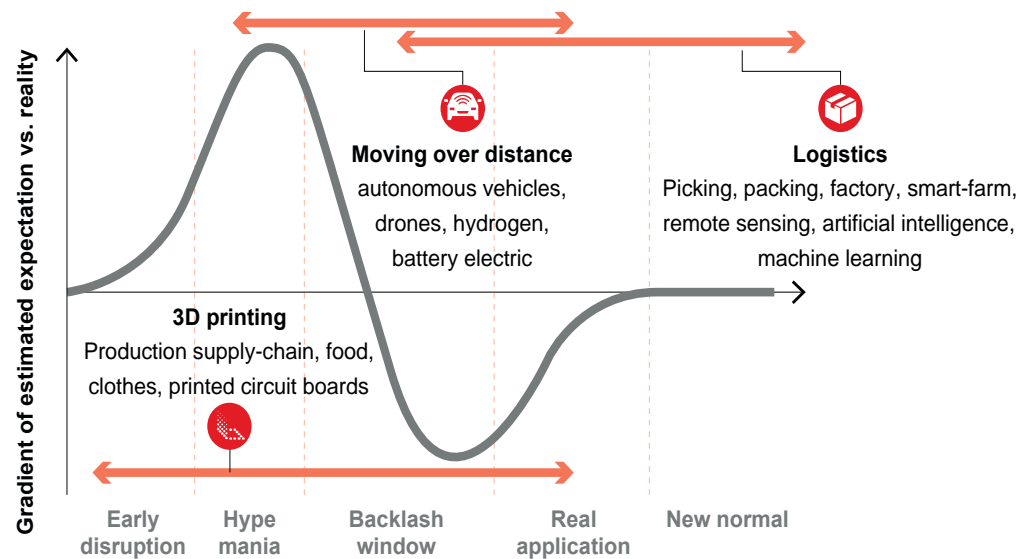
Automation is interconnected and can be found within many other themes



Source: HSBC

HSBC Disruption Framework

HSBC Disruption Framework: Automation infrastructure



Source: HSBC

Defining automation

- ◆ Automation relates to machines operating without human control
- ◆ Pursuit of efficiency via mechanisation is thousands of years old
- ◆ Automation also involves substitution of human labour

Extending human capabilities...

Automation has two definitions, each with different implications.

The first definition centres on the pursuit of increased efficiency via mechanisation. This, we note, has been evolving since the stone age. Arguably the most notable development in the history of modern automation was in 1913 with Henry Ford's introduction of mechanised production lines in the automotive industry. This revolutionised manufacturing; controls allowed increased production volumes by reducing the time taken to produce one automobile from 12 hours to 1.5 hours.

“ The use of machines and computers that can operate without needing human control

Definition of “automation” #1, Cambridge dictionary

Assembly lines today are scattered with automated robotics and electronics. A range of other technologies, including robotics, digital computer controls and artificial intelligence, are driving increased automation and making the machines themselves more autonomous. Automation in the digital age has the potential to drive productivity enhancements in the home as well as in a range of industries.

But social implications have raised fears

The second definition focuses not on improving human capabilities but on the substitutional impact, centred on the threat of replacing human labour. Whilst reducing human error via automation is beneficial to the overall quality of manufactured product, replacing people with machines has longer-term social repercussions which need to be addressed.

“ The use of machines or computers instead of people to do a job, especially in a factory or office

Definition of “automation” #2, Cambridge dictionary

We tend to take a constructive view of labour substitution given the evidence suggests that workforces globally tend to adapt quickly to new roles as machines are put in place. The recent rise in collaborative co-bots, which are robots designed to interact and work alongside humans, suggests the way forward may be less threatening than feared.

A brief history of automation

- ◆ The pursuit of efficiency has driven automation developments over history
- ◆ Early advances helped industrialise manufacturing processes
- ◆ The digital revolution and greater data analysis capabilities are fuelling wider adoption of robotics and artificial intelligence

The pursuit of efficiency

Early developments – from ancient times to the industrial revolution

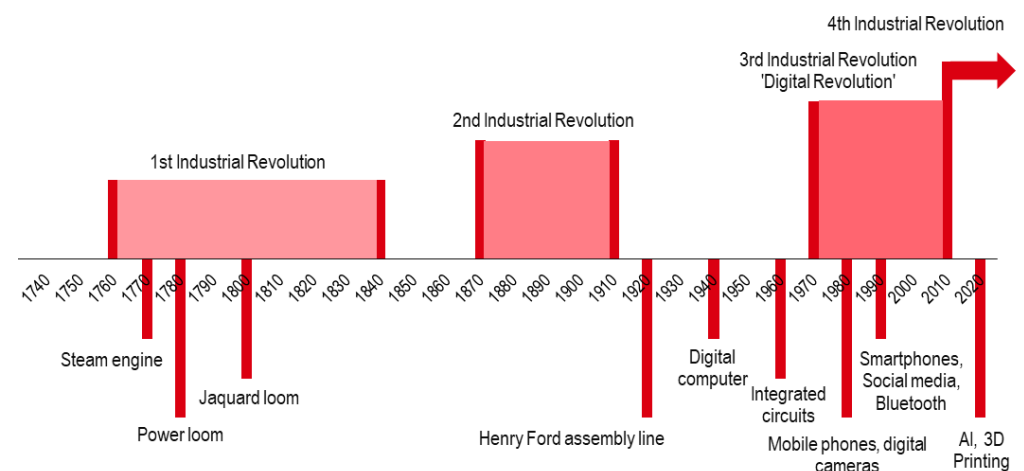
Utilising tools to complete tasks

Across history the drive to increase efficiency of tasks has been a key goal of the human race. Prehistoric periods such as the stone age demonstrate early human fascination with using tools to complete tasks. The ancient Egyptians and ancient Greeks further developed the idea of automating tasks without the need for human strength in devices such as simple steam driven devices and water wheels.

The industrial revolution represents a significant advancement in automation

The Industrial Revolution ushered in significant advances in technological innovation and in development of powered machines. In the late 1700s, the new steam engine, developed by James Watt, building on work by his predecessors, harnessed steam power to produce mechanical work. Watt greatly improved the device by allowing rotation and a separate condenser to avoid heating and cooling the cylinder with each stroke.

Chart 1. Automation timeline



Source: HSBC

The loom represents another revolutionary automation development during the same era, which helped drive the industrialisation of textile manufacturing. Edmund Cartwright introduced the

power loom in the 1780s, which was followed by the Jacquard loom in the early 1800s, invented by Joseph-Marie Jacquard. This mechanised loom included a programmable device enabling the production of more complex patterns without increasing labour needs.

Automation in the early 20th century

'Automation' coined in 1946

In 1913 Henry Ford introduced mechanised production lines in the automotive industry. This revolutionised manufacturing; controls allowed increased volumes of automobile production by reducing the time taken to produce one unit from 12 hours to 1.5 hours. The word 'automation' was coined in 1946 by the automotive industry as it increased the use of mechanised production lines. Revolutionising mass production, this changed the way manufacturing functioned, not only across the automotive industry, but in a multitude of other industries.

Introduction of the digital computer...

The 1940s also brought the development of the digital computer, notably the ENIAC (Electronic Numerical Integrator and Computer) developed by the University of Pennsylvania in the US. With advances in data-storage technology, software, sensor technology and mathematical control theory, progress in automation evolved quickly in the mid-20th century. Integrated circuits in the 1960s led to the development of smaller desktop computers, which provided less expensive and quicker ways of performing calculations. With this came the improvement of program storage technology, including tapes and disks.

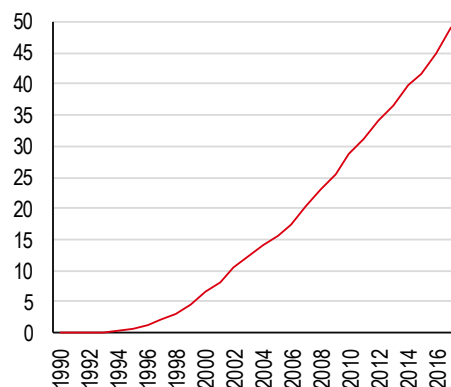
For manufacturing, the first industrial robot was developed in the late 1950s in the US, by the engineer George Devol. The use of automated robots in factories took off in the 1970s and 1980s, with the concept of 'lights out' factories, where robots took on a greater number of jobs that human labour once did¹.

Late 20th and early 21st century – the digital revolution

The digital revolution takes off in the 1970/80s

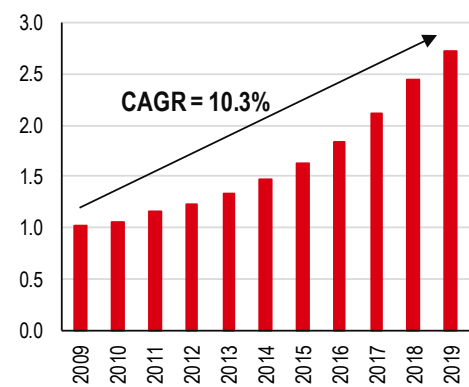
The late 20th century marked the so-called 'digital revolution', with further improvements in computing technologies, storage capabilities and battery technology. The 1980s brought technologies such as mobile phones and digital cameras as well as the introduction of the World Wide Web. The 1990s introduced smartphones, social media and Bluetooth to name a few.

Chart 2. Internet users as a percentage of the global population (1990-2017)



Source: World Bank Data

Chart 3. Global operational stock of industrial robots reached 2.7 million units in 2019 (units millions) (2009-2019)



Source: HSBC, International Federation of Robotics (IFR)

...and has accelerated in the early 21st century

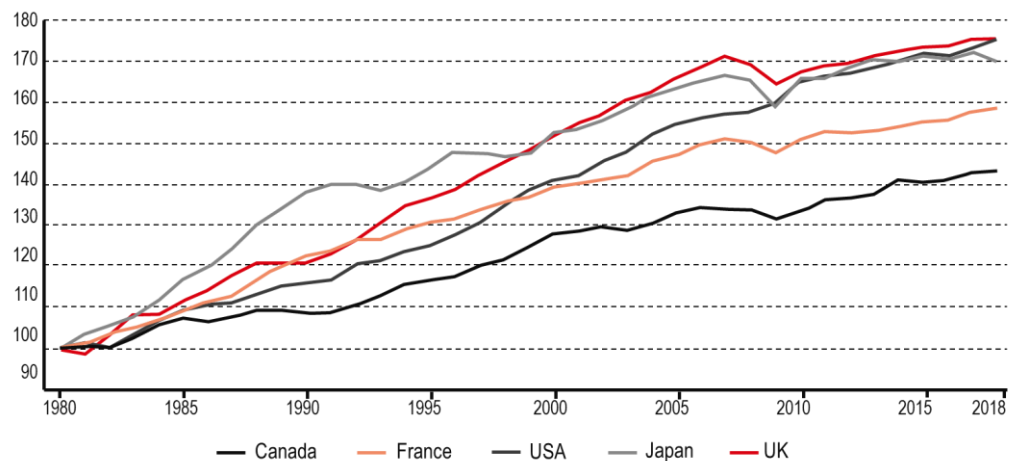
¹ 'The history of automation', PR Automation

Rising productivity since 1980, though tapering since 2008

The start of the 21st century has seen global adoption of digital technologies, with an estimated 53.6% of the world population being internet users in 2019². Chart 2 illustrates the rise in users from 1990 to 2017.

This substantial pace of developments has driven significant improvements in productivity in a vast range of industries, from agriculture to manufacturing, with GDP per worker rising in many developed markets by 45-75% between 1980 and 2018 (at a 1.0-1.5% CAGR), see Chart 4. It is worth noting that the increasing level of productivity growth across regions slowed, specifically post-financial crisis. This we think can be explained by the 'productivity paradox', i.e. that despite technology advances, productivity growth remains well below that of the industrial revolutions, which could be attributable to advances in technologies such as Artificial Intelligence (AI) which have the ability to replace workers and thus decrease productivity growth across the workforce, especially within manual occupations.

Chart 4. Real GDP per worker employed across regions highlights productivity gains (base 100 = 1980)



Source: HSBC, Integromat

Developments in AI and robotics

In the last decade AI and robotics have advanced significantly. Breakthroughs for AI have included Facebook's DeepFace algorithm, which detects individuals' faces in photos and suggests who to tag, with a 97.53% accuracy, similar to that of a human. Additionally, Microsoft's speech recognition technology has achieved a human level of word error at 5.9%³. Robotics have been utilised in a multitude of industries including healthcare, mining, agriculture and defence. Chart 3 illustrates the increase in operational stock of industrial robots across a 10-year time frame, illustrating a CAGR of 10.3%.

Machine vision gives robots eyes allowing automated inspection and quality control

Another example of enhanced robotics capabilities through data processing is Machine vision (MV). MV utilises technology to process images and perform automatic inspection and process control functions, utilised mostly in manufacturing and quality control roles. Driven mainly by smart manufacturing, MV demand has grown and the industry is expected to reach 30-35% CAGR over the next five years in China alone, see *Global Machine Vision* (25 May 2021). Key developments include 3D vision inspection and the potential for shortened payback periods for those adopting the technology, which is partly driven by labour costs increasing across China.

² 'Measuring digital development', ITU Publications, 2019

³ 'A Decade of Advancements as We Enter a New Age of AI', Forbes, 31 Dec 2019

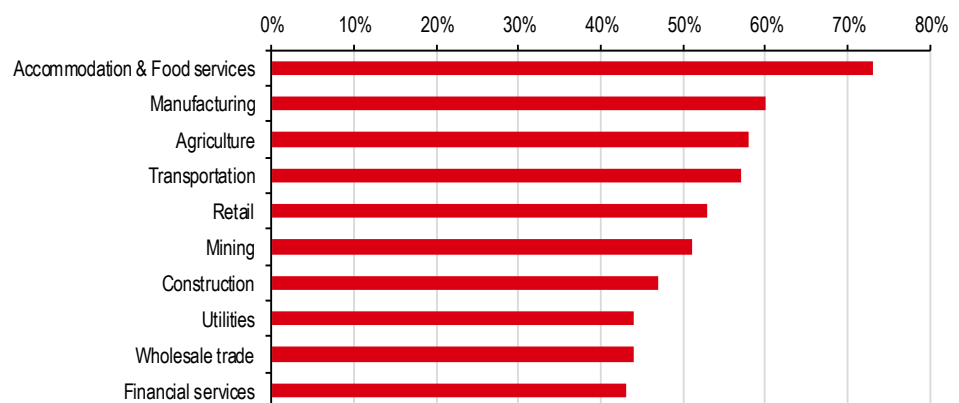
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The full note contains a look at automation by sector, including what the automation potential is, and an explanation of automation in manufacturing, transport, healthcare, telecoms and finance.

We also explore the nexus of Automation and ESG, looking at the benefits in emissions, waste and water, impact on health and safety, and unemployment, and take a look at the oversight of automation and associated technology

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Chart 5. Top 10 industries for automation potential % (2017)



Source: Fortune

The benefits and drawbacks of increased automation

Benefits

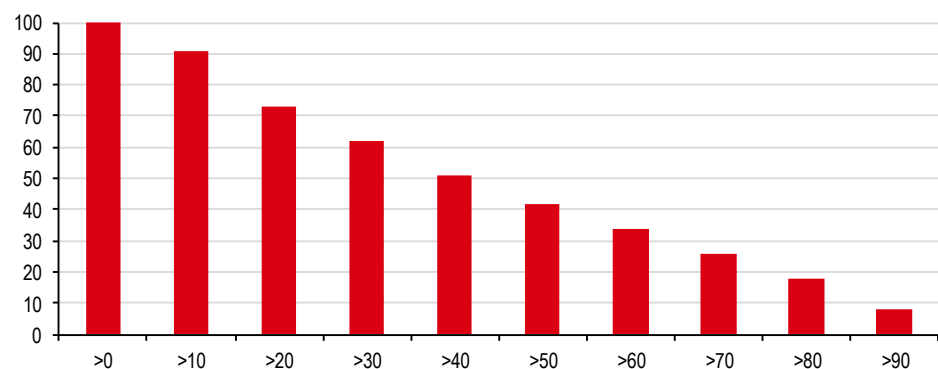
- ◆ Higher production and efficiency rates, increasing output
- ◆ Product quality improvements
- ◆ Safety improvements
- ◆ Reduced labour required for firms, lower labour costs
- ◆ Reduced human error
- ◆ Increased consistency of output and quality
- ◆ More efficient use of materials, reduced waste
- ◆ Increased competitiveness

Drawbacks

- ◆ Worker displacement and unemployment
- ◆ High capital expenditure on automation investment
- ◆ Maintenance and operational costs
- ◆ Automation dependency risks
- ◆ Reduced human privacy
- ◆ Cybersecurity risks
- ◆ Requirement for skilled workers to operate technologies
- ◆ Lack of flexibility to production changes
- ◆ Potential pollution risks when powering machinery

Source: HSBC, Britannica

Chart 6. Around 60% of occupations have at least 30% technical automation potential (x-axis: % technical automation potential, y-axis: % share of roles) (2017)



Source: World Economic Forum

Disclosure appendix

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