A FUTURE THAT WORKS:

the impact of automation in Denmark

McKinsey&Company

AARHUS BSS
THE TUBORG RESEARCH CENTRE FOR GLOBALISATION AND FIRMS
INSTITUT FOR ØKONOMI
AARHUS UNIVERSITET

The Tuborg Research Centre For Globalisation and Firms
Aarhus University
Fuglesangs Allé 4
DK-8210 Aarhus V

McKinsey & Company
Ved Stranden 14
DK-1061 Copenhagen

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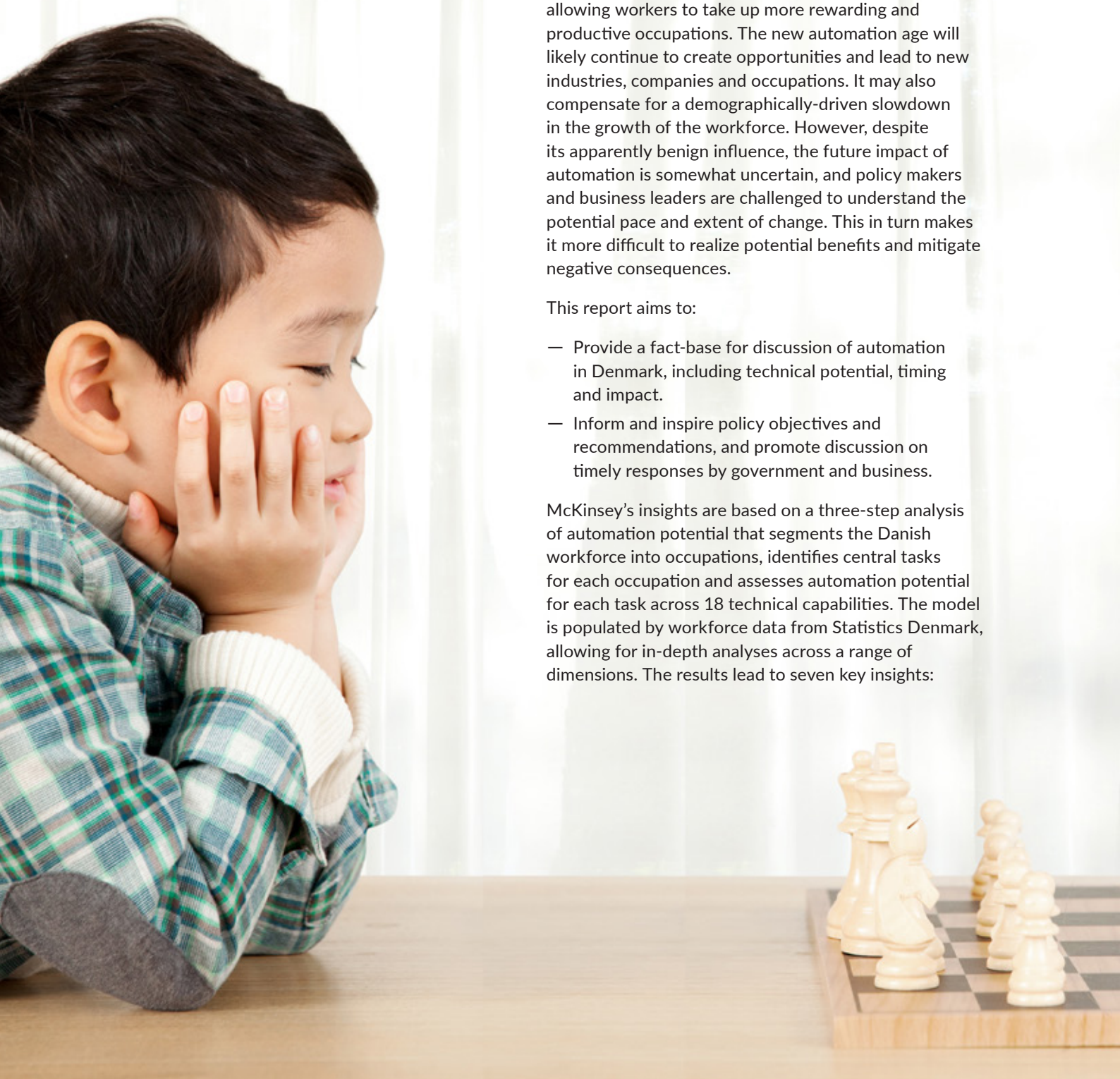
EXECUTIVE SUMMARY



Advances in technology suggest the world of work is on the brink of a new automation age, in which machines, robots and artificial intelligence graduate from routine tasks on the factory floor to activities across industries, skill sets and pay scales. Based on groundbreaking McKinsey research, this report shows that a staggering 40 percent of Danish working hours could be automated by current technologies.

Automation is nothing new; it has shaped the workplace since the Industrial Revolution, when power looms replaced human weavers to boost productivity in the textile industry. Machines have had a generally positive impact over the years, creating value and allowing workers to take up more rewarding and productive occupations. The new automation age will likely continue to create opportunities and lead to new industries, companies and occupations. It may also compensate for a demographically-driven slowdown in the growth of the workforce. However, despite its apparently benign influence, the future impact of automation is somewhat uncertain, and policy makers and business leaders are challenged to understand the potential pace and extent of change. This in turn makes it more difficult to realize potential benefits and mitigate negative consequences.

This report aims to:

— Provide a fact-base for discussion of automation in Denmark, including technical potential, timing and impact.

— Inform and inspire policy objectives and recommendations, and promote discussion on timely responses by government and business.

McKinsey's insights are based on a three-step analysis of automation potential that segments the Danish workforce into occupations, identifies central tasks for each occupation and assesses automation potential for each task across 18 technical capabilities. The model is populated by workforce data from Statistics Denmark, allowing for in-depth analyses across a range of dimensions. The results lead to seven key insights:

- **Some 40 percent of working hours in Denmark are automatable based on demonstrated technologies.** All occupations will be affected by automation, but few occupations can be fully automated.
- **Occupations with a higher share of predictable job tasks are more prone to automation.** At one end of the spectrum, machine operators who perform routine tasks face automation potential of up to 73 percent. At the other end, workers such as professionals, who spend most of their time interacting in non-routine ways, have an automation potential of 19 percent.
- **Less educated workers face a higher degree of automation.** Education length is correlated with the nature of tasks performed; workers with shorter educations typically spend more time on tasks susceptible to automation. The relationship, however, should not be interpreted as causal. Many of the skills shielded from automation, such as creativity and social intelligence, relate more to how people are educated than length of education.
- **Middle-income jobs are more exposed to automation than low- and high-income jobs.** People with annual wages between DKK275,000 and DKK350,000 are on average most exposed to automation.
- **There are significant differences in automation potential across sectors of the Danish economy.** Occupations in manufacturing and trade have the highest automation potential. Conversely, industries with a large component of service-related activities, including business services and the public sector, are less automatable.
- **Automation impacts the whole country.** Regional differences are driven by differences in sector composition.
- **Danish automation potential is lower than the global average of 49 percent.** McKinsey Global Institute research, focusing on 47 countries representing 95 percent of global GDP, finds the average level of automation potential corresponds to 49 percent of the working hours currently supplied by the global workforce. Denmark's 40 percent is mainly due to sector composition, e.g., a large public sector.

The impacts of automation will play out in the Danish workplace over the coming years, but the pace of change is uncertain and may vary based on factors including the political climate, investment capabilities and society's willingness to embrace technology. Still, on the basis of the labor substitution effects of automation, and assuming displaced labor re-enters the workforce at 2014 levels of productivity, automation will boost economic growth by 0.8 percentage points to 1.4 percentage points annually by 2065, McKinsey's Proprietary Growth Model shows. Further, products and services produced by automated processes usually become cheaper, suggesting there will be lower real prices for consumers and a positive real income effect.

As machines and software increasingly perform routine tasks, it is likely there will be a shift in labor toward hard-to-automate skills: those that require e.g., creativity, emotional and social capabilities and critical and systems thinking. For example, in the public sector, from the police to the education system, machine learning and advanced algorithms will automate a large amount of time spent on reporting and documentation, releasing capacity for core tasks. Likewise craftsmen such as carpenters may be spared physically demanding activities and care workers can spend more time on direct care as robots take over routine tasks such as cleaning.

While automation will bring substantial improvements in prosperity, the transition will also create challenges. Job creation has in the past kept pace with technological development, but a number of leading academics have questioned whether this time will be different. Either way, our research suggests that most jobs will change and some may become obsolete, leading to challenges around labor force transitions. Also, there is no guarantee that new jobs will appear in the same industries, sectors and geographies as those that disappear, and many workers may be hard-pressed to adapt.

Automation could furthermore strengthen the recent trend of consistent job growth for high-skilled workers and slower growth for low- and middle-skilled workers. Industries may be increasingly dominated by 'winner-takes-most' markets, and more new jobs could appear in the freelance economy. All of these imply that automation – if left unaddressed – could exacerbate the dynamics of inequality.

Meeting these challenges while ensuring that Denmark reaps the benefits of automation will require thoughtful and timely policy responses. Danish policy makers should prioritize three key objectives:

1. Promote a smooth workforce transition by increasing skill development and job mobility

- Many occupations face structural change or displacement, so facilitating the resulting labor transition will be essential. For those already employed, this will require increased opportunities for reskilling later in life, for example through short-stint programs created by the private sector and educational institutions.
- Preparing for the automation age requires reorientation of the education system toward future essential skills. This entails areas complementing automation, such as IT literacy and programming, but also hard-to-automate skills requiring creativity, emotion-based tasks and systems thinking. Improving these will require adjustments to curricula, education design and teaching methods.
- Finally, policy makers must tirelessly support those in transition, for example by strengthening and optimizing job-seeker programs; and secure the welfare of those struck by unemployment.

2. Enable automation across the economy and lead by example in the public sector

- Policy makers will play a vital role in paving the way for transformation in Denmark. They can help by prioritizing build-out of next-generation digital infrastructure and direct investment through government innovation and research programs.
- As technologies such as drones, autonomous vehicles and service delivery requiring personal data take hold, regulatory frameworks must be revisited. The technologies offer real gains for citizens, but bring complicated legal and ethical challenges.
- Policy makers have an opportunity to lead by example in the public sector, where automation can help professionals including teachers, nurses and care personnel deliver services with the help of robotics and intelligent software. They can also contribute to improving public service delivery through digitization of public-to-citizen touch points.

3. Ensure gains from automation are broadly distributed

- Policy makers must ensure and demonstrate that automation benefits all citizens, particularly in light of recent backlashes against technology and globalization across the developed world.

- Distributing the benefits of automation is likely to require a gradual change in taxation policy to mirror shifts in value creation. This may include international cooperation on taxation of multinationals, sustainable frameworks for taxing independent work and tax incentives that do not hinder job creation.
- Relative skill equality rather than economic redistribution are the foundations of income equality across Danish society. Strengthening equality will thus also require improved educational systems, including early childhood education, particularly for at-risk groups.

In summary, automation presents an opportunity over the coming decades to improve Danish living standards, create new jobs and grow the economy. However, there is a danger that as innovation accelerates some will be left behind. It is incumbent on the government, employers and employees to engage with the challenges ahead to ensure a future that works.

A DANISH PERSPECTIVE ON THE GLOBAL OUTLOOK OF AUTOMATION

This report complements the recently published McKinsey Global Institute report *"Harnessing automation for a future that works"*, and provides McKinsey's perspective on the potential for automation in Denmark. The report is structured as follows. In Section 1, we provide a brief introduction to the emerging automation technologies. In Section 2, we introduce the novel methodology for assessing the potential of automation developed by the McKinsey Global Institute, and the results on automation potential in the Danish workforce. In Section 3, we briefly review the five factors that will determine the pace and extent of automation, as well as its impact in Denmark. Last, in Section 4, we highlight how policy makers, business leaders and workers can start preparing for the transformation, and ensure that Denmark will harness the full potential of automation.

For readers interested in a more in-depth perspective on methodology, projections and models, we refer to the global report *"Harnessing automation for a future that works"* by McKinsey Global Institute.

The McKinsey Global Institute report unfolds the potential of automation in greater detail and in a global perspective, including a thorough description of the methodology behind the assessment, an analysis on the pace of technology adaption, and of the automation potential for 47 countries. Moreover, it provides a number of case studies to illustrate the impact of automation and presents a global perspective on the implications of automation and resulting recommendations.

This report has been jointly authored by McKinsey & Company and The Tuborg Research Centre for Globalization and Firms at Aarhus University. We welcome any feedback and comments.

Jens Riis Andersen
Associate Partner | McKinsey & Company

Bjarne Corydon
Director | McKinsey Center for Government

Jacob Staun
Partner | McKinsey & Company

Jacques Bughin
Senior Partner | McKinsey Global Institute

Johannes Lüneborg
Partner | McKinsey & Company

Philipp Schröder
Professor and Centre Director | Aarhus University

CONTRIBUTORS

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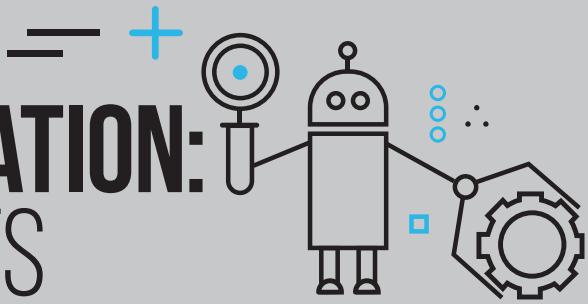
DANISH AUTOMATION: SOME KEY POINTS



40%
OF TOTAL WORKING HOURS
in the Danish labor force could be automated with existing technology. This corresponds to 1 million full time equivalent jobs.

GLOBALLY, HALF OF TODAY'S WORK ACTIVITIES COULD BE AUTOMATED BY
2055

ONLY
5%
OF JOBS HAVE MORE THAN
80%
AUTOMATABLE ACTIVITIES.

Jobs within Industry have
63%
AUTOMATABLE ACTIVITIES, while only
27%
of job activities within the public sector are automatable.

Workers with primary school as their highest education are active in occupations that face a
52%
AUTOMATION POTENTIAL – SIGNIFICANTLY MORE THAN THE
24%
for the occupations that workers with long higher education tend to work in.

Half of all Danish workers are in occupations where more than
30%
OF WORKING HOURS ARE AUTOMATABLE ACTIVITIES.

Automation could increase economic growth by up to
1.4 PP
(PERCENTAGE POINTS) ANNUALLY.

The technical automation potential differs from
35% TO 49%
OF WORKING HOURS ACROSS MUNICIPALITIES.

1. THE NEW FRONTIER

New technologies, software and machines are increasingly performing tasks previously restricted to humans, and are often leaving human capabilities trailing in their wake. In recent years, they have also expanded their influence, migrating from the factory floor to the service sector and taking the place of humans in a range of activities from financial transactions to transport route optimization.[1,2] Further, machines and robots are increasingly programmed to learn, meaning they improve with time and undertake cognitive activities.[3] *Exhibit 3* lists some technologies being developed to enable automation of work activities.

The ability of technology to disrupt is nothing new; it has been a constant factor in the Danish economy for more than two hundred years. However, it is now becoming pervasive across the work environment in fields from journalism to medicine to law. Its influence is overwhelmingly positive, and in some cases life affirming, for example in 2016 where IBM's Watson made headlines by diagnosing a rare form of leukemia that had eluded doctors.[4]

Automation comes in multiple forms, from robotics to artificial intelligence and neural networks. The power of artificial intelligence was highlighted in 2016 when a computer overcame the 18-time world champion, Lee Sedol, in the complex board game Go.[5] In another example, Google's DeepMind and the University of Oxford used neural networks inspired by animal visual capabilities to create a lip-reading system that outperformed a professional human by a factor of almost four to one.[6] Elsewhere, developers created robot "skin", made of a piezo-electronic transistor mesh, which was as sensitive as human skin and could "feel" textures and find objects by touch, while technologists in the UK developed a humanoid robot called KASPAR, a therapeutic toy for children with autism.[7,8]

These type of advances suggest that the relatively recent science fiction that saw robots replicating advanced human skills is closer to becoming a reality.

1 Swisslog offers a medication management system, www.swisslog.com/en/products. For a transport and logistics example, see www.aethon.com/tug/tughealthcare.

2 Baxter robots by Rethink Robotics can now pick up items that are not precisely aligned, and then reorient and place them correctly. http://www.rethinkrobotics.com/baxter/what-makes-our-robots-different.

3 Tamersov Acar et al., Large-scale Insider-trading analysis: Patterns and discoveries, Georgia Institute of Technology, August 2014.

4 Bernie Monegain, "IBM Watson pinpoints rare form of leukemia after doctors misdiagnosed patient," Healthcare IT News, August 8, 2016.

5 Choe Sang-Hun, "Google's computer program beats Lee Se-dol in Go tournament," New York Times, March 15, 2016.

6 Hal Hodson, "Google's DeepMind AI can lip-read TV shows better than a pro," New Scientist, November 21, 2016.

7 Klint Finley, "Syntouch is giving robots the ability to feel textures like humans do," Wired, December 17, 2015.

8 Ricky Boleto, "Could robots help children with autism?" BBC News, March 10, 2014. See also the University of Hertfordshire web page for KASPAR, http://www.herts.ac.uk/kaspar/supporting-children-with-autism.

MACHINES AND ROBOTS ARE INCREASINGLY PROGRAMMED TO LEARN, MEANING THEY IMPROVE WITH TIME AND UNDERTAKE COGNITIVE ACTIVITIES.

Courtesy of Museum of Copenhagen ©

THE DANISH LABOR MARKET: A HISTORY OF CHANGE

ECHOES OF TRANSFORMATION – HAVE WE SEEN IT ALL BEFORE?

Periods of transformative change driven by technology are nothing new, and a stroll through history reveals echoes of current dynamics. Between 1872 and 1914 the number of Danish industrial companies tripled to 4,500, while workers employed in manufacturing almost quadrupled to 134,000. The population of Copenhagen during the period rose from 198,000 to 614,000 as families moved from the countryside to the city in search of jobs.

The Danish labor market has also gone through significant change in more recent times *(Exhibit 1)*. The public sector doubled its share of the total working hours between 1970 and 2015, while the primary sector (e.g., agriculture and fishing) saw 77 percent fewer working hours.[9] Meanwhile, half of jobs in the industrial sector have disappeared or have been redesignated as business services.[10]

Many of today's large job categories did not exist 30 years ago, suggesting that as technology evolves and prosperity increases, new occupations tend to appear. However, while today's labor market dynamics are different from previous eras, one observation across time is that there is transitional unemployment as new industries take the place of the old.

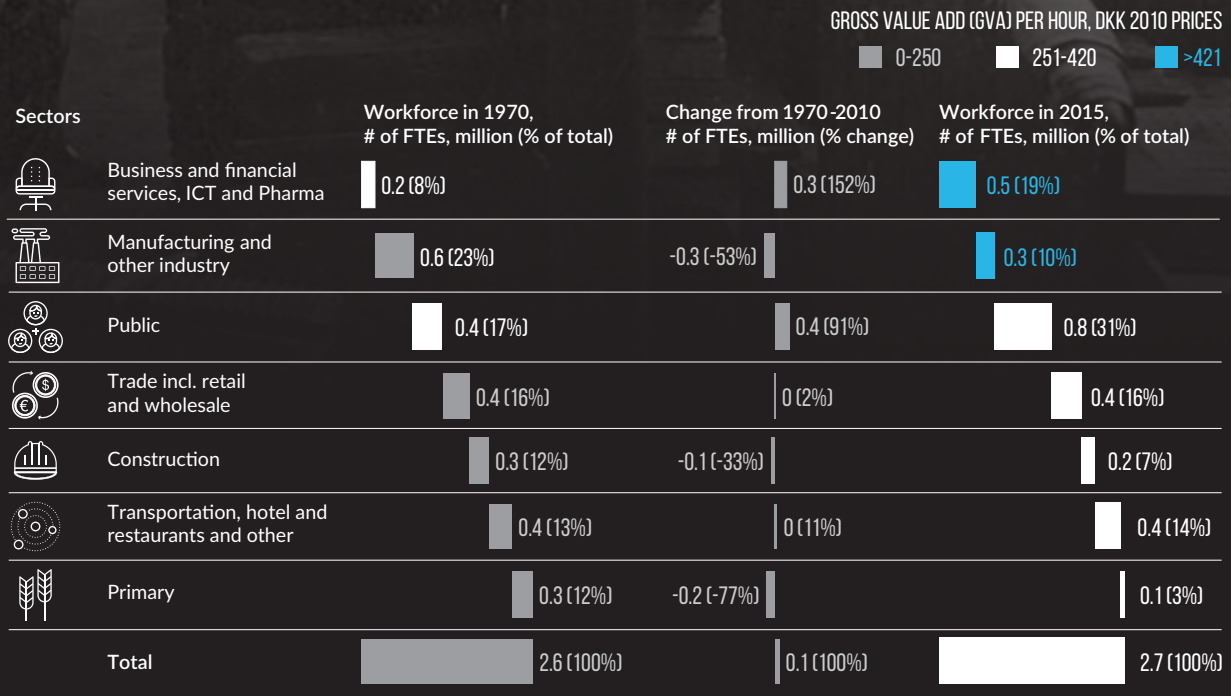
MANY OF TODAY'S LARGE JOB CATEGORIES DID NOT EXIST 30 YEARS AGO, SUGGESTNG THAT AS TECHNOLOGY EVOLVES AND PROSPERITY INCREASES, NEW OCCUPATONS TEND TO APPEAR.

9 Defined as full-time equivalent, or the hours worked by one employee on a full-time basis. Note, that the reduction in agricultural labor coincides with impressive productivity advances in the sector.

10 The mechanics of deindustrialization in Denmark, and the re-emergence of jobs in other sectors have been studied recently in Andrew B. Bernard Valerie Smeets Frederic Warzynski (2017), Rethinking deindustrialization, in: Economic Policy, Vol. 32 (89): pp. 5-38.

EXHIBIT 1

THE DANISH WORKFORCE HAS TRANSFORMED IN RECENT YEARS



SOURCE: Statistics Denmark; McKinsey Analysis

WILL THIS TIME BE DIFFERENT?

Job automation has evolved over a long period, and for the most part as some jobs have disappeared others have taken their place. The labor market has until now always adapted, with price effects tending to balance forces of automation and creating new tasks that reward human labor. One recent example is in the financial sector, where 11,000 bank teller jobs disappeared between 1994 and 2014 *(Exhibit 2)*. However, the decrease coincided with the creation of 9,000 new bank advisor jobs – often through a transition by the same employees. Can the same be expected moving forward, or has the speed of automation reached a point where it can outpace job creation?

Some argue this automation era differs from those of the past. MIT Sloan School of Management faculty members Eric Brynjolfsson and Andrew McAfee describe an inflection point between the first machine age, comprising automation of physical tasks, and a second machine age in which cognitive tasks are substituted by digital technologies.[11] This relates to the work of Economists Daron Acemoglu and David Autor, who differentiate between routine and non-routine work, and point out that the current generation of technology is the first to automate non-routine tasks, for example diagnosing diseases or autonomously navigating cars through busy streets.[12] The implication is that while automation mainly affected blue-collar jobs in the past, this generation of technology will also replace activities in white-collar occupations.

There is no crystal ball to definitively say if this time will be different, or if the Danish economy and labor market will adapt as it has in the past. Regardless, policy makers and corporate leaders must be prepared to mitigate transitional instability and unemployment along the way.

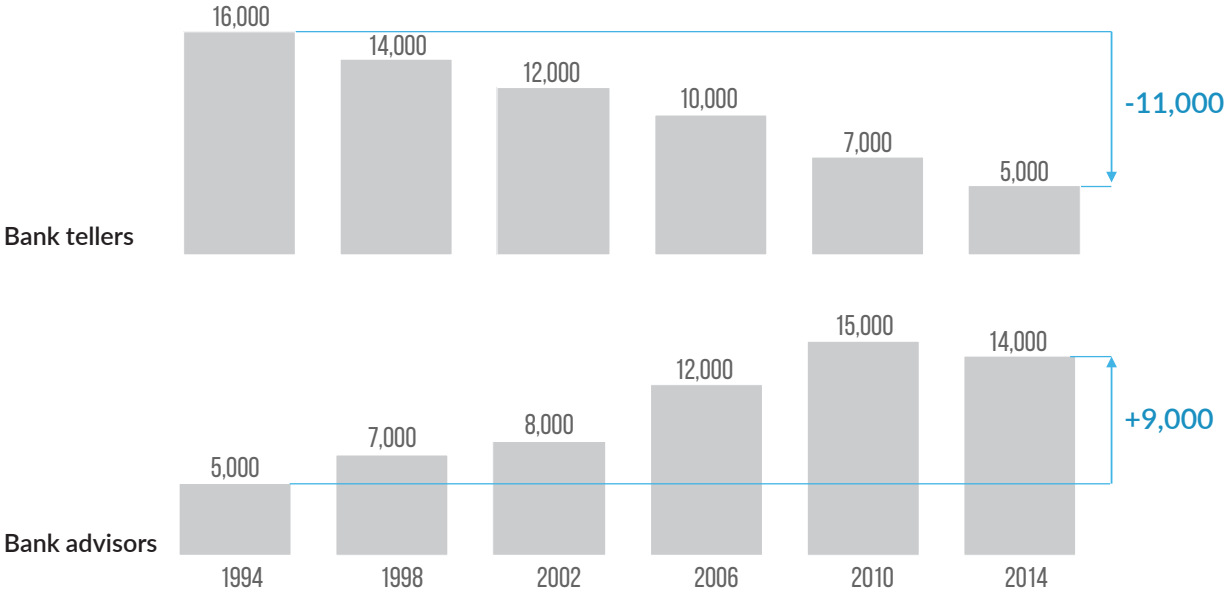
11 Erik Brynjolfsson and Andrew McAfee, The second machine age: Work, progress, and prosperity in a time of brilliant technologies, W. W. Norton & Company, 2014

12 Daron Acemoglu and David H. Autor, "Skills, tasks, and technologies: Implications for employment and earnings," in Handbook of Labor Economics, volume 4B, David Card and Orley Ashenfelter, eds., Elsevier, 2011; Darron Aceemoglu and Restrepo, "Robots and Jobs - Evidence from US labour market", NBER Working paper 2017; Jeffrey Sachs, Seth Benzell and Guillermo LaGarda, "Robots: Curse or blessing? A basic framework", NBER Working paper 2015

EXHIBIT 2

DECREASE IN NUMBER OF BANK TELLERS OVER LAST 20 YEARS COINCIDES WITH AN INCREASE IN BANK ADVISORS

Number of employees, 1994-2014 (Denmark)



SOURCE: Finanssektorens Arbejdsgiverforening; McKinsey analysis

EXHIBIT 3

GLOSSARY OF AUTOMATION TECHNOLOGIES AND TECHNIQUES*

TECHNOLOGIES AND TECHNIQUES	EXAMPLES	DESCRIPTION
Artificial intelligence: *Field of computer science specializing in developing systems that exhibit "intelligence". Often abbreviated as AI, the term was coined by John McCarthy at the Dartmouth Conference in 1956, the first conference devoted to this topic*	**Machine learning**	*Subfield of artificial intelligence developing systems that "learn" i.e., practitioners "train" these systems rather than programming them*
	Supervised learning	*Machine learning techniques that train a system to respond appropriately to stimuli by providing a set of sample input and desired output pairs. Supervised learning has been used for email spam detection*
	Transfer learning	*Subfield of machine learning developing systems that store knowledge gained while solving one problem and applying it to a different but related problem, e.g., repurposing a system trained on a large non. medical image data set to recognize tumors in radiology scans*
	Reinforcement learning	*Subfield of machine learning developing systems that are trained by receiving virtual "rewards" or "punishment" for behaviors rather than supervised leaning on correct input-output pairs. In February 2015, DeepMind described a reinforcement learning system that learned how to play a variety of Atari computer games. In Mach 2016, DeepMind's AiphaGo system defeated the world champion in the game of Go*
	Cognitive computing	*Synonym for artificial intelligence*
Neural networks	**Artificial neural network**	*AI systems based on simulating connected "neural units", loosely modeling on the way that neurons interact in the brain. Computational models inspired by neural connections have been studied since the 1940s*
	Deep learning	*Use of neural networks that have many layers "deep" or a large number (millions) of artificial neurons. The term was first used in 2000*
	Convolutional neural network	*Artificial neural networks in which the connections between neural layers are inspired by the organization of the animal visual colas, the portion of the brain that processes images; well suited for perceptual tasks*
	Recurrent neural network	*Artificial neural networks whose connection between neurons include loops, well-suited for processing sequences of inputs*

SOURCE: John McCarthy et al, "A proposal for the Dartmouth summer research project on artificial intelligence, August 31, 1995", AI Magazine, volume 27, number 4, 2016; Hayit Greenspan, Bram van Ginneken, and Ronald M. Summers, "Deep learning in Medical imaging: Overview and future promise of an exciting new techniques." IEEE Transactions on Medical Imaging, volume 35, number 5, May 2016; Volodymyr Mnih, "Human-level control through deep reinforcement learning", Nature, February 25, 2015; Igor Aizenberg, Naum N. Aizenberg, and Joos P.L.Vandewalle, Multi-valued and Universal binary neurons; Theory, learning and applications, Springer Science and Business Media, 2000; www.image-net.org; Yannis M. Assael et al, LipNet: End to End sentence level lipreading." University of Oxford (forthcoming); McKinsey Global Institute analysis

TECHNOLOGIES AND TECHNIQUES	EXAMPLES	DESCRIPTION
Robotics	**Soft robotics**	*Non-rigid robots constructed with soft and deformable materials that can manipulate items of varying size, shape and weight with a single device*
	Swarm robotics	*Coordinated multi-robot systems, often involving large numbers of mostly physical robots*
	Tactile/touch robotics	*Robotic body pails (often biologically inspired hands) with capability to sense, touch, exhibit dexterity and perform variety of tasks*
	Serpentine robots	*Serpentine robots with many internal degrees of freedom to thread through tightly packed spaces*
	Humanoid robots	*Robots physical similar to human beings (often bi-pedal) that investigate variety of AI and robotics technologies and are capable of performing human tasks (including movement across terrains, object recognition, speech, emotion sensing, etc.)*
Automation product categories	**Autonomous cars and trucks**	*Wheeled vehicles capable of operating without a human driver. In July 2016, Tesla reported that its cars had driven over 130 million miles while on "Autopilot". In December 2016. Rio Tinto had a fleet of 73 driverless trucks hauling iron ore 24 hours/day in mines in Western Australia*
	Unmanned aerial vehicles	*Flying vehicles capable of operating without a human pilot. The unarmed General Atomics Predator XP UAV, with roughly half the wingspan of a Boeing 737, can fly autonomously for up to 35 hours from take-off to landing*
	Chatbots	*AI systems designed to simulate conversation with human users, particularly those integrated into messaging apps. In December 2015, the General Services Administration of the US Government described how it used a chatbot named Mrs. Landingham (a character from the television show The West Wing) to help onboard new employees*
	Robotic process automation	*Class of software "robots" that replicates the actions of a human being interacting with the user interfaces of other software systems. Enables the automation of many "back-office" workflows without requiring expensive IT integration*

SOURCE: www.aid.softbankrobotics.com; A tragic loss, Testla blog, Junes 30,2016; Resource revolution: Transformation beyond the supercycle, McKinsey Global Institute, forthcoming in 2017; www.ga-asi.com/predator-xp; Jessica Young, How a bot named Dolores Landingham transformed 18Fs onboarding, www.18f.gsa.gov, December 15, 2015; McKinsey Global Institute analysis

* THIS LIST IS NOT COMPREHENSIVE BUT ILLUSTRATES SOME TECHNOLOGIES AND TECHNIQUES ENABLING AUTOMATION OF WORK ACTIVITIES

2. THE POTENTIAL FOR AUTOMATION IN DENMARK

Our core finding is that 40 percent of Danish work hours, equivalent to the labor input of 1 million workers, are automatable based on currently demonstrated technologies *(Exhibit 4)*. However, that does not imply that 40 percent of jobs are at risk, as the majority are only partially automatable.

The figures are staggering, and the impact of automation will be felt across industries, job roles and activities, from factory workers to the CEOs.

McKinsey's estimates are in line with those presented by policy institutes, academics and organizations such as the World Economic Forum and the OECD. Danish think tanks Kraka and CEVEA and the labor union HK have found that 34 percent to 38 percent of Danish jobs are at high risk (>70 percent possibility) of being substituted by automation. However, many of these projections focus on *occupations* perceived to be at risk. Also, in only analyzing occupations with high automation probability, some parts of the job market are disregarded.[13] McKinsey's approach, by contrast, focuses on work activities, which allows for a more granular understanding of automation potential.

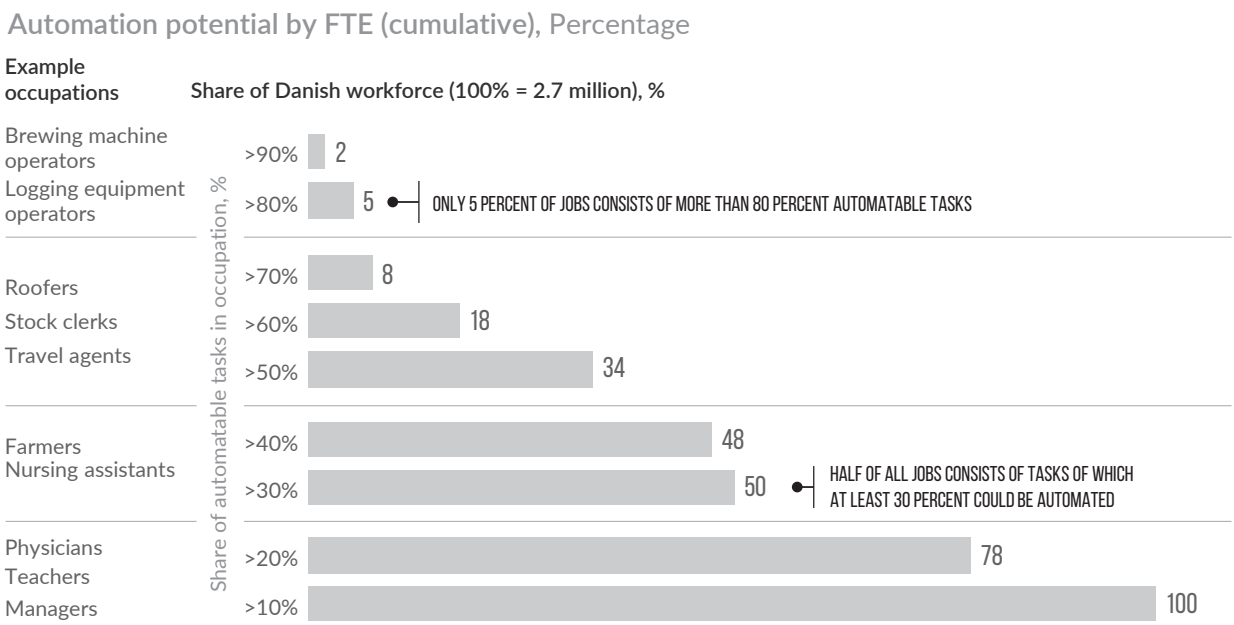
Our work complements the more recent economics literature, which has advanced from the routine versus non-routine research to e.g., leverage data from the US Bureau of Labor Statistics and O*Net to look at many other dimensions of tasks related to occupations. Further, a number of papers have recently investigated Danish data in the context of the outsourcing of jobs and the associated labour market responses, such as wage developments.[14]

13 Several of these use the methodology developed by Carl Benedikt Frey and Michael A. Osborne, The future of employment: How susceptible are jobs to computerization? Oxford Martin School, September 17, 2013. These all focus on occupations that it categorizes as being susceptible to automation.

14 See e.g., Sharon Traiberman: Occupations and Import Competition: Evidence from Denmark (Working paper, 2016); David Hummels, Rasmus Jørgensen, Jakob Munch, and Chong Xiang: The Wage Effects of Offshoring - Evidence from Danish Matched Worker-Firm Data (American Economic Review, 2014)

EXHIBIT 4

FEW JOBS ARE COMPLETELY AUTOMATABLE, BUT CLOSE TO HALF CONSISTS OF 40% AUTOMATABLE TASKS



SOURCE: Statistics Denmark; Global Automation Impact Model; McKinsey analysis

2.1 Estimating the technical potential for automation

Humans perform a wide variety of tasks, from planting corn to examining spreadsheets, meeting clients and lifting crates in a store. Each of these actions requires a combination of innate or acquired capabilities, ranging from social perceptiveness to fine motor skills and natural language understanding.

To understand and map automation feasibility by existing technology, McKinsey has developed a framework of 18 technical capabilities that can substitute tasks performed by humans. The capabilities are grouped in five categories: sensory, cognitive, language, social and emotional and physical *(Exhibit 5)*.

This capability-based perspective is the foundation for assessing automation potential. McKinsey analysed ~400 occupations, which are broken down into more than 2000 tasks, taking into account the distribution of time spent on each task. Each task is broken down into a mix of the 18 technical capabilities required to complete the task, and the automation potential for each of the 18 generic technical capabilities was assessed based on the current state-of-the-art in emerging technologies.

Our results show a wide range of automation potential. Some tasks are fully automatable, while others, particularly around social and emotional sensing, are less so.[15, 16]

Many sit somewhere in between; for example, natural language processing has some automation potential today.

This means that some share of each activity is automatable – and that each occupation has a fraction of hours current technology can automate. In *Exhibit 6* we outline the concept of the analytical framework. As it is shown, a number of tasks are required to fulfill the occupation of a retail sales person, including greeting customers, answering questions and maintaining work areas. Each task relies on a number of technical capabilities and each technical capability has a probability of becoming automated.

McKinsey has applied the methodology to the Danish workforce of around 2.7 million employees, based on data from Statistics Denmark. The granularity of the analysis allows for aggregating automation potential across a range of dimensions, including sectors, occupations and level of educational attainment.

15 See exhibit 5, or for more details, Chapter 2 in the report from McKinsey Global Institute.

16 It should be noted that great technological progress has also been in this area with computers becoming increasingly skillful at creating art and music.

EXHIBIT 5

CURRENT TECHNOLOGIES HAVE ACHIEVED DIFFERENT LEVELS OF HUMAN PERFORMANCE ACROSS 18 CAPABILITIES

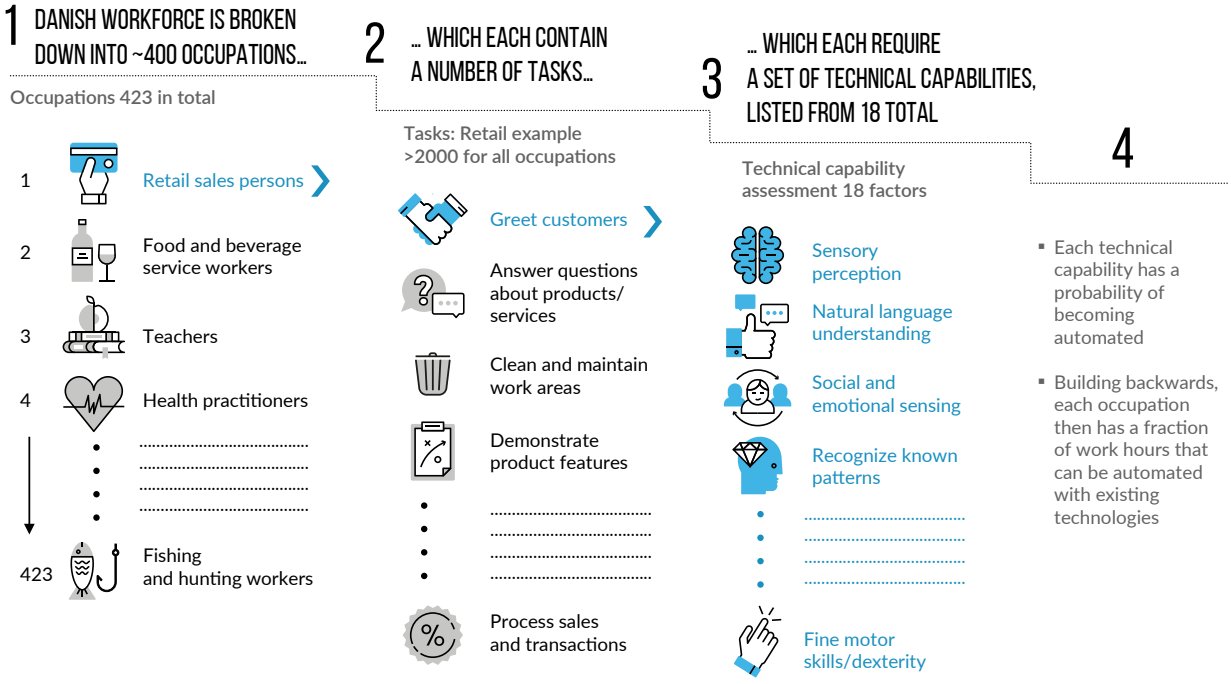
BELOW MEDIAN | MEDIAN | TOP QUARTILE

AUTOMATION CAPABILITY		CAPABILITY LEVEL[1]	DESCRIPTION (ABILITY TO…)
Sensory perception	Sensory perception		Autonomously infer and integrate complex inputs using sensors
Cognitive capabilities	Recognizing known patterns/ categories (supervised learning)		Recognize single/complex known patterns and categories other than sensory perception
	Generating novel patterns/categories		Create and recognize new patterns/categories (e.g., hypothesized categories)
	Logical reasoning/problem solving		Solve problems in an organized way using contextual information and increasingly complex input variables other than optimization and planning
	Optimization and planning		Optimize and plan for objective outcomes across various constraints
	Creativity		Create diverse and novel ideas, or novel combinations of ideas
	Information retrieval		Search and retrieve information from a large range of sources (breadth, depth and degree of integration)
	Coordination with multiple agents		Interact with others, including humans, to coordinate group activity
	Output articulation/presentation		Deliver outputs/visualizations across a variety of mediums other than natural language
National language processing	Natural language generation		Deliver messages in natural language, including nuanced human interaction and some quasi language (e.g., gestures)
Social and emotional capabilities	Natural language understanding		Comprehend language, including nuanced human interaction
	Social and emotional sensing		Identify social and emotional state
	Social and emotional reasoning		Accurately, draw conclusions about social and emotional state, and determine appropriate response/action
	Social and emotional output		Produce emotional, appropriate output (e.g., speech, body language)
Physical capabilities	Fine motor skills/dexterity		Manipulate objects with dexterity and sensitivity
	Gross motor skills		Move objects with multi-dimensional motor skills
	Navigation		Autonomously navigate in various environments
	Mobility		Move within and across various environments and terrain

1 Assumes technical capabilities demonstrated in commercial products, R&D, and academic settings; compared against human performance
SOURCE: McKinsey Global Institute analysis

EXHIBIT 6

MCKINSEY'S ANALYTICAL FRAMEWORK ASSESSES THE POTENTIAL FOR AUTOMATION AT TASK AND TECHNICAL CAPABILITY LEVELS



SOURCE: Statistics Denmark; McKinsey Analysis

2.2 Seven highlights revealed by the framework

The research conducted for this report leads to seven key conclusions:

- Some 40 percent of working hours currently supplied/delivered by the Danish workforce are automatable.
- Middle-income jobs are more exposed to automation than low- and high-income jobs.
- Occupations with a higher share of predictable job tasks are more prone to automation.
- Less educated workers face a higher degree of automation.
- There are significant differences in automation potential across sectors.
- Automation impacts the whole country.
- Danish automation potential is close to, but slightly lower than, the global average

SOME 40 PERCENT OF WORKING HOURS IN DENMARK ARE AUTOMATABLE

Around 40 percent of the Danish workforce's current working hours are automatable with existing technologies, after aggregating automation potential across occupations *(Exhibit 7)*.

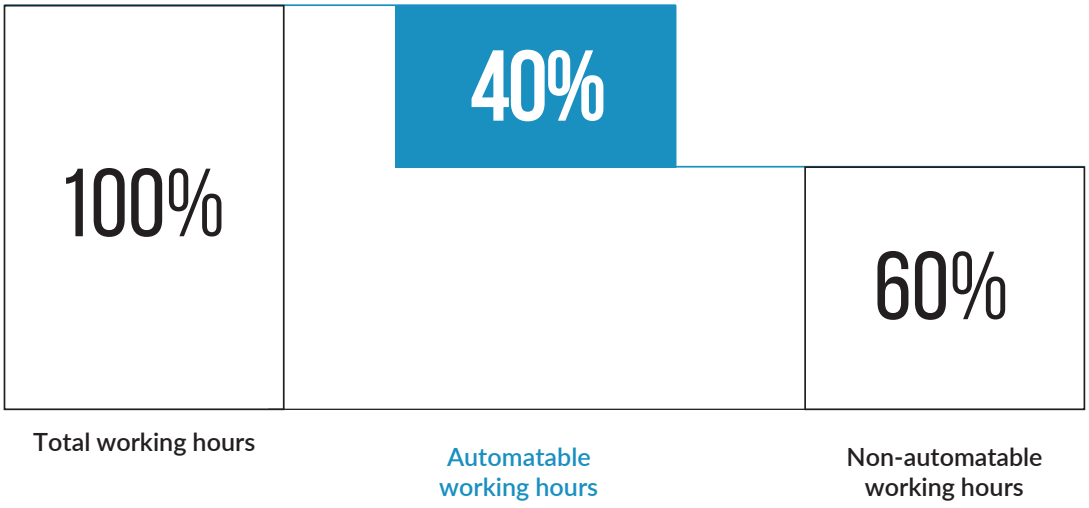
While only a small share of workers are in occupations that can be completely automated (less than 2 percent), half of Danish workers are in occupations where more than 30 percent of the activities could be automated. While some jobs will become obsolete, most workers will find that automation has the effect of allowing them to shift to activities that are more difficult to automate, e.g., the nurse or the doctor can spend more time with the patient instead of documentation and administration.

Technical feasibility is a necessary condition of automation, but not a guarantee that an activity will be automated. Cost and supply of labour, and the price of implementing automation, are also pivotal factors. Other elements are the benefits of automation beyond labor substitution, including output-levels, quality and error-rates. Regulatory and social acceptance must also be weighed. A robot may, in theory, be able to replace some functions of a nurse, but is it desirable? The potential for automation to take hold in a sector or occupation is based on a subtle interplay between these factors.

EXHIBIT 7

TECHNICALLY AUTOMATABLE TASKS REPRESENT ~40% OF CURRENT WORKING HOURS IN DENMARK

Working hours by technical automation potential for Denmark[1], 2016



1 We define automation potential by the work activities that can be automated by adapting currently demonstrated technology
SOURCE: Statistics Denmark; McKinsey analysis

Even where machines replace some human activities, it does not mean the end of jobs in that line of work. In fact sometimes the opposite, because the overall demand for the remaining performed activities may continue to grow as the balance of supply and demand shifts.

MIDDLE-INCOME JOBS ARE MORE EXPOSED TO AUTOMATION THAN LOW- AND HIGH-INCOME JOBS

Wage level is not an absolute predictor of automation potential, but there is a tendency for occupations in the lower middle of the income spectrum to have the highest share of automatable activities, while jobs with lower and higher wage levels are less exposed *(Exhibit 8)*.

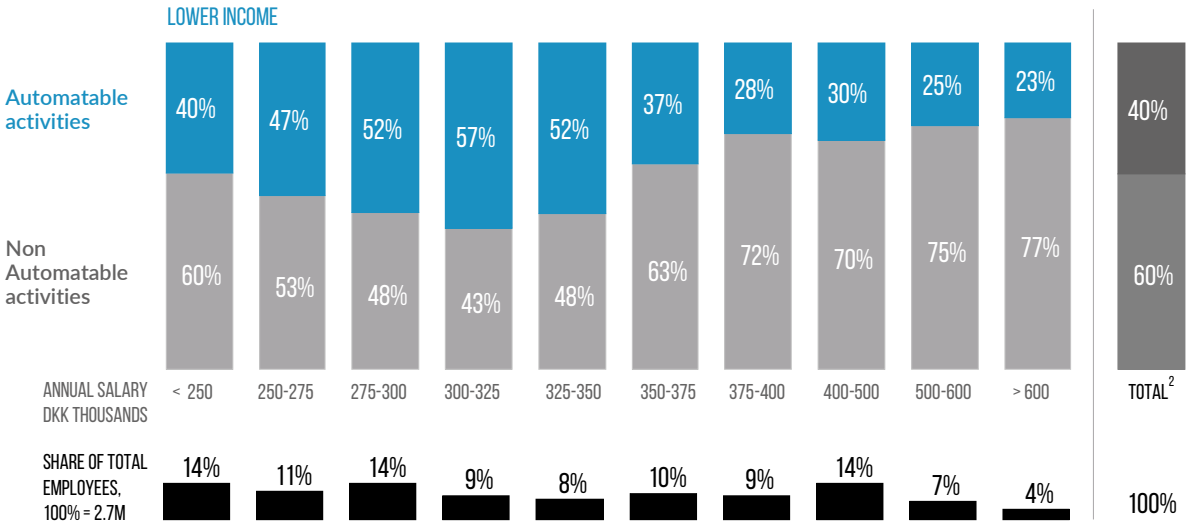
In the Danish context, people with annual wages between DKK300,000 and DKK325,000 are most exposed to automation, with 57 percent of working hours/activities considered automatable. Conversely, 40 percent of working hours in jobs paying less than DKK250,000 per year are automatable. In the top income brackets, automation potential is significantly lower. Only 23 percent of activities associated with jobs that earn more than DKK600,000 per year have automation potential.

WAGE LEVEL IS NOT AN ABSOLUTE PREDICTOR OF AUTOMATON POTENTAL, BUT THERE IS A TENDENCY FOR OCCUPATONS IN THE LOWER MIDDLE OF THE INCOME SPECTRUM TO HAVE THE HIGHEST SHARE OF AUTOMATABLE ACTVITES, WHILE JOBS WITH LOWER AND HIGHER WAGE LEVELS ARE LESS EXPOSED.

EXHIBIT 8

ANNUAL SALARY LEVEL ALONE IS NOT A STRONG PREDICTOR OF AUTOMATION POTENTIAL

Technical automation potential of work activities by annual salary, Percent[1]



1 We define automation potential by the work activities that can be automated by adapting currently demonstrated technology
2 Calculated as sumproduct of automatable potential and share of employees
SOURCE: Statistics Denmark; McKinsey analysis

The trend that is sometimes referred to as the "squeezed middle" has in fact been in place for a number of years. From 1993-2010, employment in the lowest paying occupations increased by 3 percent, while there was a 9 percent rise in employment in the highest paying occupations. However, employment in middle-paying occupations fell 12 percent over the same period.[17] An additional effect of a reduced supply of jobs at the intermediate level has been increased competition in the lower segments, resulting in a slowdown in wage growth in the medium- and low-wage occupations.

The reason middle-income jobs are more susceptible to automation is the nature of core tasks required at different levels, which can be divided into three groups:

- **Routine tasks** - characterized by being fully understood and easily broken down into a series of instructions that can be followed by a machine or software program. These are highly susceptible to automation.
- **Non-routine manual tasks** - requiring a high degree of situational adaptability, which makes them difficult to program into an algorithm, for example the laying of domestic electrical wiring by an electrician.
- **Non-routine cognitive tasks** - characterized by abstract thinking and inter-personal relations. Examples include research, design and teaching. This group is the hardest to automate.

In general, lower middle-income occupations tend to consist of routine tasks that are easier to automate, while non-routine manual and cognitive tasks are less so. The uneven impact of automation could—if left unaddressed—have profound impacts on equality in Denmark.

OCCUPATIONS WITH A HIGHER SHARE OF PREDICTABLE JOB TASKS ARE MORE PRONE TO AUTOMATION

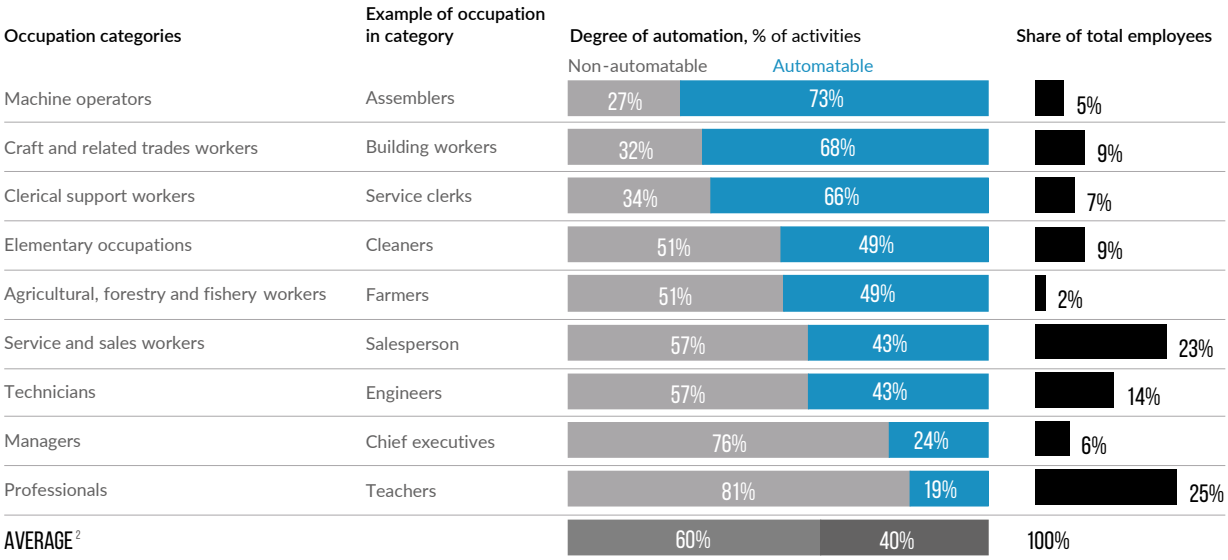
There is a strong correlation between occupation types and automation potential. Workers such as machine operators who perform fairly routine tasks face automation potential of up to 73 percent of the job tasks in this given occupation, while professionals such as teachers spend up to 19 percent of their time on tasks that can be automated *(Exhibit 9)*. A key question for policy makers and stakeholders is how the workforce can be educated to focus on skills that require valuable human input.

17 Goos, Maarten, Alan Manning, and Anna Salomon, *"Explaining Job Polarization: Routine-Biased Technological Change and Offshoring."* in the American Economic Review 2014

EXHIBIT 9

OCCUPATIONS WITH HIGH PREDICTABILITY HAVE THE LARGEST PROPORTION OF ACTIVITIES WITH AUTOMATION POTENTIAL

Technical automation potential of work activities, Percent[1]



1 We define automation potential by the work activities that can be automated by adapting currently demonstrated technology
2 Calculated as sumproduct of automatable potential and share of employees
SOURCE: Statistics Denmark; McKinsey analysis

It should be noted that many other factors determine which jobs will be affected, for example agile ways of working, which are being employed in the financial sector to reduce the number of managers required.

LESS EDUCATED WORKERS FACE A HIGHER DEGREE OF AUTOMATION

There is a correlation between time spent in education and job susceptibility to automation, because workers with shorter educations tend to spend more time on routine tasks. Workers whose highest education level is primary school work in occupations where an average of 52 percent of tasks could be automated. At the opposite end of the spectrum, occupations where workers have completed a PhD face only 18 percent automation potential. The result is comparable for jobs in the second-highest educational bracket (e.g., Master's degree), where 24 percent of activities may be automated.

Still, many skills taught to students in higher educational programs are also prone to automation, e.g., the collection and processing of data. Hence, in adapting our educational system it is not only about the length of education, but also skills taught.

Again, social and emotional capabilities and creativity stand out as most resistant to machine-based competition.[18]

MANY SKILLS TAUGHT TO STUDENTS IN HIGHER EDUCATIONAL PROGRAMS ARE ALSO PRONE TO AUTOMATION, E.G., THE COLLECTION AND PROCESSING OF DATA.

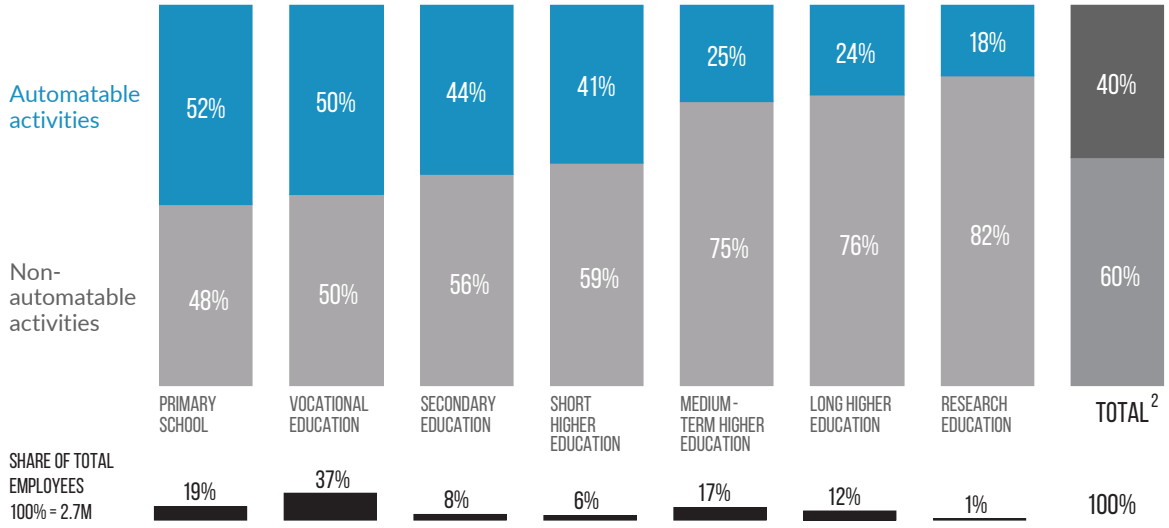
We cannot infer a causal link between length of education and automation potential. Rather, the results show that individuals with longer educations on average perform fewer automatable activities. We therefore cannot conclude that raising length of education alone will reduce susceptibility to automation.

18 Goos, Maarten, Alan Manning, and Anna Salomon, *"Explaining Job Polarization: Routine-Biased Technological Change and Offshoring."* in the American Economic Review 2014

EXHIBIT 10

OCCUPATIONS REQUIRING HIGHER LEVELS OF EDUCATION HAVE A LOWER PROPORTION OF ACTIVITIES THAT CAN BE AUTOMATED

Technical automation potential of work activities by educational background, Percent[1]



1 We define automation potential by the work activities that can be automated by adapting currently demonstrated technology
2 Calculated as sumproduct of automatable potential and share of employees
SOURCE: Statistics Denmark; McKinsey analysis

THERE ARE SIGNIFICANT DIFFERENCES IN AUTOMATION POTENTIAL ACROSS INDUSTRIES

There are significant differences in automation potential across Danish industries and sectors, driven by variations in job composition and activities in each industry.

Generally, jobs in manufacturing and trade have the highest automation potential, explained by their high degree of routine manual activity. Trade, encompassing retail and wholesale, is the largest private sector segment in the analysis. In retail, a significant share of customer-facing and warehousing operations are automatable. One very visible example is self-service checkouts. In wholesale, routine cognitive tasks such as planning delivery schedules can be automated.

At the other end of the spectrum, industries with a large component of direct customer related activities are generally less automatable; healthcare and education are standout examples.

While level of routine is a good sign of susceptibility to automation, there is no hard and fast rule. For example, transportation is both highly automatable and has a large non-routine component. The growing use of autonomous vehicles is expected to bring significant changes to that industry over the coming decades.

Where sectors are highly automatable, the ability to exploit that potential will be key to competitiveness in the coming years, and will be crucial to sustaining jobs in the longer term. Potential success will depend on underlying sector structure and the legal framework around it.

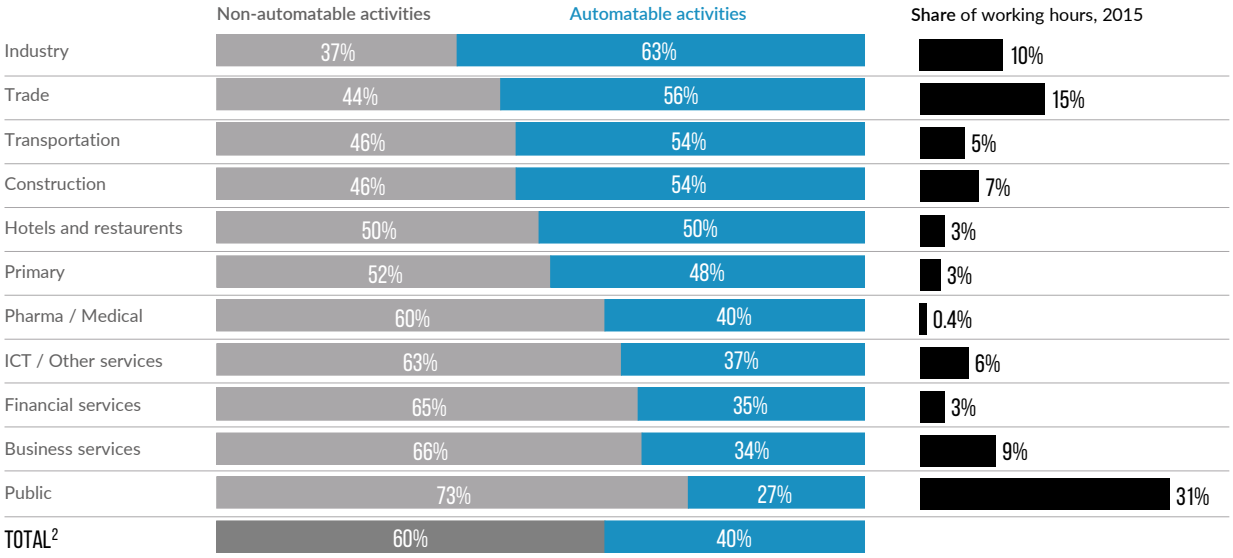
An important driver of the pace of automation is competitive environment and degree of internationalization. Sectors with higher competitive intensity and deeper integration into global value chains will face greater pressure to realize the benefits from automation to adapt their cost base in response to price pressure. This also emphasizes the need for Danish companies to seek out opportunities in the global marketplace to achieve a return on investment in technology. Previous work by McKinsey & Company and researchers from Aarhus University has shown that there is a strong correlation in Danish business between size, degree of internationalization, growth and profitability.[19]

19 McKinsey & Company: Winning in the Next Decade (2016)

EXHIBIT 11

LARGE VARIATION IN TECHNICAL AUTOMATION POTENTIAL BY SECTOR IN DENMARK

Technical automation potential of work activities by sector, Percent[1]



1 We define automation potential by the work activities that can be automated by adapting currently demonstrated technology
2 Calculated as sumproduct of automatable potential and share of employees. Also include other sectors (e.g., raw materials)
SOURCE: Statistics Denmark; McKinsey analysis

Productivity varies across different sectors of the economy and automation can play a key role in improving performance, for example in trade where lower transportation costs drive an increase in online sales *(Exhibit 12)*. Also, it provides an opportunity to increase productivity in domestic-focused sectors, which historically have lagged.[20]

The sector structure of the Danish economy will be strongly impacted by automation, which will bring challenges and opportunities:

— **Traditional industries will be disrupted.** Competitive dynamics in easily-automatable industries will change, and some segments may disappear completely. Firms will be forced to undertake extensive restructuring to keep up with competition.

— **Opportunity for localization of production.** Automated tasks are less exposed to local wage pressures, meaning they are less geographically dependent than waged tasks. That enables more local production, creating an upside in high-wage countries. It raises the question of how Denmark can boost its industrial sector vis-à-vis its European peers if production relocates back to Europe from lower-wage economies. Certainly being an open economy highly integrated into the global value chain will help, but Denmark must accelerate adoption of technology and framework conditions to maximise job creation in relevant sectors.

— **New emerging business and business areas.** Technology enables new business, and Denmark must minimise regulatory and structural impediments to innovation and investment.

AUTOMATION IMPACTS THE WHOLE COUNTRY

Automation impacts the entire country and, while variations exist, there is a maximum of 15 percentage points of difference in automation potential between municipalities.

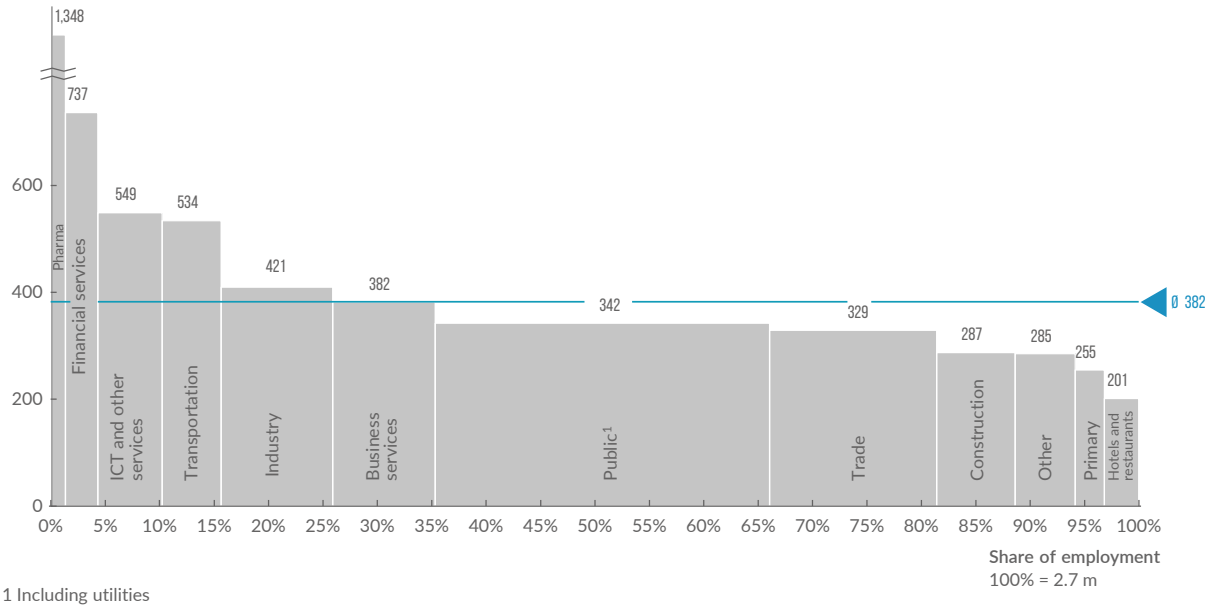
Regional differences are driven by local sector composition. Some municipalities in the western part of the country, for example, have more jobs in the industrial sector, which are more exposed to automation. By contrast, the Copenhagen area has more jobs in financial and business services and the public sector, which are less automatable. In general, rural areas are more likely to see job automation.

20 McKinsey & Company: Creating Economic Growth In Denmark Through Competition (2010)

EXHIBIT 12

GROSS VALUE ADDED PER WORKING HOUR ACROSS SECTORS OF THE DANISH ECONOMY

2010 prices in DKK, 2015

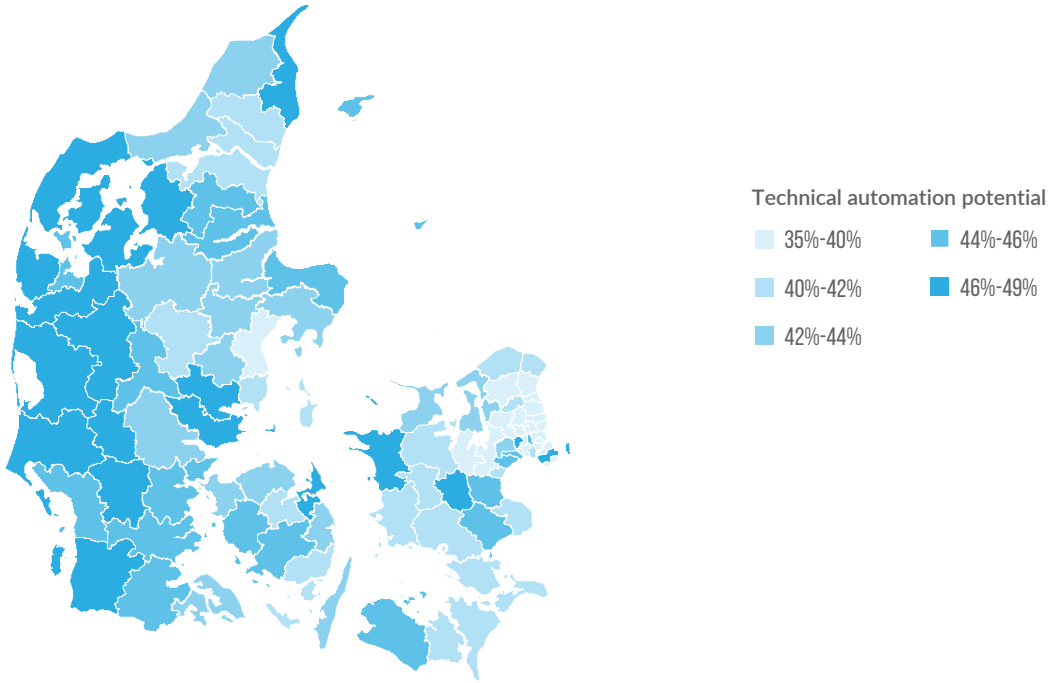


1 Including utilities
SOURCE: Statistics Denmark; McKinsey analysis

EXHIBIT 13

AUTOMATION IMPACTS THE ENTIRE COUNTRY

Aggregated technical automation potential by municipality, Percent of working hours



SOURCE: Statistics Denmark; McKinsey analysis

DANISH AUTOMATION POTENTIAL IS SLIGHTLY LOWER THAN THE GLOBAL AVERAGE

McKinsey Global Institute's research on the automation potential of the global economy, focusing on 47 countries representing 95 percent of global GDP, finds that automation technology has the potential to impact around 2.3 billion workers globally - corresponding to 49 percent of the workforce.

India and China are among the countries with the highest automation potential at above 50 percent, but developed countries like the U.S. and Germany are not far behind, averaging around 47 percent automation potential.

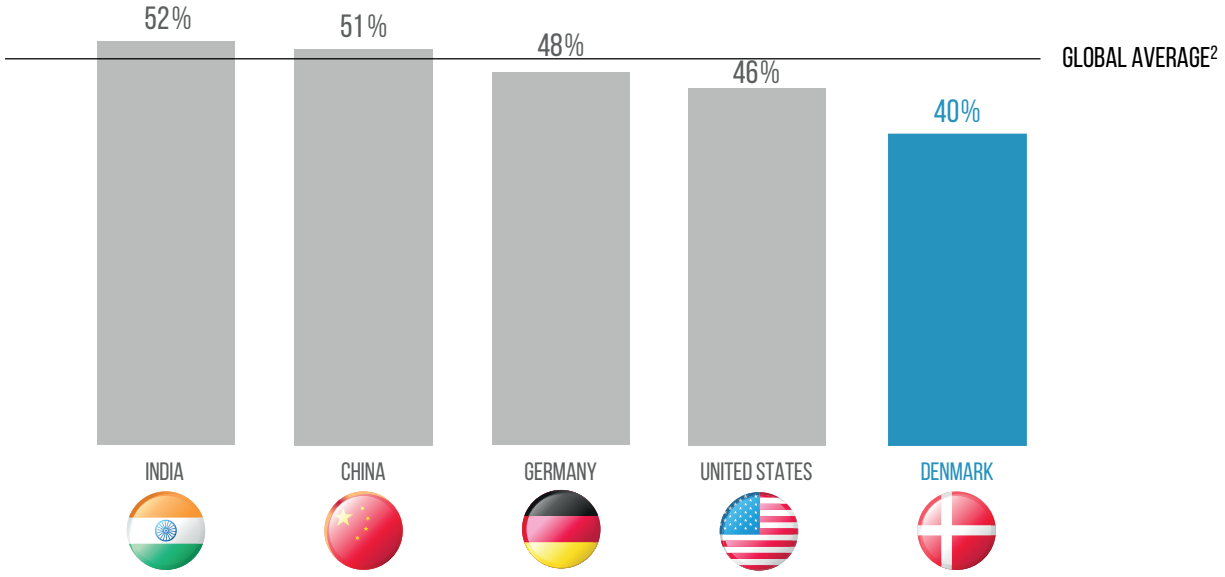
The Danish automation potential at 40 percent is lower than the global average, but in general inter-country variations are moderate.

Differences are driven by sector compositions, and in-sector variation in terms of job types, e.g., by the fact that the public sector is large in Denmark. While variations in composition ultimately reflect national specializations, a number of economic indicators can be mapped to the variations. Labor productivity, GDP per capita and share of population with a tertiary degree correlate negatively with automation potential, which partly explains why Danish automation potential is slightly lower than most countries.

EXHIBIT 14

TECHNICAL AUTOMATION POTENTIAL VARIES ACROSS COUNTRIES

Aggregated technical automation potential of countries, Percent of working hours[1]



1 We define automation potential by the work activities that can be automated by adapting currently demonstrated technology
2 Average of 46 countries representing (without Denmark) approximately 80% of jobs globally
SOURCE: Statistics Denmark; McKinsey Global Institute; McKinsey analysis

3. TIMING AND IMPACT OF AUTOMATION

Automation of the workplace is a global phenomenon that eventually will influence all countries, sectors, jobs and work activities. A key change will be shifting sources of value creation in the economy, with some occupations becoming obsolete and others taking their place, and attendant changes to the way that people work and their rewards for doing so.

FIVE FACTORS SHAPING THE PACE AND EXTENT OF AUTOMATION

Although the technical potential for automating job tasks is high, its deployment will not happen overnight. Five broad factors will determine the pace and extent of automation: technical feasibility, the cost of developing and deploying solutions, labor market dynamics, economic benefits and regulatory and social acceptance *(Exhibit 15)*.

EXHIBIT 15

FIVE FACTORS SHAPE THE PACE AND EXTENT OF AUTOMATION

FACTOR	DESCRIPTION
Technical feasibility	*For automation to gain hold, new technology has to be invented, integrated and adapted into solutions that automate specific activities. Deployment in the workplace can begin only when machines have reached the required level of performance in the capabilities required to carry out particular activities. While machines can already match or outperform humans on some of the 18 capabilities in our framework, including information retrieval, gross motor skills, and optimization and planning, many other capabilities require more development*
Cost of developing and deploying solutions 	*The cost of automation affects the business case for adoption and development of automation technologies requires capital. Hardware solutions range from standard computers to costly, highly designed, application-specific hardware such as robots with arms and other moving parts. Software solutions, by comparison, tend to have a minimal marginal cost, which usually makes them less expensive than wages. Overtime, both hardware and software costs decline, making solutions competitive with human labor for an increasing number of activities*
Labor market dynamics	*The quality, quantity, supply, demand and cost of human labor impact which activities will be automated. For example, restaurant cooking has high automation potential, more than 15 percent, based on currently demonstrated technologies, but a decision to deploy the technology must take into account the relatively low wages paid to chefs, and the abundance of people willing to working at that wage. Further, the effects of automation can interact with labor market skills and supply. For example, if middle-income workers are displaced by the automation, they could move into lower paid occupations, increasing supply and putting downward pressure on wages, which in turn makes the following business case for investing in automation technology less attractive*
Economic benefits	*In addition to labor cost savings, a business case for automation could include performance gains, increased throughput and productivity, improved safety and higher quality as well as social acceptance, which sometimes exceed the benefits of labor substitution. For example, automated driving of cars and trucks could not only reduce the labor costs associated with drivers but also improve safety and fuel efficiency*
Regulatory and social acceptance	*Even when deploying automation makes business sense, the rate of adoption can be affected by contextual factors such as regulatory approval and the reaction of users. The shift of capital investment into these new technologies takes time (in aggregate), as does changing organizational processes and practices to adapt to new technologies. Government policy can slow adoption, and different businesses adopt technologies at different rates. Changing worker activities also requires dedicated effort. Individuals may feel uncomfortable about a world in which machines replace human interaction in settings such as a hospital, or in places where machines are expected to make life-and death decisions, such as when driving*

AUTOMATION WILL NOT HAPPEN OVERNIGHT

Some 50 percent of global work activities could be automated by around 2055, though there are scenarios where it occurs 20 years earlier or later *(Exhibit 16)*.

That calculation is based on a model of change dynamics comprising five factors that will determine the pace and extent of automation, discussed above. The model takes the global near-average of 50 percent of automatable hours as its key benchmark, rather than the 40 percent specific to Denmark. The scenarios create a time range for the potential pace of automation, and have two theoretical bookends comprising an "earliest" and "latest" scenario. Note that novel breakthroughs would change the patterns, as the scenarios are based on currently demonstrated technologies of automation.

The model estimates when automation technologies will reach specific performance levels across the 18 technical capabilities, the time required to integrate the capabilities into solutions tailored for specific activities, when economic feasibility makes automation attractive and the time required for adoption and deployment.

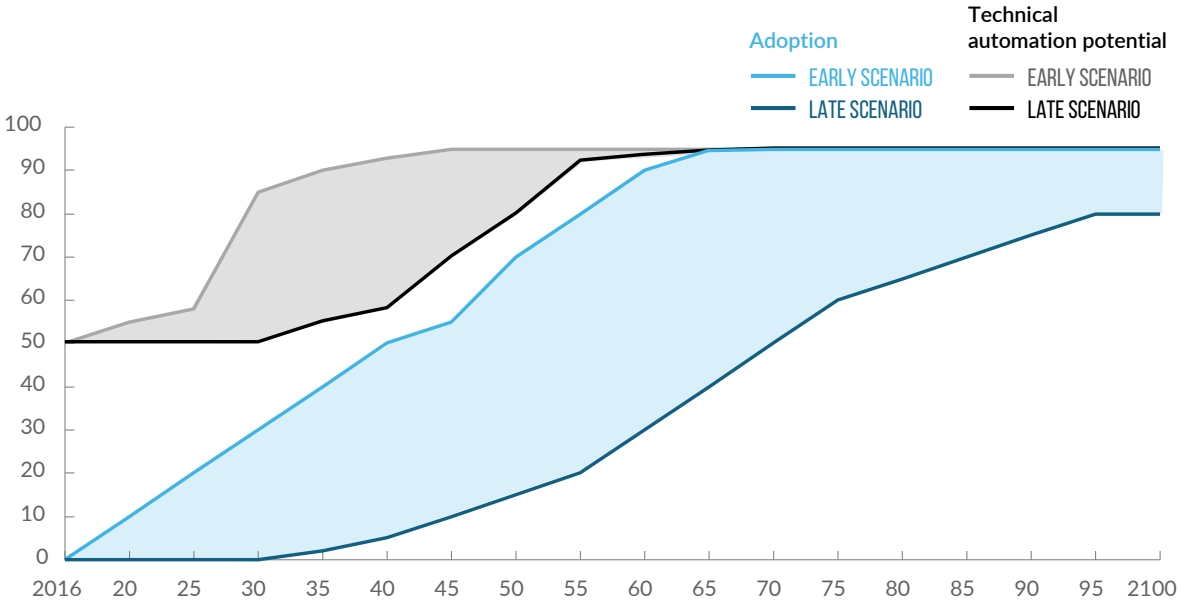
Given the restricted parameters that calibrate the model it is unlikely to be highly accurate in terms of the year in which specific proportions of automated job hours is reached, but it gives a general sense of how things may play out. The impact will of course vary by occupation, with the jobs most exposed to automation set to reach the 50 percent benchmark earliest.[21]

21 We refer the reader to the full McKinsey Global Institute report (A Future That Works: Automation, Employment and Productivity, 2017) for details of assumptions and modelling approach.

EXHIBIT 16

GLOBAL PERSPECTIVE: AUTOMATION WILL BE A GLOBAL FORCE, BUT ADOPTION WILL TAKE DECADES AND THERE IS SIGNIFICANT UNCERTAINTY ON TIMING

Time spent on current work activities[1], Percent



1 Forty six countries used in this calculation, representing about 80% of global labor force
SOURCE: McKinsey Global Institute analysis

AUTOMATION AS AN ENGINE OF GROWTH

The initial impact of automation of a given sector or economy is an investment boom. Robots must be built, machine parks replaced and new solutions developed and employed. As investment works its way through the economy it will lead to a positive business cycle impetus. In the longer term, the key driver of growth is increased productivity *(Exhibit 17)*. To model the long-term effects of automation for the Danish economy, we have used McKinsey's proprietary Global Growth Model.[22] The methodology takes into account only labor substitution gains, i.e., the gain from reallocating substituted labor to other productive activities. Other performance gains—in the form of improved quality, fewer breakdowns, greater safety and so on—are not included. Based on these assumptions we estimate that the productivity enabled by automation will lift economic growth by 0.8 percentage points to 1.4 percentage points annually.

AUTOMATION WILL CHANGE THE ROLE OF HUMAN LABOR

The value of any particular market (including wages paid) is the result of a complex interplay of supply and demand. Therefore, as the role of machines expands, it will have a direct impact on the value of human labor. However, not all types of labor will be affected in the same way.

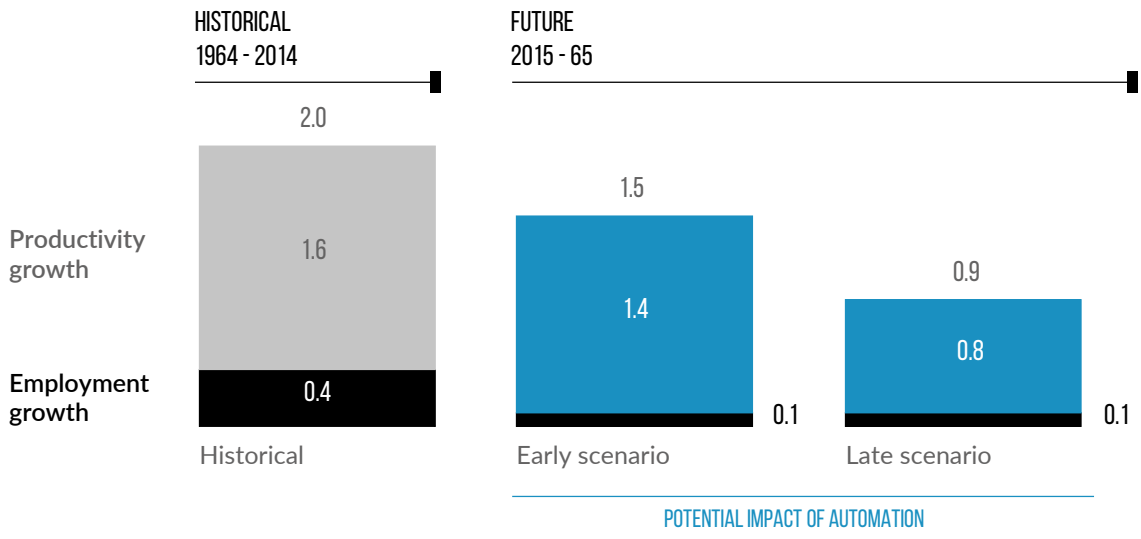
It is reasonable to expect that the value of highly automatable capabilities will decline, and as a consequence (parts of) occupations that build on these capabilities may no longer be profitable if performed by humans. Conversely, the value of other human capabilities will increase, and the wages paid to perform tasks building on those capabilities will rise. This will directly affect occupations that can complement automation technology (digitally augmented jobs). Many people will need to cooperate with robots in the performance of work tasks (also called cobots), and it will become a critical capability to be able to do so. Other human skills will experience a direct demand and hence increased wages, such as software engineers. Moreover, occupations least prone to automation may also increase in value. These include jobs that require creativity and personal interaction, for example personal care.

22 For the purposes of the analysis, country-level GDP projections are based on on McKinsey's proprietary Global Growth Model

EXHIBIT 17

AUTOMATION COULD BECOME AN ECONOMIC GROWTH ENGINE AS EMPLOYMENT GROWTH WANES

GDP growth for Denmark, compound annual growth rate, Percent



SOURCE: The Conference Board Total Economy database; United Nations; Statistics Denmark; McKinsey Global Institute analysis

The shifting dynamics will impact creation of new jobs and sectors. As technology evolves and prosperity increases, occupations that cater to previously unmet demand will appear. Many of these will likely be in the services sector, which is characterized by a high share of non-automatable tasks. Factors that will drive the change include real income effects and migration of talent away from jobs that are automated. Demand for some services could increase, for example in care for the elderly or health. Lastly, some people will leverage the opportunity to trade off work with leisure, which in turn will create new jobs in the leisure industry.

THE SHIFTING DYNAMICS WILL IMPACT CREATION OF NEW JOBS AND SECTORS. AS TECHNOLOGY EVOLVES AND PROSPERITY INCREASES, OCCUPATIONS THAT CATER TO PREVIOUSLY UNMET DEMAND WILL APPEAR. MANY OF THESE WILL LIKELY BE IN THE SERVICES SECTOR, WHICH IS CHARACTERIZED BY A HIGH SHARE OF NON-AUTOMATABLE TASKS.

POSITIVE REAL INCOME EFFECT AS GOODS AND SERVICES BECOMES CHEAPER

An important effect of automation is that the cost of production tends to fall, which leads to lower real prices and an increase in real purchasing power for consumers. This in turn may stimulate demand and lead to the creation of new jobs.

ACCELERATING THE TREND TOWARD A FREELANCE ECONOMY

Currently around 9 percent of Danish workers are self-employed, one of the lowest rates globally.[23] However, with increasing automation and digitization the proportion is likely to increase.

As digital platforms such as Uber, Etsy and Upwork offer increasingly convenient alternatives to traditional payroll jobs, the proportion of self-employed people is likely to rise. Early evidence shows the platforms tend to challenge conventional ideas about how and where work is undertaken, and bring benefits including opportunities for the unemployed, a higher labor participation rate and increased productivity.[24]

Still, an increasing trend toward a freelance economy might also bring challenges. Some of the potential issues that will require additional attention from Danish policy makers are:

- rising income inequality
- incomplete safety net or employment benefits such as maternity pay, sick pay and pension
- a lack of formalized employee training
- a potential shrinking taxation base as many platform providers will be located outside Denmark

AUTOMATION MIGHT EXACERBATE INEQUALITY

Workers should on average experience real income growth as automation kicks in. However, some will do better than others, suggesting that absent policy intervention inequality might rise.

Automation could accelerate the opportunity divide between high- and low-skill workers. In the past two decades, there has been a clear pattern of consistent job growth for high-skill workers and little or no growth for low- and middle-skilled workers. Since lower-middle income workers are most susceptible to automation and low-income jobs are easier to enter for replaced workers, large-scale job automation could accelerate the wage gap across the income spectrum.

MANY PEOPLE WILL NEED TO COOPERATE WITH ROBOTS IN THE PERFORMANCE OF WORK TASKS (ALSO CALLED COBOTS), AND IT WILL BECOME A CRITICAL CAPABILITY TO BE ABLE TO DO SO.

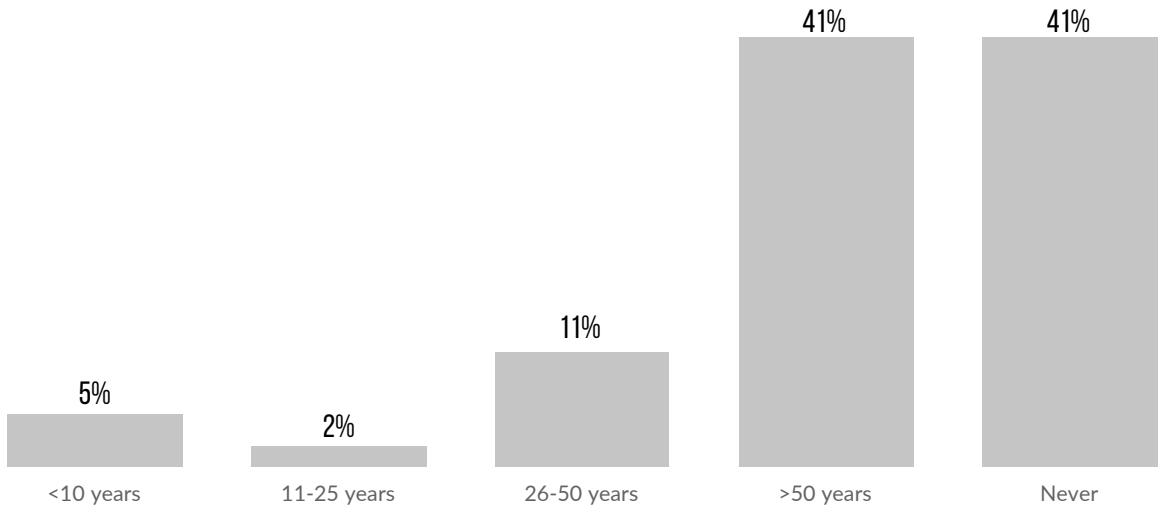
23 OECD Labour Force Statistics (2016)

24 Berger et. al, "Drivers of Disruption? Estimating the Uber Effect", University of Oxford, 2017

EXHIBIT 18

LARGE VARIATION IN EXPERT PREDICTIONS OF ARTIFICIAL INTELLIGENCE POTENTIAL

QUESTION: THE EARLIEST THAT MACHINES WILL BE ABLE TO SIMULATE LEARNING AND EVERY OTHER ASPECT OF HUMAN INTELLIGENCE
N=123 (Based on response to questionnaire to leading experts working within field of artificial intelligence)



SOURCE: Müller, Vincent C. and Bostrom, Nick (2016), 'Future progress in artificial intelligence: A survey of expert opinion', in Vincent C. Müller (ed.), Fundamental Issues of Artificial Intelligence (Synthese Library; Berlin: Springer), 553-571

In relative terms, automation could shift the balance between capital and labor income. As companies invest in new automation technologies, the capital intensity of many industries will increase. Such a shift would push the distribution of income towards capital owners relative to workers, increasing inequality. There will, however, be offsetting second order effects as the increase in wealth among capital owners should result in increased demand for products and services, which will stimulate job creation.

Further, the cost of investment will depend on the international and national firms that provide automation solutions and the associated capital equipment. These sectors might experience volatile price developments as new technologies mature and competition kicks in.

HOW WRONG WILL WE BE?

Given that the estimates in this report are based on currently demonstrated technologies, there is a strong chance they are conservative. However, we are not making any prediction about to what extent the adoption of new technologies could be delayed, e.g. through political decision. A poll of experts in the field of artificial intelligence reinforces that predictions about the future capabilities of technology tend to be diverse *(Exhibit 18)*. When asked to estimate the earliest time computers will be able to simulate learning and every other aspect of human intelligence, the experts made forecasts that ranged from less than 10 years to never.

4. PREPARING FOR DISRUPTION

Automation is largely positive, and brings benefits to society and individuals, leading to more productive jobs and greater wealth. Still, it also presents challenges, including how to capture positive effects and manage complex change processes that may have significant social, economic and employment repercussions.

Policy makers must work to put the right framework in place to ease the transition, while executives in the private and public sector should establish a strategic agenda that ensures Denmark does not lag its peers. Finally, workers must learn how to work with technology, adapt to significant changes in their jobs and task composition, or will need to relocate from old to new occupations.

POLICY MAKERS WILL BE VITAL IN ENSURING AUTOMATION LEADS TO BROAD INCREASES IN PROSPERITY

Policy makers will play a vital role in shaping the impact of automation in Denmark, which potentially will lead to significant social and political stress. However, while policy makers may be tempted to slow the pace of automation, it is pertinent to realize that Denmark is a small open economy that will not be able to break global technology trends. Moves that shield Denmark from automation will likely reduce Denmark's competitiveness, holding back productivity growth without durably protecting jobs.

Policy makers should work towards shaping automation into a tool to alleviate some of the greatest economic challenges facing Denmark. Those include slowing productivity growth, demographic shifts due to an aging population and increasing pressure on public finances. On a long time horizon, automation will be a substantial driver of prosperity and make an important contribution towards meeting these challenges.

Ensuring a successful adoption of automation technology requires a three-fold focus *(Exhibit 19)*:

A) Promote a smooth workforce transition by increasing skill development and job mobility.

B) Enable automation across the economy and lead by example in the public sector.

C) Ensure gains from automation are broadly distributed.

EXHIBIT 19

TO ENSURE DENMARK REAPS THE FULL BENEFITS OF AUTOMATION, POLICY MAKERS SHOULD ADOPT THREE OBJECTIVES

OBJECTIVE		CONSIDERATIONS
A **Promote a smooth workforce transition by increasing both skill development and job mobility**	**A1.** Increase opportunities for reskilling and lifelong learning	▪ *Establish short reskilling programs in cooperation with universities and private companies* ▪ *Promote more frequent work/education switches* ▪ *Leverage automation potential to provide effective, scalable, and personalized educational offerings*
	A2. Reorient educational systems towards future essential skills	▪ *Consider shortening of educational programs as importance of lifelong learning increases* ▪ *Provide all students with easy access to skills that complement automation, e.g, exploring STEM[1] fields, incl. coding, across all education levels* ▪ *Prioritize hard-to-automate skills in education (e.g. creativity, social and emotional skills, critical and systems thinking) – in curricula, education design and teaching methods* ▪ *Ensure broad education mix in every cohort* ▪ *Promote entrepreneurialism (e.g., through tax incentives or investments) as many potential future jobs do not exist today. Many will be needed in the service sector*
	A3. Ensure continuous support for those in transition	▪ *Strengthen the unemployment support model in cooperation with employers and labor unions, e.g. with reemployment programs for particularly exposed industry switchers, potentially including transitional wage subsidies* ▪ *Improve job-seeker support via e.g., targeted analytics in 'jobcentres' or digital matching platforms*
B **Support the private sector and lead by example in the public sector**	**B1.** Support early technology development and deployment	▪ *Support investment in next-generation digital infrastructure, such as 5G* ▪ *Consider increasing direct investment in automation solutions through government funds* ▪ *Ensure that experts, talents and foreign businesses are attracted to Denmark to bring latest knowledge and capital* ▪ *Monitor the development and adoption of automation in terms of whether monopolies emerge from first-mover advantages, standard setting, lock-in effects*
	B2. Rethink needlessly obstructive regulation, while protecting societal concerns	▪ *Ensure right framework conditions for new technology, e.g., use of autonomous vehicles or drones for delivery of goods – in order to increase productivity of trade sector and attraction of FDI* ▪ *Create framework to allow technology platforms for independent work to contribute to worker security* ▪ *Rethink personal data legislation that is increasingly preventing novel analytics-based solutions in e.g., health care and social service interventions*
	B3. Lead by example in the public sector	▪ *Promote spread of automation in public sector, to free up time for professionals to focus on face-to-face interactions (e.g., elderly home care personnel), both on broad programmatic basis and through individual pilot projects* ▪ *Continue world-leading digitization journey of public-to-citizen touch points* ▪ *Build center of excellence in e.g., Digitaliserings- or Moderniseringsstyrelsen that can pave the way for implementing the technology – and do jointly with the private sector to build technology and know-how that can be exported*
	B4. Ensure a level playing field for entrants and incumbent firms	▪ *Install and monitor checks and balances on platform driven mega-firms in sectors with risk of natural monopoly* ▪ *Work towards open standards and the entry of foreign knowledge and firms, such as to minimize entry barriers and thereby tackle market power of incumbents*

1 STEM: Science, technology, engineering and mathematics

OBJECTIVE		CONSIDERATIONS
C **Ensure that gains from automation are broadly distributed**	**C1.** Reconfigure tax system to prepare for shifts in future value creation	▪ *Push for international schemes of taxing multinationals to meet expected increase in capital income share, while preserving incentives for making investment in Denmark* ▪ *Develop framework for sustainable taxation of independent work through technology platforms* ▪ *Identify the most relevant taxation base to ensure future robustness of taxation system*
	C2. Strengthen core educational institutions to ensure relative skill equality	▪ *Ensure that relative skill equality remains the foundation of Danish labor income equality by promoting educational attendance for every citizen* ▪ *Broaden early childhood education, particularly for at-risk groups*
	C3. Ensure the viability of the redistribution system and the social contract	▪ *Ensure that e.g., the pension, tax system and welfare scheme are adapted to the impact from automation and the increase of freelance work, and that the incentives are aligned*

A) PROMOTE A SMOOTH WORKFORCE TRANSITION BY INCREASING SKILL DEVELOPMENT AND JOB MOBILITY

A1. For people already in the workforce, policy makers may seek to intervene to help workers develop skills suited for the automation age.

The Danish economy is likely to face a significant skill gap going forward, and workers most affected by automation are currently the least equipped in terms of education. In addition, Denmark faces a skills shortage in key areas such as data science and engineers.[25] The government should partner with the private sector to ensure those shortages are addressed through more education and training. This should be accompanied by a general shift in education policy toward lifelong learning, to allow workers to keep pace with changes in technology. Technology itself may be instrumental in creating cost-effective and scalable education offerings. Machine learning, for instance, can help tailor technologies to individual needs.

For inspiration, the Danish government might look to Southeast Asia, where the Singapore government recently launched a 'SkillsFuture' platform in collaboration with educational institutions and employers.[26] The platform allows all citizens to sign up for reskilling courses of different lengths. The effort is supported by wage subsidies to workers that switch careers, public prizes and recognition of companies that stand out in terms of facilitating skill development.

An example from the private sector is the 'hacking boot camps' popular in the U.S. In two or three intensive months (nanodegrees), participants who have little or no previous experience with coding are brought to a level of proficiency that would allow them to take on jobs as software developers. While the first Danish examples are appearing, policy makers could do more to support private sector initiatives.

Individual companies can also play a role. In one example US telco AT&T offers nanodegrees to full time employees wishing to move jobs within the company, aiming to facilitate changes to the skill mix required for the future.[27]

A2. For those not yet in the workforce, policy makers should ensure education systems are reoriented towards future essential skills.

The foundations of the Danish education system were laid in previous centuries, and the system needs to adjust in order to prepare students for tomorrow's workplace. In particular, it will be increasingly crucial to "learn to learn", because jobs and required skills will change as technology moves forward.

Denmark ranks below peer countries on share of graduates in science and engineering and on the fit between educational focus and employer needs.[28] As technology progresses, existing knowledge and skills rapidly become obsolete. This may mean that the current system of a secondary education followed by three- to six-year higher degree should be shortened or redesigned for closer interaction between the private and public sectors. In many countries, master's degrees are already directed at students with previous working experience, while in Denmark they are often considered a natural extension of a bachelor's degree.

Educational curricula are also likely to require redesign. Policy makers should work with education providers to develop skills that will be increasingly valuable. For example, coding and advanced software literacy are becoming important in a broad range of careers. One piece of research found that 20 percent of U.S. "career track" jobs in 2015 valued coding skills, and those jobs on average paid a third more.

Other skills that will be in demand include difficult-to-automate capacities such as creativity, emotional intelligence and the ability to manage and coach others. It will also increasingly become crucial to "learn to learn", because jobs will change as technology moves forward. Classes, classrooms and teaching in primary and secondary schools should reflect these priorities. Furthermore, policy makers should try to ensure a sustainable mix of education specializations and study length in every cohort.

Finally, many occupations of the future don't exist today (see appendix for examples of jobs most in demand today and how prone Danish adults are to problem solving in technology-rich environments). To enable job creation, regulators and policy makers should encourage and incentivize entrepreneurs, for example through tax frameworks, investment and/or subsidies.

A3. Workers must be supported as they transition from one set of activities to another.

As work evolves at a higher rate of change between sectors, locations, activities and skill requirements, many workers may need assistance in adjusting. Some may be stretched to find employment close to where they live, or at all.

25 *The age of analytics: Competing in a data-driven world*, McKinsey Global Institute, December 2016

26 See www.skillsfuture.sg. Similar tests have been tried in other countries

27 Donovan and Benko, "AT&T's Talent Overhaul", Harvard Business Review, October 2016 Issue

28 Denmark ranks as number 40 – well behind European peers - on the World Economic Forum's measure of fit between educational focus and future qualifications demand.

Relative to peer countries, Denmark is in a good position on workforce flexibility, and Danish workers are significantly more prone to switch jobs than employees in France and Germany.[29] However, during substantial future workforce transitions, the economics of the current model may be challenged. In that case, the government should work closely with employers and labor unions to ensure adequate support for workers during transitional periods. This could include targeted programs for highly exposed industry switchers, including transitional wage subsidies. Simultaneously, policy makers should strengthen efforts in job centers through sharing of best-practice and tools such as analytics-based targeted interventions.

B) ENABLE AUTOMATION ACROSS THE ECONOMY AND LEAD BY EXAMPLE IN THE PUBLIC SECTOR

Policy makers must support innovation through legislative frameworks that pave the way for deployment of automation technologies in the private and public sectors. Denmark is a small open economy and leveraging new technologies could be a decisive factor in ensuring future competitiveness and supporting the welfare state.

B1. Policy support can help accelerate early technology development and deployment.

Policy makers can help create the conditions for innovation in the workplace, backed by in-depth research and monitoring of the evolving landscape. Policy should support early adoption, both in terms of development and deployment. Support could include investment, funding of basic research and commercialization, as well as development of infrastructure for automation. A basic requirement is widespread and cheap access to high-speed internet (building towards 5G). In addition, infrastructure should support the Internet of Things (IoT), cloud storage (SaaS, PaaS, IasS), and quantum computing. Policy makers should consider questions around development, security and integration with public data and systems. Denmark must seek to attract the best foreign talent and be willing to adopt best practice from other countries.

The capital markets ecosystem and venture capital and investment climate will be increasingly important in helping build businesses to employ those displaced by automation. Current venture capital volumes in Denmark are 25 percent to 40 percent lower than peer countries such as Sweden and Finland, and global leaders such as Israel and the U.S. see ten times more flow.[30] The government has set up vehicles for early stage funding, including Innovation Fund Denmark and the Market Development Fund and those institutions can serve as levers to expand funding further. Another key area is tax policy, which should support capital and funding markets.

B2. Thoughtful regulatory dialogue and policymaking will be important to ensure the benefits of automation are achieved while addressing other societal concerns.

Legal frameworks must be adjusted to reflect the new digital and automated landscape. As recent disputes around Uber and AirBnB have shown, it can be hard to reconcile emerging businesses models with existing regulation. As automation continues, many more regulatory quandaries will surface, which may be more complex and ambiguous. For example who is responsible for the crash of a self-driving car – the owner, the automaker or the algorithm designer?

THE CAPITAL MARKETS ECOSYSTEM AND VENTURE CAPITAL AND INVESTMENT CLIMATE WILL BE INCREASINGLY IMPORTANT IN HELPING BUILD BUSINESSES TO EMPLOY THOSE DISPLACED BY AUTOMATION. CURRENT VENTURE CAPITAL VOLUMES IN DENMARK ARE 25 PERCENT TO 40 PERCENT LOWER THAN PEER COUNTRIES SUCH AS SWEDEN AND FINLAND, AND GLOBAL LEADERS SUCH AS ISRAEL AND THE U.S. SEE TEN TIMES MORE FLOW.

As more employees choose to be self-employed there should be a smooth passage out of fulltime employment, and perhaps back again, focusing on financial security, work conditions, skills and training.

29 OECD Statistics

30 *"Entrepreneurship at a glance"*, OECD 2016

Policy makers and regulators should also work with labor unions to find solutions for integrating independent work platforms such as Etsy and Uber with existing labour market institutions. Likewise, finding models for efficient taxation of value creation by such platforms will be imperative.

Getting the legal frameworks right will position Denmark as a pioneering country for technological solutions, attract investment and pioneer new services.

A first step should be to map regulation that currently is an obstruction to implementation of new technology. One key area regards data privacy concerns, which will increase with the wider use and availability of individual data and recorded activities. On one hand, laws such as the Danish Act on Processing of Personal Data hinders innovative solutions and business models, and regulation of personal data is considered a key barrier to deployment of IoT-based solutions in Denmark.[31] One example is the restriction on hospitals in the use of advanced analytics and machine learning in targeting individuals for treatment and follow-ups. On the other hand, legislation must balance technological experimentation and advancement with the interests and privacy concerns of individuals.

DENMARK COULD WORK WITH LEADING TECHNOLOGY COMPANIES TO INCREASE PRODUCTVITY, ATTRACT FOREIGN INVESTMENT AND CREATE TECHNOLOGY-RELATED JOBS. GIVEN DENMARK'S STRONG ICT INFRASTRUCTURE AND WORKFORCE SKILL-LEVEL, THERE IS A SIGNIFCANT OPPORTUNITY.

Policy makers should also anticipate areas where Denmark can be a test bed for new technology. For example, one lever to increase productivity in the trade sector would be to lower transportation costs by enabling the use of autonomous cars or drones. Denmark could work with leading technology companies to increase productivity, attract foreign investment and create technology-related jobs. Given Denmark's strong ICT infrastrcuture and workforce skill-level with respect to problem solving in technology rich environments, there is a significant opportunity.

B3. The public sector should showcase gains from automation, allowing policy makers to lead by example.

Automatable tasks constitute 27 percent of current working hours in the public sector. It is vital that policy makers champion automation in the public sector to improve productivity and increase innovation.

In countless areas, automation can improve public services, for example reducing the time spent on collecting and processing data for reporting and documentation to allow for more face-to-face contact with citiziens, students and patients. As an example, the homecare professional can spend his time in conversation with the elderly he visits, and let a robot do the vacuum cleaning. Likewise, augmented decision support from machine learning can improve areas including patient care, education, detection of tax fraud and job search assistance for the unemployed.[32]

The Danish public sector is already at the forefront of supporting and implementing digital technology in public services and should build on that platform to ensure continuous improvements. Automation need not always come in the form of 'robots'. Allowing citizens to apply for a new passport from a mobile phone also serves as automation. Policy makers have already made progress, but many areas of improvement of opportunity remain.[33] One example would be to create a center of excellence in Digitaliserings or Moderniseringsstyrelsen to support automation, perhaps working with the private sector to develop new businesses and export Danish expertise.

B4. Ensure a level playing field for entrants and incumbent firms.

A critical challenge for policy makers includes the oversight of market dynamics, and particularly the risk of excessive market concentration and market power due to first mover advantage, standard-setting, ownership of data and customer lock-in effects. The consequences from these economic dynamics cannot all be solved by Denmark in isolation, and often requires cooperation with European peer countries to ensure a level playing field.

31 Analysis by the Danish Business Authority in 2016, available here (in Danish): https://erhvervsstyrelsen.dk/sites/default/files/media/iot-rapport_og_10_cases.pdf

32 For a case study on highly automated hospital emergency room, see our global report *'A Future That Works: Automation, Employment, and Productivity'* by the McKinsey Global Institute

33 Denmark ranks first in the European Commission's Digital Economy & Society Index (DESI) and second in the United Nation's ICT development index.

Maintaining competitive pressure and contestability of markets, for example through open technological standards and interfaces that allow new firms to compete on established platforms, are essential for harvesting the full potential and productivity gains that stem from automation.

C. ENSURING GAINS FROM AUTOMATION ARE BROADLY DISTRIBUTED

Automation has the potential to increase prosperity, but not everybody will see the benefits, and across developed markets there is evidence of anxiety over jobs and income that has led to a backlash against globalization in some countries. The risk that automation could become a scapegoat is real. Ensuring that gains from automation will reach every member of society should therefore be a priority, requiring Danish policy makers to adjust taxation and address wealth distribution, both indirectly and directly.

C1. Policy makers should gradually reconfigure tax systems to balance preservation of public finances with incentives for economic activity.

Automation may lead to a change in sources of value creation in the economy, and preserving the tax base while creating thoughtful incentives for workers and companies will require clever policy work.

Three areas of priority stand out. First, automation technologies may exacerbate industrial winner-takes-all dynamics, leading to wealth concentration among multinationals and Danish regulators should prioritize working with international peers to develop taxation frameworks. At the same time it will remain vital to facilitate technology investment in Denmark.

Second, policy makers must find ways to tax value creation from digital platforms for independent work, such as Uber, Etsy and Upwork. Third, policy makers must consider gradually shifting the taxation base from labor income to other sources, to not disadvantage employment. In particular, tax levers and minimum wage levels may have to be adjusted to enable job creation in the service sector.

C2. Strengthen core educational institutions to preserve future income equality.

The relatively large degree of income equality in Denmark today is not only due to income transfers, but to pre-tax earnings equality, which stems from generally high level of skills among workers. Denmark's core educational institutions are a primary source of skills equality, from daycare centers to higher education. Historically, these institutions have been central to providing Danes with adequate skills to succeed in the labor market. It is vital to support and maintain this advantage, particularly for at-risk groups. It's not just about funding – it is about making sure outcomes match the economy's needs.

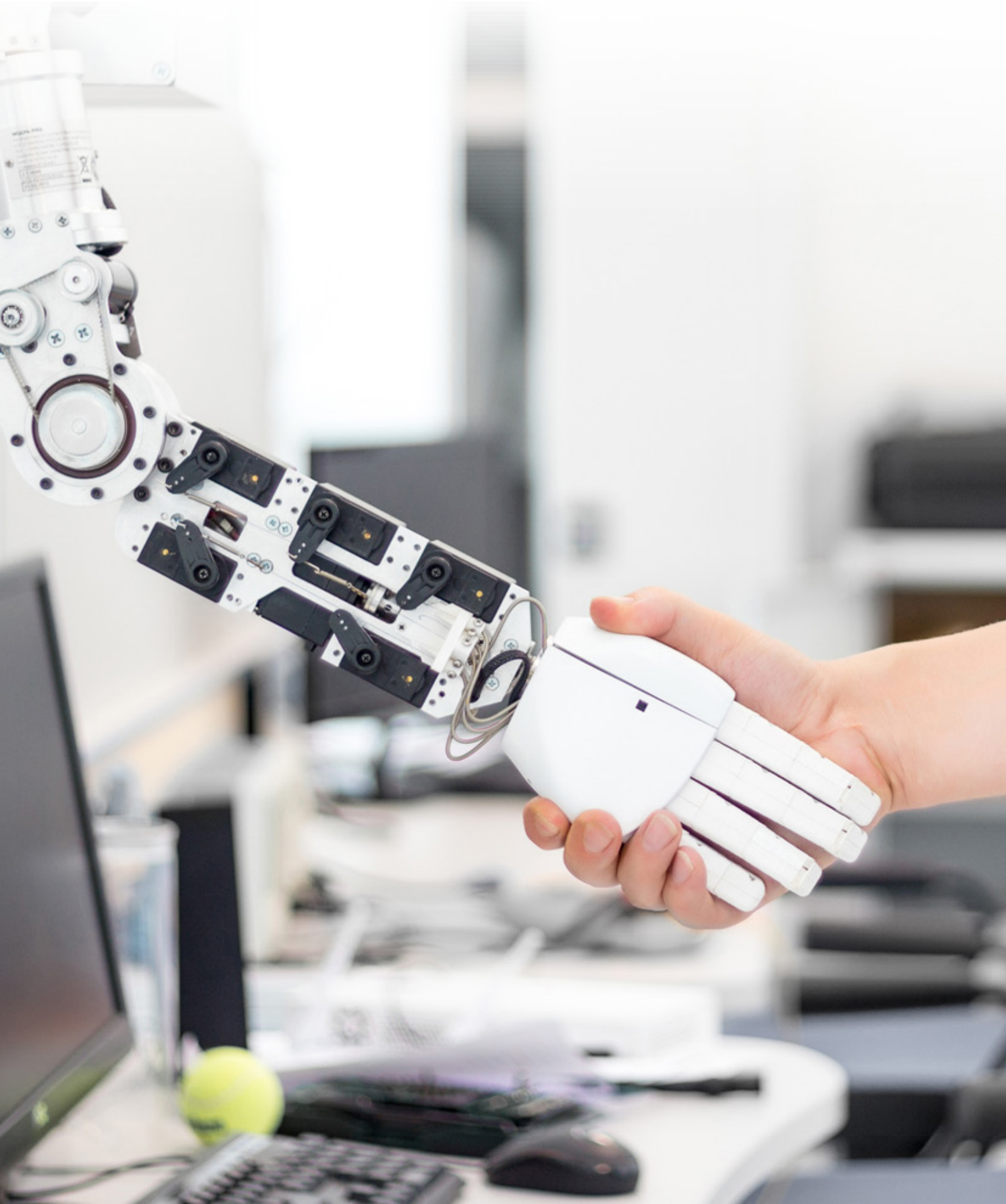
C3. Ensure the viability of the redistribution system and the social contract.

There is a need to ensure that the pension, tax system and welfare state are adapted to the impact of automation and the increase of freelance work, and that incentives are aligned. This is required to ensure the redistribution system is kept intact and social contract is maintained.

WHEN SOME OLD POLICY IDEAS ARE NEW AGAIN

Many of the potential policy measures that could be adopted to help the workforce adjust to the impact of automation are not entirely new. One idea that has returned is providing a universal basic income, or providing all citizens with an unconditional sum of money. Automation has given the idea a new lease of life among policy makers, some academics and a number of business leaders in Silicon Valley, although it remains controversial. In a June 2016 referendum, Swiss voters overwhelmingly rejected a proposal to establish a universal basic income. A full basic income program has never been enacted and properly studied. However, in Finland an experiment that started on January 1, 2017, will pay an unconditional basic income of 560 euros per month for two years to a random sample of 2,000 individuals drawn from current working-age beneficiaries of unemployment benefits. The experiment is aimed at comparing the employment rate of beneficiaries of the basic income with those who receive traditional unemployment benefits.

Others have suggested that if we need human labor working alongside automation to achieve economic growth, social assistance programs should incentivize work, for example negative income taxes. The history of a negative income tax for low-paid workers spans back to the 1940s, when it was proposed by British politician Juliet Rhys-Williams, and it was advocated by Milton Friedman in the 1960s. In 1975, the United States introduced a negative income tax, the earned income tax credit, which provides income subsidies to the working poor. The program has survived for 40 years and has been adopted in other countries.



AUTOMATION WILL CHANGE WORK ROLES AND REQUIRE CLOSER COLLABORATION WITH TECHNOLOGY

In the short to medium term, workers will need to engage more comprehensively with machines as part of their everyday activities. Tighter integration with technology (digitally augmented jobs) will free up time for activities that machines have not yet mastered. This is exactly why people employed in such jobs will experience a rise in their productivity. However, this could make work more complex, and harder to organize, with managers spending more time on coaching. As young people in particular make education and career choices, they should be made aware of the factors driving automation in particular sectors, to help them identify skills that could be useful.[34] High-skill workers who work closely with technology will likely be in strong demand. Those involved in developing and deploying automation technologies will have many opportunities.

In addition, workers who are paid to do activities that are complements of automation will also find themselves in an advantageous position, as Brynjolfsson and McAfee described it *"racing with the machines rather than racing against them"*.[35] There may also be more opportunity for independent work as the corporate landscape shifts and more projects are outsourced. Low-skill workers working with technology will be able to achieve more in terms of output and productivity, but may experience wage pressure given the potentially larger supply of similarly low-skill workers.

Education systems will need to evolve for a changed workplace, with policy makers working with education providers to improve basic skills, and a new emphasis on creativity, emotional intelligence and leading and coaching others. Individuals should be prepared for lifelong learning – perhaps re-entering longer formal education programs throughout ones career.

The service sector is likely to increase in importance, which will create job opportunities. For all, developing agility, resilience, and flexibility will be important at a time when everybody's job is likely to change to some degree.

Still, it is worth emphasizing that automation will boost the production of goods and services and hence provides a unique opportunity to raise living standards for all.

■ ■ ■

For now, many workplaces still expect people to perform rote tasks that do not stretch innate capabilities. As machines take on more routine work activities, non-automatable skills will be at a premium. Considerable uncertainty surrounds the advent of the automation era, and the speed of adoption will vary, with impacts playing out in myriad ways. However, automation represents an opportunity at a time of weak productivity and a declining working-age population. It will reshape the business landscape and create considerable value. How to capture the opportunities and prepare for the possible consequences will be a key political, economic, corporate and social challenge. Now is the time for concerted action and determined efforts to make automation work.

34 Erik Brynjolfsson and Andrew McAfee, *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*, W. W. Norton & Company, 2014.

35 Ibid.

APPENDIX

EXHIBIT A1

'HOTTEST' SKILLS OF 2015 ON LINKEDIN

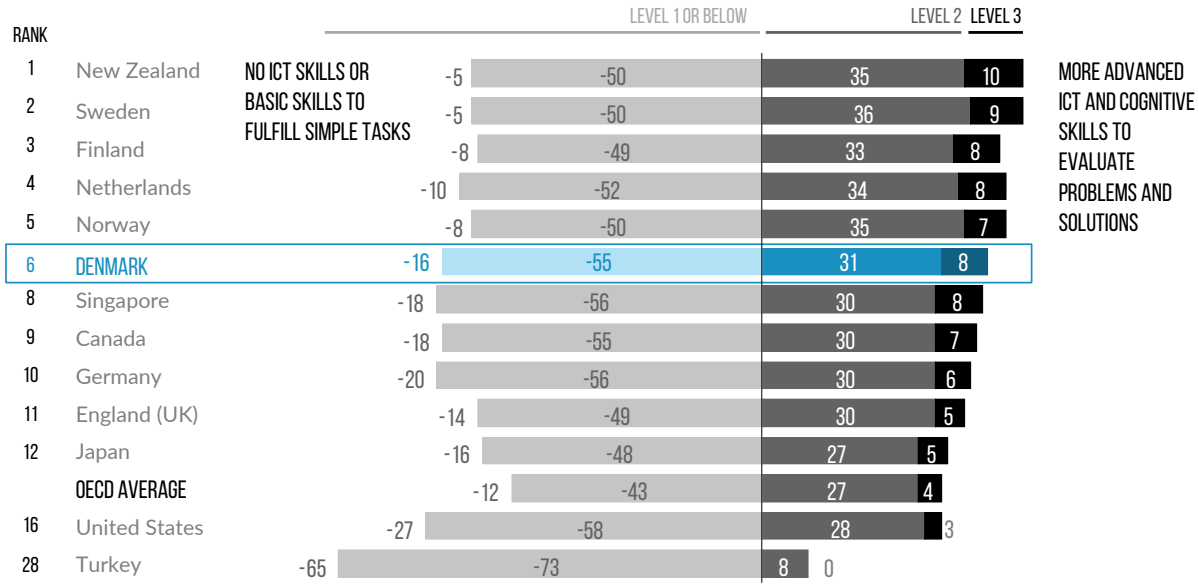
1 Cloud and Distributed Computing
2 Statistical Analysis and Data Mining
3 Marketing Campaign Management
4 SEO/SEM Marketing
5 Middleware and Integration Software
6 Mobile Development
7 Network and Information Security
8 Storage Systems and Management
9 Web Architecture and Development Frameworks
10 User Interface Design
11 Data Engineering and Data Warehousing
12 Algorithm Design
13 Perl/Python/Ruby
14 Shell Scripting Languages
15 Mac, Linux and Unix Systems
16 Channel Marketing
17 Virtualisation
18 Business Intelligence
19 Java Development
20 Electronic and Electrical Engineering
21 Database Management and Software
22 Software Modeling and Process Design
23 Software QA and User Testing
24 Economics
25 Corporate Law Governance

SOURCE: Linkedin

EXHIBIT A2

PROFICIENCY OF DANISH ADULTS IN PROBLEM SOLVING IN TECHNOLOGY-RICH ENVIRONMENTS IS AMONG HIGHEST IN OECD

Percentage of 16-65 year-olds performing in each proficiency level



Notes: Individuals in Level 2 or Level 3 have more advanced ICT and cognitive skills to evaluate problems and solutions than those in Level 1 or below
SOURCE: OECD (2015c); Survey of Adult Skills (PIAAC) 2015

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