STATE OF THE DIGITAL REGION

2017

EXPLORING AUTOMATION, EDUCATION AND LEARNING IN THE BALTIC SEA REGION

Joakim Wernberg
Martin Andersson

sustainable growth
innovation
competitiveness
Baltic Development Forum

Microsoft

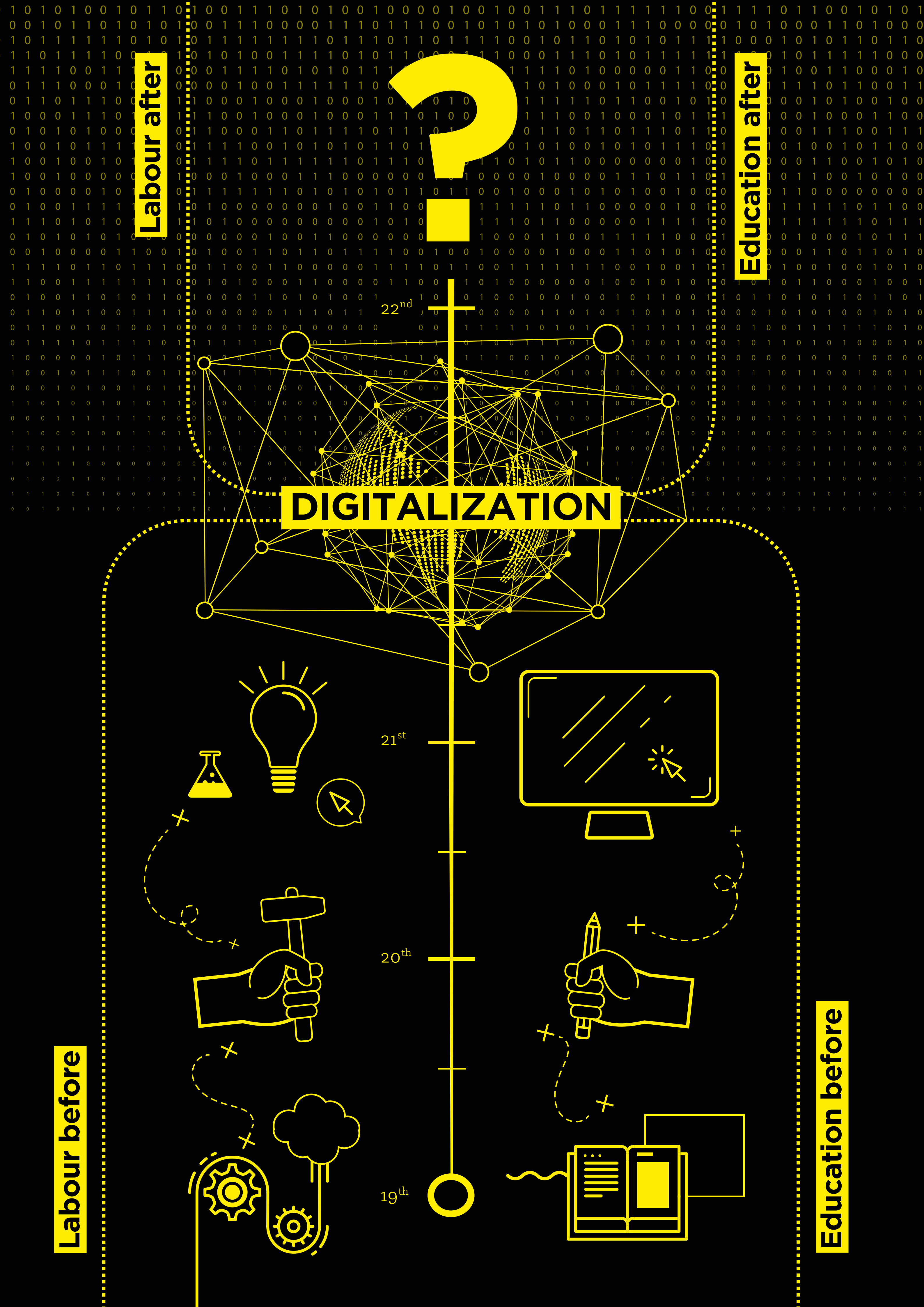
top of digital Europe

top of digital
Europe

ICT Think Tank
for the Baltic Sea Region

sustainable growth
innovation
competitiveness
Baltic Development Forum

Microsoft


Labour after
Education after
22nd
DIGITALIZATION
21st
20th
19th
Labour before
Education before

FOREWORD

For the third consecutive year, we are proud to present the *State of the Digital Region Report*, our annual overview of achievements, trends and potentials in the digital economy in the Baltic Sea Region (BSR)[1].

Every year, the report provides an updated overview of how the countries in the BSR, often ranked as global digital frontrunners, are performing in the digital economy, and recommendations to how they could stay in the lead as a global ICT hub.

In the previous editions of the State of the Digital Region Report, we examined the importance of a regional market for human capital (2015) and cross-border city-to-city cooperation (2016) for integrating a digital single market in the Baltic Sea Region. This year, we turn the thematic spotlight towards automation, education and learning. We ask, what are the implications of the current shifts in the labour markets for education and learning in the countries in the BSR?

It is now three years since Baltic Development Forum and Microsoft established the ICT think tank for the BSR "Top of Digital Europe". By promoting the Region as a leader in the ICT sector, facilitating cross-border dialogue and developing new innovative public-private initiatives, Top of Digital Europe has the ambition to drive forward a closer cooperation between countries, cities, regions and businesses. We are pleased to see that this is happening, step by step, and in line with many of our recommendations.

We hope that by highlighting the Region's potentials and competences, this report will inspire further commitments and steps towards a digital BSR. Even if countries are digital frontrunners, none of them are leading across all areas of digitalization. This leaves a great potential to learn from neighbouring countries, often related in terms of culture, society, language etc. Furthermore, as small, open and digitalised economies the BSR countries have a clear interest in and ability to inspire and impact the digital future of the EU.

As we publish this report we turn already to the next edition. In an ever disruptive digital world we are eager to engage new stakeholders in dialogue and practice to provide the best insights into the future of digitization across the BSR and beyond. We hope to spread the knowledge presented here across new platforms, to begin a conversation, not only with policy makers, but with practitioners and end users, to shout about the vast potentials of the digital economy across the BSR. We hope you will join us in doing this and we welcome any comment or idea you may have.

Once again, we thank the research team, Professor Martin Andersson from Blekinge Institute of Technology and Lund University, and Dr. Joakim Wernberg from Swedish Entrepreneurship Forum for giving new insight and recommendations to how this region jointly can take advantage of the new opportunities from digitalization.

Top of Digital Europe

Baltic Development Forum
Microsoft

1 The analysis in this report is limited to eight countries in the Baltic Sea Region: Denmark, Finland, Norway, Sweden, Estonia, Latvia, Lithuania and Poland.

TABLE OF CONTENT

EXECUTIVE SUMMARY

THE UPDATED STATE OF THE DIGITAL REGION

Is the Baltic Sea Region (BSR) at a crossroads? An overview of the development of the countries in the BSR on a selected set of core indicators suggests that BSR may have come to an impasse. With the exception of Estonia, the gap between the Nordics and the Baltics and Poland is not closing. In particular, Poland, Lithuania and Latvia do not seem to be taking off.

- As in previous years, the Nordics are leading more or less across the board, but are not exhibiting strong development. They are "lagging ahead".
- Estonia is showing strong signs of development and is closing in on the Nordics on several indicators, moving away from the other Baltic countries.
- Poland, even if lagging behind, could make an important contribution by its sheer size.

Unless the entire region strengthens their macro-regional cross-border efforts and develops an increasingly joint digital market, there is a considerable risk that the BSR grows more fragmented.

- The Nordics are strong when it comes to digitization, but they are not alone in the global frontline and they are comparatively small. They could benefit from being part of a larger macro-regional market. Meanwhile, the Baltics and Poland all have the basic conditions for catching up and perhaps even leapfrogging in different ways in their own digitization.
- Estonia, catching up with the Nordics, might be able to provide a link between the Nordics and the Baltics, but on the other hand it might not be big enough to "hold the region together."

Several recent policy initiatives show a development in the right direction of moving towards increasing cooperation and improving the conditions for a joint digital market.

- In April 2017, the ministers in charge of digital development in the Nordic and Baltic countries signed a declaration which expressed a desire to strengthen digital co-operation in the region and leverage its leading position.
- A number of policy related cross-border pilot initiatives has been launched in the BSR, including ideas and projects, for example, to facilitate digital identification (eID), to connect digital start-up ecosystems in small and medium-sized cities in different countries as well as to develop the BSR towards a position as a global digital test hub.
- Still, as the speed of digitalization and technological change intensifies, there is an urgent need to realize the potential in macro-regional collaboration in the BSR and go from grand visions to action and short-term change.

AUTOMATION, EDUCATION AND LEARNING IN THE BALTIC SEA REGION

Automation is not about the destruction of jobs, but about the reorganization of tasks and the increased need for learning in the digitized economy.

Tasks are being shifted from human to computational activities, which changes the organization of tasks into jobs and the organization of jobs in the economy. This implies a gradual shift that involves both the creation and destruction of jobs. Just as the automation of tasks may remove them from a certain type of job, automation may also make a certain type of task available to a wider variety of worker simply because they can leverage technological tools.

Recent technological change brought by computers and computational technology has fuelled job polarization in many countries, i.e. the simultaneous growth of high-education/high-wage jobs and low-education/low-income jobs at the expense of middle-education/middle-wage jobs. However, empirical evidence from task-based investigations indicate that technological progress is unlikely to destroy a large number of jobs. On the other hand, the negative impact of task automation risks being concentrated on the low-qualified share of the workforce, a group that will arguably have a harder time to adapt to the development.

The report presents three dimensions along which to approach automation and the learning shift: Direction, Speed and Adaptive Capacity

- The direction of change in the labour market becomes much more uncertain with the introduction of digital general-purpose technologies and accelerated technological progress. This calls for a shift from long-term predictions of the labour market demand for skills to short-term adaptability.

- The accelerated speed in technological change means that the turnover of skills increases even among people with university educations. In addition, the faster demand for new general technological skills is falling out of pace with the slower supply of specific business-oriented skills. That is, a new university graduate does not by default have the technical know-how that the employer demands. The speed of technological progress also challenges the rate of adaptation to new technological potential in the educational system, ranging from EdTech in elementary schools to MOOCs in universities.

- The increased speed and uncertainty of direction requires a policy response that is adaptive on a much shorter time-scale. There is a need for educational institutions that cater to education and training throughout a career, not just at the very beginning of it. However, technological progress also provides tools that lower the threshold to a wider set of tasks, while urbanization provides dense digital markets that foster innovation and the emergence of new services and products. Finally, cross-border interactions and market integration contributes to a larger human capital ecosystem with increased potential for individuals and groups to leverage their comparative advantages in the economy.

An analysis of the BSR with regards to education, business (investments in knowledge and learning) and labour markets shows that there are marked differences between the BSR countries, where most indicators confirm a rather significant gap between the Nordics and the Baltics and Poland, though Estonia shows a strong development on many of the indicators. A main conclusion from the data is that the BSR faces a risk of "dual polarization".

Available data on the labour market consequences of automation indicate that the BSR countries fall below the EU and OECD average with respect to the risk of job automation. This does not, however, mean that the region does not need to adapt to the development.

There is a significant risk of further polarization between high and low skill workers *within* individual BSR countries.

The Nordic countries are still ahead of the other countries, but Estonia's development is strong and if it continues at its current pace, it will soon catch-up with, or even surpass, the Nordics. If Poland, Latvia and Lithuania do not pick up their pace, there will be further polarization *between* the countries in the BSR.

POLICY PROPOSALS

Against this backdrop, policy proposals underscore the need for short-term adaptability and experimentation over long-term predictions of labour market changes. Three broad areas for potential macro-regional and cross-border policy initiatives are proposed, focusing on the digitization of education, the restructuring of the educational system to career-long learning, and a better understanding of tomorrow's labour market:

- Developing a cross-border testbed conditions for innovation in EdTech and technological change within the education system.

- Reforming institutions to accommodate the need for learning and re-education throughout a career, not just at the beginning of it.

- Investigating and collecting data on the reorganization of tasks, jobs and the labour market.

INTRODUCTION

Data and information have become hallmarks of digitisation. The internet was known early on as the *information super highway* and data has been dubbed *the oil of the digital economy*. Yet, data and information on their own have only very limited value. The real value-creation lies in the processing of data and information into different types of learning. How people, businesses, governments, machines and artificial intelligences can, and indeed will need to, learn in new ways is a key driver the digitized economy. This is especially evident in the light of the ongoing and growing debate on automation. Development in computational technologies has made possible machine learning and artificial intelligence that can crunch large amounts of data to uncover patterns, take on complex behaviours and adapt to changing environments. As the machines get better at learning, so too must people. The turnover of knowledge is speeding up and in the future more people, even those with a university degree, will need education and training throughout their careers, not just at the beginning of it. This is a learning shift.

Promoting market integration in the digitized economy is not just a top-down process of regulations, but also a bottom-up process of exchange, collaboration and trust (Top of Digital Europe 2015a). The purpose of the State of the Digital Region project is to, on a yearly basis, explore and highlight the potential of a macro-regional approach to a digital single market in the Baltic Sea Region (in this context Norway, Sweden, Finland, Denmark, Estonia, Lithuania, Latvia, Poland). Cross-border collaboration between these countries can act as a complement to EU-wide and national policy programs and initiatives.

The project has now been running for three years and every year the report focuses on a specific theme related to digitization. In 2015, the theme was human capital and the potential for a cross-border human capital ecosystem. In 2016, the attention was shifted to the role of cities and networks of cities in promoting start-ups and creating geographical focal points in the digitized economy. This year, the theme of the report turns its spotlight towards automation. Automation is, we will argue, ultimately not about robots but about learning. Therefore, we connect automation and education to describe the new conditions for learning in a digitized economy.

Europe and the BSR face several difficult challenges ahead that in different ways tie into how we relate to learning in the wake of digitisation. Fear is growing that robots and automation will destroy jobs and leave people without technological skills behind. Education is struggling to keep up with and relate to digitisation, and e-skills (both general and expertise) have long been a major concern in many countries. Empirical evidence suggests that while the rumour of jobs being destroyed seems exaggerated, the BSR countries risk facing a double polarization: job polarization in each country, and a growing fragmentation between the countries as some develop while others do not seem to be able to catch up. Against this backdrop, tackling the challenges associated to automation, education and learning is not about preventing jobs from being destroyed, it is about adapting to a labour market in which the life cycle of both skills and jobs is shortened.

The rest of the report is organized as follows. **Chapter 2** contains a general overview of the digital state of the region, following up on previous years' reports. **Chapter 3** describes the background and implications of automation and advances in computational technology in relation to the labour market. Section 3.5 connects the conceptual discussion to statistics related to labour markets, job polarization and education in the BSR countries. Finally, **Chapter 4** presents implications and suggestions for policymakers.

2 DEVELOPMENT IN THE REGION

2.1 REVISITING THE GAP SIZE GRAPH

Since the initiation of the State of the Digital Region project, the development has been summarized in a gap size graph, showing a ranking of gaps within the BSR and the ranking of countries for each gap indicator. This year, the set of indicators has been updated somewhat with the ambition of finding data sources and indicators that are updated as frequently as possible in order to better capture ongoing developments.

A main point with the gap size graph is to illustrate that the gap between countries in the BSR is not constant. The picture is one of heterogeneity where different countries have strengths within different aspects of the digital economy. It is not the case that the Nordic countries are in the lead across the different indicators or that the Baltic countries always maintain a middle position. There is also a large variation in terms of the size of the gap between leaders and laggards. There is thus a twofold meaning of the fact the that there is no constant gap:

1. The gap size between the leaders and laggards is not uniform across indicators.

2. The ranking of countries is not constant across indicators

The gap size graph presents the position of each country according to representative indicators. The size of the gap in terms of the distance between the best and worst performing country is represented vertically. To illustrate the gap-size across indicators, we calculate it as a percentage of the score of the top performer. For example, if the top country scores 4 while the bottom country score 1, the gap-size in percent of the top performer is 3/4=75%. For an indicator placed in the bottom part of the figure, the size of the gap is small. As a consequence, the horizontal distance between the countries is small.

The overall results in this year's ranking largely matches the trend from previous years, with some notable changes. *New ICT-related firm start-ups* is now the largest gap in the region, spanning from Poland (13,876 start-ups in 2014) in the lead down to Denmark (481). This number will of course shift if the number of start-ups is measured per capita since the size difference between the countries is so large. However, using absolute numbers gives an important hint at the distribution of population-related activities within the BSR.

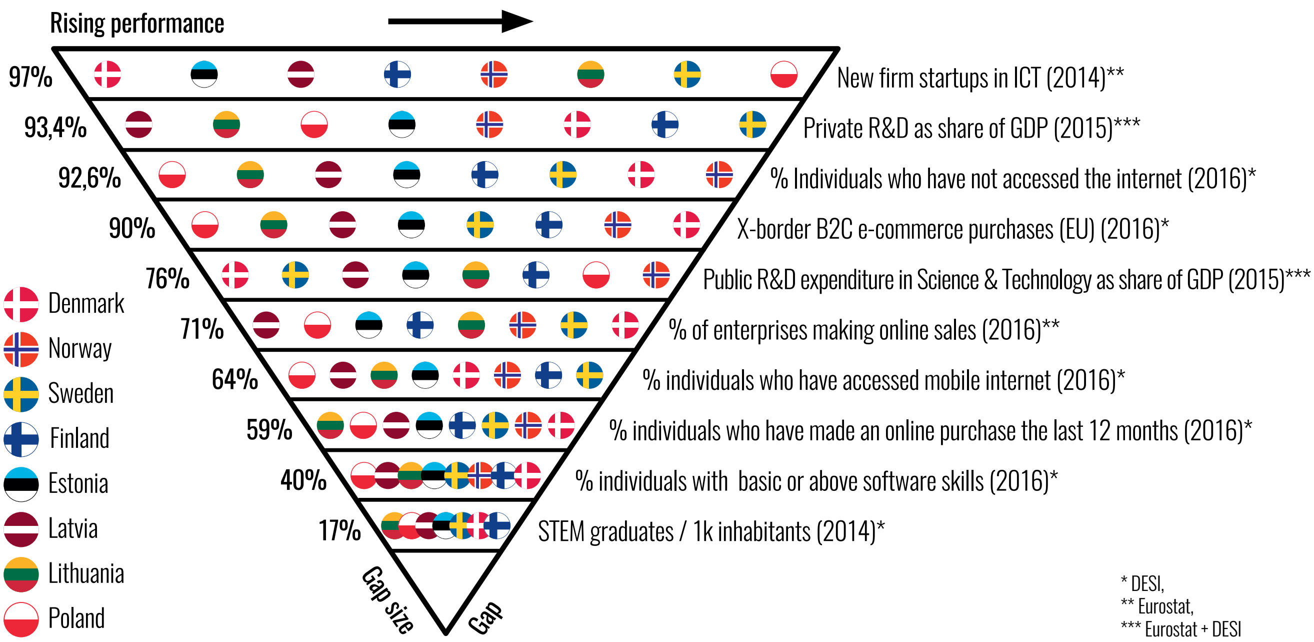
Another issue is to measure the conversion rate from starting up to scaling up. Latvia was in previous reports the country with most start-ups per capita, but at the same time the country faces significant challenges in their general digitization and many of the new firms do not seem to make it off the ground. It is one thing to measure the amounts of attempts, which is what this indicator tells us, and quite another to identify what is needed for these attempts to succeed. For the latter, start-ups must be put into the wider context of digitization and economic development.

For *private investments in R&D*, measured as share of GDP, the internal ranking between the countries remains the same except that Sweden has overtaken Finland in the lead. The gap between leader and lagger has grown somewhat since last year, but not to the levels of 2013 (96%).

The third largest gap is a new indicator, but an extremely important one. It measures the share of the population that reportedly is not a regular *user of internet services and functions*. In some sense, this is a measurement of the portion of each country that is lagging behind in the digitization of society and the economy. Here there is a clear and worrisome gap between the Nordics and the Baltics and Poland. While about one and a half percent of Swedes have not accessed the internet, the corresponding number in Poland is over 22%. Even though Latvia may have many ICT-related start-ups per capita, it is also noteworthy that more than 17% of Latvians are not internet users. This indicator provides an idea of how adaptable each country will be to new technological developments. While Estonia is still the leading fast-mover in overall digitization in the BSR, it is still in between the Nordics and the other Baltic countries and Poland when it comes to internet users, implying that there is still some work to be done there.

Cross-border business to consumer purchases remains a large gap within the region (90% between the leader and the lagger). While the total gap has only decreased marginally, it is noteworthy that Finland has fallen behind both Norway and Denmark, which takes the lead. In combination with the indicators for share of businesses making online sales and share of people making online purchases, this provides some idea of the current

Gap size graph



state of e-commerce. Denmark comes out a strong leader in all categories, followed most closely by Norway and Sweden. Poland finishes last in online purchases, and next to last both when it comes to firms selling and consumers purchasing online. Lithuania appears to have a fairly strong presence of firms selling online, but has the lowest share of individuals buying online. In addition, the gap in use of mobile internet is growing, from 54% in 2015 to 64% in 2016. This echoes the worries from the number of people who are not internet users, in particular in Poland.

When it comes to *public R&D expenditure* the overall gap has grown marginally, but the order of the countries has shifted somewhat. Latvia has overtaken Estonia, and Finland falls behind Norway and Poland. Perhaps a bit surprising, the next to smallest gap is the share of individuals with basic or above *software skills*. This is an important indicator of the conditions to adapt to digitization in the labour market in each country. The share ranges from 47% in Poland to 79% in Denmark. While the Nordics stick out in this category, its relevant to note that almost half of people in Poland are estimated to have basic or above software skills, even though the definition of very basic refers mostly to using software and processing content.

The smallest gap in this year's data is that for *graduates in Science, Technology, Engineering and Manufacturing (STEM)* per 1000 inhabitants. Again, the picture will look different in absolute numbers, where Poland sticks out. In combination with the share of the population who are not internet users, this indicator provides an idea of how human capital can be leveraged to advance digitization within each economy. In some sense, these two indicators, which span different ends of the gap size graph, together illustrate a balance between people leading ahead and lagging behind in each country.

There are some general conclusions that are echoed from previous years. Poland, even when lagging behind, makes an important contribution by its sheer size. The Nordics are leading more or less across the board, but are not exhibiting strong development. They are still "lagging ahead", to use the phrase from last year's report. Estonia is showing strong signs of development and is closing in on the Nordics on several indicators, moving away from the other Baltic countries. The most important conclusion, however, is that not much is changing, and this is starting to look like a real problem.

2.2 AT A CROSS-ROADS

The science fiction author William Gibson is quoted to have said "The future is already here. It is just not evenly distributed". This appears to be increasingly true in the BSR. During the three years that this report has monitored the development, it has become evident that each of the eight countries have some comparative advantages and that they could potentially benefit from closer macro-regional cooperation. However, it is equally clear that, with the exception of Estonia, the gap between the Nordics and the Baltics and Poland is not closing. In particular, Poland, Lithuania and Latvia do not seem to be taking off.

The situation can be summarized as follows:

- While the BSR has the potential to realize the idea of a "top of digital Europe", the last three years this report has shown that the region does not fully manage to leverage this potential. There is a considerable risk that the region is going to be fragmented, as Estonia breaks away from the Baltics and competes with the Nordics. At the same time, some of the leading Nordic countries appear to be stuck "lagging ahead", exposing them to being taken over by others with stronger development. Without more market integration and progressive policy measures, the region risks fragmenting, making it harder to cooperate in the future.

- Estonia is moving fast and shows strong development across the board. If the current pace of change continues, the country may soon catch-up, if not surpass, the Nordics and other digital frontrunners in Europe. In terms of economic size, Estonia is too small to lift the entire Baltics on its own, but it could act as a bridge between the Nordics and the Baltics.

2.3 A STRONG CASE FOR CONTINUED AND DEEPER EFFORTS FOR MACRO-REGIONAL COOPERATION

The three State of the Digital Region reports (2015, 2016 and the current year 2017) present policy proposals to further strengthen macro-regional cooperation in the BSR and to leverage the comparative advantages of the individual BSR countries. The first report emphasized the need to strengthen the region's human capital ecosystem through e.g. mobility of human capital, to develop transnational testbeds and develop data to better understand adoption of and adaption to digital technologies in the education system. The second report emphasized the role that cities in the BSR-region could play in being forerunners for their countries in establishing cross-border solutions and connecting start-up ecosystems through city-to-city networks. This year's report follows in the footsteps of the previous ones, but emphasizes the need to strengthen learning and suggest for example a BSR-wide testbed for reinventing education.

While three years is arguably a short time to adapt to a digital shift in the economy, this is also a crucial point in the global development of digitized economies. Automation, which is the theme for this year's report, is on the rise, but so is nationalism and protectionism. Unless the entire region strengthens their macro-regional cross-border efforts and develops an increasingly joint digital market, there is a considerable risk that it grows more fragmented instead.

This would be a missed opportunity for all countries. The Nordics are strong when it comes to digitization, but they are not alone in the global frontline and they are comparatively small. They could benefit from being part of a larger macro-regional market. Meanwhile, the Baltics and Poland all have the basic conditions for catching up and perhaps even leapfrogging in different ways in their own digitization. What all this comes down to is that the BSR countries are at a cross-roads, choosing between developing together or breaking apart.

There are several different policy initiatives in the direction to encourage and support a joint development. For example, at the Nordic-Baltic Ministerial Conference on Digitalisation in April 2017, the ministers in charge of digital development in Norway, Sweden, Denmark, Finland, Iceland, Faroe Islands, Greenland, Åland, Estonia, Latvia and Lithuania, signed a declaration which expressed a desire to strengthen digital co-operation in the region and to leverage its leading position in order to spearhead the realisation of a digital single market and develop a cohesive digital infrastructure in the region.

Furthermore, in 2016, BDF and Estonia jointly published a working paper for Transnational Digital Collaboration in the Baltic Sea Region.[2] National policymakers and ICT associations from the entire BSR jointly identified three action areas:

2 http://www.bdforum.org/transnational-innovation-and-digitalisation-policy-papers-and-strategy-guide/

(i) strengthening the knowledge base, (ii) support exchange of experiences and regulatory dialogue and (iii) define and launch transnational projects with a clear BSR added value. This laid the foundation for an ambitious pilot project on transnational collaboration in digital transformation, cross-border digital services and digital policies, DIGINNO, co-funded by the Interreg BSR programme, to be implemented 2017-2020 by ministries and ICT business associations from nine BSR countries[3].

There are also examples of policy related cross-border pilot initiatives in the BSR. This includes ideas and projects to facilitate digital identification (eID)[4], to connect digital start-up ecosystems in small and medium-sized cities in different countries[5] as well as to develop the BSR towards a position as a global digital test hub[6].

Despite these initiatives, the realities of the development of the BSR in recent years is that the region is at a cross-roads. This is also emphasized further by this year's thematic focus on automation. Statistics from the BSR countries suggest the potential of a double polarization in the BSR economy. Each country is subject to job polarization, while also being part of a polarization between the Nordics on the one hand and between the Baltics and Poland on the other hand. Estonia keeps catching up with the Nordics, but this raises the question of whether Estonia can play the role of bridging the gap in the region or not.

As the speed of technological change intensifies, there is an urgent need to realize the potential in macro-regional collaboration in the BSR and go from grand visions to action and short-term change. Realising the macroregional potential (and avoiding fragmentation) calls for a spectrum of policy initiatives. As stated above, previous reports on the State of the Digital Region have for example emphasized policies to develop transnational testbeds and cross-border friendly data (Top of Digital Europe 2015a) as well as the potential in connecting cities and digital startup ecosystems in the region (Top of Digital Europe 2016). This year's report emphasizes education and learning.

3 http://www.bdforum.org/speed-up-a-baltic-sea-region-digital-single-market/
4 http://norden.diva-portal.org/smash/get/diva2:902133/FULLTEXT01.pdf
5 http://www.bdforum.org/publications/connecting-digital-start-up-ecosystems-in-nordic-cities/
6 http://www.bdforum.org/16630-2/

3 AUTOMATION: A LEARNING SHIFT IN THE DIGITIZED ECONOMY

3.1 CHANGE IS A CONSTANT

For as long as we have had technological advances and innovations in the economy, we have had heated debates about the possible impacts of new technologies on employment. A typical example is the so-called "Luddites" in England in the 19th century. The Luddites were textile workers and weavers who destroyed weaving machinery to protest against the increasing use of machinery in their industry. They were afraid that their skills would become useless if machines came to replace them. The term "technological unemployment" is sometimes used to denote the loss of jobs caused by technological change.

Despite frequent fears of technological unemployment, there is in fact rather little historical support for the hypothesis that employment rates are reduced by new technologies, at least at the aggregate level. During the 20th century, for instance, the employment-to-population ratio rose despite the fact that technological advances were rapid and labour supply increased as many women entered the labour force (Autor 2014, 2015). Unemployment rates showed no systematic long-term increase. Furthermore, even though certain segments of the economy experience falling employment, they tend to be compensated by rising employment in other parts of the economy. For instance, from around the 1950s and onwards, agricultural productivity rose sharply in many countries because farmers could increasingly use machinery, e.g. tractors and combine harvesters, to facilitate sowing and harvesting across large areas. As a result, employment in agriculture fell. But at the same time, employment in more modern manufacturing industries rose. In a similar manner, in many advanced economies today, manufacturing employment is stagnant even though productivity is strong. It is instead employment in services that appear to grow.

This illustrates that labour markets are not constant over time. The relative demand for different types of skills, experiences and education profiles in a country evolves as economies and societies develop and change. For example:

■ **Globalization** has implied shifts in industry specialization patterns. Many developed countries have witnessed a gradual process of re-location of labour-intensive activities towards countries in which labour and production costs are lower. The countries from which such activities leave then experience lower relative demand for the kinds of jobs associated with those activities. For example, in the late 20th century when the "iron-curtain" fell and the Baltic countries opened up for global trade, many firms in the textile industry in Sweden re-located labour-intensive tasks to the Baltic countries to take advantage of significantly lower wage costs.

■ **Technological development** implies that new types of products and services emerge, and that firms respond by changing their production technology and work organization. Because of this, the nature of job tasks and the relative demand for different skills change. An example of this is the growing importance of software in many industries. Software is becoming "ubiquitous" in the sense that it is an essential part of many different products and services. As a result, software development is today a core activity in many different firms. A recent investigation in Sweden suggested that among many of the large R&D-intensive firms in the country, 4 out of 10 R&D workers are occupied with software development.[7] This is a drastic change as compared to the situation just 10 to 15 years ago.

■ The combination of urbanization and digitalization has implied the emergence of **new types of markets**. A case in point is the growth of dense digital markets in cities (Top of Digital Europe 2016, Wernberg and Dexe 2016). This has facilitated the growth of "matchmaking businesses", like Uber and Airbnb, that develop digital platforms that connect supply and demand in more efficient ways. Development of new business and new business models also often imply demands for new types of skills or changes in the relative demand for existing skills.

The points above are just a few examples. The bottom line is that labour markets have never been, and will never be, constant. As forcefully emphasized by Joseph Schumpeter (1931), the economy is dynamic and evolving. Over the course of history, the economy has been subject to (and has endogenously created), changes in technology, changes in preferences of consumers, changes in competition and changes in location patterns of people as well as firms. Schumpeter argued that such dynamics are associated with "creative destruction" - i.e. '*the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one*' (Schumpeter 1942). In fact, creative destruction is an inherent characteristic of economic development and leaves significant footprints in labour markets: processes of creative destruction continuously alter the structure and nature of industries, firms as well as whole economies. Because of this, the types of skills that are rewarded and demanded in the economy are evolving.

The line of reasoning above comes to show that the issue is not whether or not computers, software and more recent computational technologies are changing labour markets; they will have an influence and labour markets are not constant. Instead, the real issues are:

1. In what ***directions*** are these new technologies changing the labour market? Do they favour certain types of workers and/or certain types of tasks, while replacing others?

2. At what ***speed*** are these changes occurring? Can we develop our human capital quickly enough to accommodate the changing nature of labour markets? For example, does it suffice to change the educational curriculums at our universities today so that a new generation of graduates with new skills and knowledge can feed industry in 5-10 years? Or, are the time scales of change much quicker so that relevant needs can only be satisfied through constant learning and re-training of the labour force?

3. Do we, at the societal level, have the necessary ***adaptive capacity*** to alter our institutions, regulations and policy initiatives? What changes are needed in educational systems? Are our old philosophies of education compatible with the new landscape? Are our labour market regulations flexible enough to cope with, for instance, rising demands on mobility, training and life-long learning?

The subsequent sections discuss what current research say about these issues and point to likely consequences for the BSR.

3.2 DIRECTION

Human and computational activity

Digitization is a general-purpose technology, comparable to steam engines or electricity. That is, its development is both vertical and horizontal in the economy and its impact is not limited to one or a few sectors (Top of Digital Europe 2015a). This also suggests that in some sense there is no specific digital market, because there is no non-digital market (Wernberg and Dexe

7 https://www.nyteknik.se/innovation/4-av-10-fou-anstallda-utvecklar-programvara-6578226#conversion-122831618

2016). The economy, as well as society at large, is going through a digital shift that is changing the conditions for innovation, entrepreneurship, and economic exchange. Or, in the words of author Cory Doctorow:[8]

> *"General-purpose computers have replaced every other device in our world. There are no airplanes, only computers that fly. There are no cars, only computers we sit in. There are no hearing aids, only computers we put in our ears."*

When it comes to assessing the impact of digitization, a lot of attention has been directed towards human-centric complementary applications of new technologies – for example word processors, smartphones, social media, apps and platform economies, or sharing economy services. All of these examples contribute to transforming the economy in different ways, but they also have in common that they are tools for human actors. The technology depends on and amplifies human activities. While human-centric applications will continue to develop and spread to new applications, this is only the tip of the iceberg.

Under the hood of digitization is computational technology, i.e. the ability for machines to perform computations that can be translated into information, decisions or actions performed by hardware. This is what powers industrial robots as well as social media feeds and "people who bought this also look at" recommendations in online bookshops. Computational technology is also what fuels development in machine learning and artificial intelligence. This in turn improves the ability for machines to perform increasingly advanced activities, pushing the balance between technological and human activities. Rather than depending on human actions or being isolated to perform a meticulously monitored activity at an assembly line, digitization is developing towards machine-to-machine interactions and autonomous technological activities, for example the internet of things and self-driving cars. This in turn shifts the balance between human and technological activities. Technological solutions are going from being mute complements to human activities to being substitutes for some of those activities. This has ignited a growing debate about automation and the "destruction of jobs".

Consider how a taxi driver's work has changed with digitization. Before GPS technology was widely available, a taxi driver had to know street names and navigation by heart, something that appears to have generated exemplary memory within this profession (Maguire et al 2000; 2006; Kalakoski and Saariluoma 2001). This was also a strong argument for having specific taxi driver licenses. With modern GPS-navigation, on the other hand, technology amplifies the driver's ability to drive by removing the need to know street names or even the direction there. This development is brought to light when ride-hailing apps like Uber and Lyft disrupt the organization of drivers into taxi companies, by matching would-be drivers with users, on demand, over their digital platforms.

Two things have happened at this point. First, the match-making platform displaces the need for taxi call centres to connect drivers and users. Second, because anyone can use their smartphone as a GPS-navigator, the ride-hailing apps tap into an underutilized resource of potential drivers. Without GPS-technology, the scope for a ride-hailing app would look very different. In the near future, it also looks like drivers may be replaced by self-driving cars. This would imply that more or less the entire taxi company has been reinvented by combining self-driving cars and a digital platform for matchmaking. If we allow ourselves to stretch the example further, much of the white-collar workers and management in this new taxi company may potentially be replaced by a blockchain ledger that keeps check on the economic history and performance of the company, turning it into a "decentralized autonomous organization" (DAO) (Bauman et al 2016). What does this mean to the future of work? Are we going to run out of jobs?

Jobs and tasks

In 2003, a group of researchers from MIT and Harvard University in USA introduced a taxonomy of occupations to map how technological development would affect different parts of the workforce (Autor et al 2003). They suggest four different categories depending on if the occupation was routine or non-routine and whether it was predominantly cognitive or manual:

- Non-routine cognitive task-intensive occupations
- Routine cognitive task-intensive occupations
- Routine manual task-intensive occupations
- Non-routine manual task-intensive occupations

They argue that non-routine cognitive but also to a lesser degree manual tasks are highly complementary with new digital technologies, while routine tasks (both cognitive and manual) are highly susceptible to being automated. Put differently, new technologies would make non-routine cognitive occupations more productive while completely automating routine occupations.

Levy and Murnane (2004) elaborate on this approach by sorting information processing tasks along a spectrum in relation to the type of cognitive skills it demands. At one end were tasks that could be easily described by algorithms, and on the other end were tasks that included uncertainty and required adaptability, like driving a truck. Their argument is that the division of labour between humans and computers should play to each's comparative advantage. Computers can make a wide range of calculations very fast, while people are better at recognizing non-trivial patterns and improvising, skills that are required for instance when driving a car. Similarly, Levy and Murnane also count complex communication to the human workforce's comparative advantages. This does not, however, take into account that technologies develop in ways that are hard to predict.

With recent development in computational technology, however, the balance on the information processing spectrum has shifted. Brynjolfsson and McAfee (2011) states that with the development of computational technology, for example algorithms related to big data analysis and pattern recognition, are becoming increasingly good at substituting even cognitive tasks. A few years later, Brynjolfsson and McAfee (2014) contrast these conclusions to the disruptive technological development that followed its publication and conclude that (ibid, p. 19):

> *"Self-driving cars went from being the stuff of science fiction to on-the-road reality in a few short years. Cutting-edge research explaining why they were not coming anytime soon was outpaced by cutting-edge science and engineering that brought them into existence, again in the space of a few short years."*

The takeaway here is *not* that Levy and Murnane got it wrong, but that predicting the direction in which new technologies are moving the labour market is becoming an increasingly complex challenge.

8 http://reviewthefuture.com/?p=317

Digital technologies are general purpose technologies that permeate the entire economy, consisting of application technologies and computational technologies that reinforce each other. First, a wide variety of new application technologies relying on the same or similar computational technologies have been increasingly adopted in all sectors of the economy. This is followed by a rapid development in the underlying computational technologies. The spread of application technologies contributes to the impact of advances in computational technologies, which in turn enables new application technologies that are more autonomous than human-centric. In addition, parallel streams of new technologies interact as advances in one niche market are translated to other parts of the economy or give rise to new niche markets.

While Levy and Murnane may have underestimated the impact of new computational technologies on the labour market, their observations and conclusions still hold great value when it comes to understanding the development as it unfolds. They define jobs as groups of tasks, which in turn are influenced by technological development. This means that it is tasks, not jobs, that are being automated. Thus, provides a much more detailed take on the relation between human and computational activity. New technologies that substitute a limited amount of the tasks within a job are considered as tools - think of the GPS navigator for taxi drivers. These tools act complimentary to the tasks that are still performed by a human. That is, when Autor et al (2003) describe technology as complementary to non-routine cognitive task-intensive occupations it is because technology only takes over parts of the tasks in these jobs. The problem with this *routinization hypothesis* is that what can be described as a routine, shifts over time, for instance with the introduction of new machine learning technologies. Consequently, there is an ongoing interaction between technological development and the labour market, that must be taken into consideration.

The organization of tasks is not constant over time either. When tasks are automated and performed by machines or software, there is no need to keep to a task organization that is defined by human capabilities and limitations. Consider again the comparison between taxi drivers and self-driving cars. A fleet of taxi drivers will act independently but perhaps be coordinated by a central switchboard operator. A fleet of self-driving taxi cars may act more like a swarm. Every car is directed by the same software, so that routes can be optimized. In addition, if one of the cars is involved in an accident, not only this car but every car in the fleet can learn from the one experience. In other words, when new technologies lead to the automation of tasks, i.e. the removal of human performance, the way the tasks are related to each other and organized into job functions will most likely shift.

The organization of human jobs is also affected by the relation to technological development. In the wake of the industrial revolution, for example, a lot of jobs were organized around factories, and later the assembly line. Since then, a lot of the tasks that have been shifted to machines and software were monotone, hard, strenuous or even dangerous. When such tasks are shifted away from people, they save time, energy and attention that can be redirected to something else. Again, when Autor et al (2003) conclude that highly educated workers may become more productive with the use of computer technology, this means that they can spend more time and energy on tasks that play to their comparative advantages. It is also possible that technological developments allow for a larger institutional reorganization of both tasks, jobs and businesses. The introduction of hospitals allowed doctors to spend more of their working time examining patients and less travelling between them, for example.

While it may be tempting to think of automation in the labour market as a finite number of tasks (or jobs) gradually being taken by machines, it is also important to consider how the reorganization of tasks have resulted in both new jobs (webmaster, barista, Uber driver) and the reintroduction of old jobs, for example as high-end services in the hipster economy (barber, butcher, craft beer brewer). Jobs, or even tasks are not finite, but defined by what other people or firms are willing to pay for in a market economy. In an interview in 2014, Google founder Larry Page remarked that

> *"The idea that everyone should slavishly work so they do something inefficiently, so they keep their job — that just doesn't make any sense to me. That can't be the right answer."*[9]

Job polarization and technological unemployment

What is the aggregate impact of computers, software and computational technologies on labour markets? In terms of what they mean for the distribution of jobs at the aggregate level, the evidence suggests that they increase the relative demand for non-routine tasks.

There are two parts to the body of empirical evidence on this issue. First, there is evidence of "job polarization" in the US as well as in Europe. For example, Autor et al (2006) present evidence from the US, Goos and Manning (2007) from Britain, Heyman et al (2016) from Sweden, and Goos et al (2009) for Europe. Job polarization means that the share of employment in occupations in the middle of the skill distribution declines, while the share of employment in occupations in the upper and the lower ends of the skill distribution rises. Typical middle skill occupations include consumer sales, office and administrative workers, production workers and operatives. High skill occupations are for example professional, managerial and technical occupations whereas examples of low skill occupations include service and labourer occupations.

Second, there is significant evidence suggesting that job polarization can be explained by the "routinization hypothesis" of Autor et al (2003). The argument is as follows: Many middle-skill occupations, e.g. manufacturing and clerical occupations, have a high intensity of routine tasks, and are consequently more susceptible to being replaced by computers. If they can be replaced by computers, then the relative demand for such jobs should fall as computers and computational technologies become more ubiquitous. On the other hand, the relative demand for non-routine jobs should increase. Key to the argument is that, as stated above, non-routine jobs consists of two categories: (i) non-routine cognitive task intensive occupations which are typically high-education and high-income jobs and (ii) non-routine manual tasks intensive occupations which are often low-education and low-income jobs.

Putting these two parts together, we get a situation in which the nature of technological change is such that it feeds a process of simultaneous growth of high-education/high-wage jobs and low-education/low-income jobs at the expense of middle-education/middle-wage jobs. This is the routinization hypothesis in action, and it has received significant empirical support from analyses that study labour market dynamics in a wide set of countries.

The work that builds from the routinization idea suggests that even if computers and computational technologies have significant consequences for labour

9 https://www.ft.com/content/3173f19e-5fbc-11e4-8c27-00144feabdc0#axzz3JSO6UoKa

markets, there will always be tasks for which humans have a comparative advantage and these tasks are associated with both high and low skills. Autor (2014) refers to Michael Polyani's famous argument that humans have a lot of so-called 'tacit knowledge', i.e. *we know more than we can tell*, and this means that there is a lot of knowledge that never can be pinned down in the form of computer code.

However, as argued above, authors like Brynjolfsson and McAfee (2014) have partly challenged conventional wisdom on these matters by claiming that new computational technologies, in particular artificial intelligence and machine learning, implies that a growing number of tasks are susceptible for automation. In short, they claim that recent advances imply that computers are starting to "take over" in job domains that just five to ten years ago were considered strongholds for humans. That is, there are arguments in favour of that technology is increasingly able to overcome the hurdles associated with non-routine tasks, at least non-routine manual tasks. This has paved the way for a renewed debate on the matter of labour market consequences of recent computational technologies.

In a much-cited study, Frey and Osborne (2013) take this line of argument even further by investigating "how susceptible jobs are to computerization". Their strategy was to ask a number of experts in machine learning to assess which occupations are likely to be automated in the near future. The experts were given a list of occupations and a list of reported task structures associated with each occupation. They were then asked to judge the technological potential for automation of the occupations.[10] Based on the assessments of occupations by these experts, Frey and Osborne estimate that about 47% of US employment is at significant risk from automation. Their analysis was widely distributed and has added significant fuel to the growing debate about automation and a possible "destruction of jobs" in the future. Partly in contrast to the job-polarization story, Frey and Osborne find that the risk of automation is especially high for low-skilled workers and low-wage occupations, i.e. workers with low education and low wages would be hit hardest.

Several studies used the same data to assess risk of automation in other countries as well. The standard idea in many of these follow-up studies is to use the data on risk of automation by occupation developed by Frey and Osborne (2013), and simply apply it to countries other than the US.

10 The question the experts were asked was: "Can the tasks of this job be sufficiently specified conditional on availability of big data, to be performed by state of the art computer-controlled equipment?" (Frey and Osborne 2013, p.30).

For example, Jeremy Bowles at BRUEGEL uses Frey and Osborne's calculations of automation risk by occupation and applies it to the EU labour force survey. His calculations suggest that on average in the EU28, 54% of jobs are at a significant risk of being automated (see Table X). There are still significant variations across individual countries. In the BSR, the Nordic countries have the lowest fraction of jobs at significant risk of automation, whereas it is somewhat higher in the Baltic countries. Poland is the only country in the BSR that is above the EU average of 54 %.

Country	**Employment in jobs with significant risk of automation (%)**
Sweden	46.7 %
Denmark	49.5 %
Finland	51.1 %
Norway	n.a
Estonia	53.9 %
Lithuania	51.9 %
Latvia	51.1 %
Poland	56.3 %
EU-28 average	54.0 %

Note: based the methodology in Frey and Osborne (2013). http://bruegel.org/2014/07/chart-of-the-week-54-of-eu-jobs-at-risk-of-computerisation/

A critique to the study by Frey and Osborne (2013) is that it assumes that whole occupations rather than single job-tasks are automated by technology. As argued previously, it is indeed important to recognize that what is automated is first and foremost *tasks* rather than whole *jobs*. In labour market research, for instance, an occupation is often conceptualized as a bundle of tasks (Gathmann and Schönberg 2010). If occupations that are classified as having a significant risk of being automated also comprise tasks that are *not* likely to be automated, then the method by Frey and Osborne (2013) is likely to overstate the risk of automation. For example, if only some of the tasks in a job may be automated, workers could switch to doing other tasks more intensively in the same job.

A recent OECD-study by Arntz et al (2016), called *The risk of automation for jobs in OECD countries*, employs a more reasonable task-based approach. To motivate a task-based approach, they, amongst other things, make a few examples of the problems of talking about the automation of whole occupations rather than tasks. One example is as follows (Arntz et al 2016, p. 14):

■ According to FO[11], people working in the occupation "Bookkeeping, Accounting, and Auditing Clerks" (SOC code: 43-3031) face an automation potential of 98%. However, only 24% of all employees in this occupation can perform their job with neither group nor face-to-face interactions.

11 FO = Frey and Osborne (2013).

The point with this example is to show that within occupations that we normally think of as being susceptible to automation, there are tasks that require typical "human skills". In the example above, these are interaction in groups and direct face-to-face communication with other people. In assessing the automatability of an occupation, we need to account for the different types of tasks that the occupation is associated with and the skills necessary to perform the different tasks.

When Arntz et al (2016) take into account that occupations are heterogeneous in terms of the composition of tasks, the calculated risk of automation is reduced rather drastically. For example, for the US, they find that only 9% of all workers face high automatability. The OECD average suggest that only 9% of workers are subject to high risk of automatability. Frey and Osborne (2013) also find significant variations across countries. Table Y below presents data for countries in the BSR, except Lithuania and Latvia for which data are not available.

It is evident from the table that, compared to the picture that emerges from Frey and Osborne (2013), see Table X, the situation looks much more positive when assessing tasks and automation rather than occupations and automation. According to the analyses in Arntz et al (2016), Norway is the country in the BSR with the highest fraction of workers facing high automatability (10 %). In these revised calculations, it is also clear that Estonia and Poland have the lowest automatability risk in the BSR. We will come back to this in our discussion of the implications for the BSR.

Country	**Share of workers at high risk of automation**	**Mean automatability**
Sweden	7 %	36 %
Denmark	9 %	38 %
Finland	7 %	35 %
Norway	10 %	37 %
Estonia	6 %	36 %
Lithuania	n.a	n.a
Latvia	n.a	n.a
Poland	7 %	40 %

Note: based on data reported in Arntz et al (2016).

Still, Arntz et al (2016) confirm one of the conclusions from Frey and Osborne (2013); i.e. that workers with lower education and lower qualifications are more likely to be hurt by automation. The automobility of their jobs are higher than for the jobs typically held by more educated and more qualified workers. A recent study for Sweden also showed that estimated probabilities for automation show a strong relationship with education levels. In Sweden, a person with only elementary education has a three times higher risk of losing his/her job due to automation than a person that has completed a doctoral degree.[12]

In summary:

- Recent technological change brought by computers and computational technology has fuelled job polarization in many countries. Job polarization refers to the simultaneous growth of high-education/high-wage jobs and low-education/low-income jobs at the expense of middle-education/middle-wage jobs.

- Empirical evidence from task-based investigations suggests that recent advances in computation technology, like artificial intelligence and machine learning, is unlikely to destroy a large number of jobs. On the other hand, the negative impact of task automation is likely to be concentrated to the low-qualified share of the workforce, a group that will arguably have a harder time to adapt to the development.

Navigating under growing uncertainty

The interactions between different streams of applications of digital technologies combined with the development of computational technologies and the reorganization of tasks across both human and computerized activities all contribute to a rising uncertainty about the direction that the labour market is taking in response to technological development. What this implies is that it is going to become harder for policymakers to predict the future need for skills and education in the labour market. This is most likely not a passing phase, but a new condition that policymakers, just as business leaders and workers, must learn to relate to. It is also affected by the increasing pace of technological change.

In a paper from the 1960s, Nobel laureate Herbert Simon discussed the potential consequences of "computerized work". He foresaw that computers would not lead to massive rates of unemployment, but that they would lead to a shift in the types and composition of jobs. In line with modern research evidence, the general conclusion was that computerization would lead to a shift from blue collar and clerical work towards jobs involving a greater intensity of the comparative advantage of humans, although it was also noted that the uncertainty regarding the particulars of the development is high. He wrote:

> *"In the entire occupied population, a larger fraction of members than present will be engaged in occupations where "personal service" involving face-to-face human interaction is an important part of the job. I am confident of stating this conclusion; far less confident in conjecturing what these occupations will be"*

3.3 SPEED

Exponential development

The perhaps most iconic illustration of how technological development is accelerating is the so-called Moore's Law. It was introduced by Gordon Moore (later cofounder of Intel) in 1965 who predicted that the number of components on one integrated circuit, i.e. its computational power, would roughly double every year. This prediction has held up remarkably well, so much so that it has become known as Moore's law (although it has also been revised and disputed, and is now commonly thought to be better defined as a doubling in computational power every 18 months). What this describes is an *exponential* development in computational power over time. This increase in computational power in turn creates an exponential increase in potential capacity for all applications relying on that computational power. This means that existing applications and uses can improve, but also that a wider variety of new (previously impossible) applications can be added.

It is against this backdrop that the futurologist Ray Kurzweil (2005) formulates a *law of accelerating returns* in interactions between technological developments in areas like robotics, nanotechnology and artificial intelligence.[13] Brynjolfsson and McAfee (2014, p. 48) illustrate the impact of exponential development in computational technologies:

> *"[C]ars that drive themselves in traffic; Jeopardy! -champion supercomputers; auto-generated news stories; cheap, flexible factory robots; and inexpensive consumer devices that are simultaneously communicators, tricorders, and computers - have all appeared since 2006, as have countless other marvels that seem quite different from what came before. One of the reasons they're all appearing now is that the digital gear at their hearts is finally both fast and cheap enough to enable them. This wasn't the case just a decade ago."*

Provided that digital technologies have already been integrated in virtually all parts of society as a general-purpose technology, this implies exponential developments in computational technologies will have a more profound impact on society and the economy, and that the turnover of such developments will accelerate.[14] This in turn suggests that the speed at which technological development is interacting with and affecting the labour market is accelerating.

Consider Gartner's typical hype cycle curve where technologies first rise to a *peak of inflated expectations*, then fall into a *trough of disillusion*, then rise again along a *slope of enlightenment* to a (lower) *plateau of productivity*.[15] With more new technologies and faster pace, overlooking technological development will become significantly harder, predicting it even more so.

Technological progress and human aging

Every new generation grows up with a set of new technologies that they become native general users of. A typical illustration of this is the numerous YouTube videos of infants unlocking tablets, or trying to swipe at their parents' tv without touch screen. Up until recently, this generational bonding to technologies was in sync with our educational system. This meant that when a new generation of high school students or university graduates entered the labour market they brought with them their native generational tech skills from childhood and from being exposed to it during the school years. This generated a turnover in implicit technical skills within companies, which then diffused vertically through the organization as these individuals advanced in their careers. That is, a sales or marketing manager with the right implicit technical skills will know how to leverage new technologies to amplify the productive

12 http://eso.expertgrupp.se/wp-content/uploads/2014/12/2016_4-Digitaliseringens-dynamik.pdf

13 Kurzweil predicts that this will lead to a technological singularity in which artificial intelligence surpasses not just individual human intelligence but the collective intelligence of humanity.

14 http://www.huffingtonpost.com/peter-diamandis/why-tech-is-accelerating_b_8951550.html https://singularityhub.com/2016/03/22/technology-feels-like-its-accelerating-because-it-actually-is/

15 http://www.gartner.com/technology/research/methodologies/hype-cycle.jsp

output that comes from their knowledge about sales or marketing.

As technological development has accelerated however, there seems to be a growing gap between implicit technical skills and educational attainment. Consequently, while new university graduates may bring expertise skills that businesses require, these are not met sufficiently well by general, implicit technical skills. In other words, technological development is now moving significantly faster than human aging and the output of the educational system.

This was for instance illustrated by a series of Swedish newspaper articles and polls reporting that Swedish companies lack "digital skills" on their boards.[16] It is also illustrated by employers stating that they cannot recruit employees with the right set of skills (including digital skills), and EU-wide reports of lacking "e-skills" (BDF 2015b). Against this backdrop, the EU commission launched a "New Skills Agenda" in 2016, with the goal to "ensure that the right training, the right skills and the right support is available to people in the European Union".[17] This is, however, not "just" a mismatch between what is being taught in the educational system and what businesses demand to maintain competitive, it is a mismatch between education and technological development altogether.

There are at least three different ways to approach this gap between specific subject knowledge and general technical skills. First, the content of the educational system can be changed to cover what is considered relevant technical skills. If this is well done and focuses on the more slowly developing foundations of computational technologies rather than specific application technologies, this might counter some of the gap between educational and technological development. On the other hand, this implies that the educational system must be able to keep up with technological change to be able to determine what to teach and also to train teachers who can then educate students. That is no small challenge. This is way the ambition to integrate end user skills (application technologies) in the school curriculum often ends up with the students being more tech savvy than the teacher teaching them (remember that if human aging and technological development moves at different speeds, the gap will be smaller when the students are younger).

The second approach to bridging specific education and general technical skills is to rearrange company organizations to try to improve the vertical diffusion of skills from newly hires in the organization. An extreme version of this argument would be to say that company boards should take on teenagers who are up to date with the newest trends in technological applications. The problem is that this teenager will lack all of the subject knowledge that this tech savviness needs to be combined with. The third approach to this issue, which is what is promoted in this report, is to rethink learning entirely.

A learning shift

While learning arguably takes centre stage in an information- and knowledge-intensive economy, it is not guaranteed that education is up to the task. In the middle of a digital shift in the economy and society, many if not most European education systems might instead be on the verge of being optimized for the industrial society.[18] For most people, this implies that after graduating from high school or university, they are "done" and have the necessary skills to make a career that lasts a lifetime. Any pedagogical opinions aside, this educational model is challenged in at least three ways: the turnover of knowledge during the duration of a career, the priority of knowing over learning, and the homogenous approach to learning.

In a labour market shaped by exponential technological change that is integrated into every part of the economy, the turnover rate of knowledge is also accelerated. The skills of a new university graduate will no longer sustain their entire careers in a profession like for example marketing. They will need to learn about new technologies, new marketing platforms, interfaces, search engine optimization techniques and viral strategies in order to remain competitive in their labour market. What they need to learn about after that, we don't even know yet. This partly comes down to the fact that some of the knowledge they got during their university education is old by the time they graduate, but this will not be solved by an updated curriculum. Educators and graduates both face the challenge of keeping up with development before and after graduation, respectively. The issue of outdated skills has always been present in labour markets, but the fact that it affects people with master's degrees is something quite new to the equation.

One thing this comes down to is the balance between knowledge and learning. Historically, when information and knowledge were scarce resources, there was an evident need to copy and retain knowledge between people. In this context, *what* people learn might arguably be considered more important than *how* they learn. Consider the phrase "knowledge is power" - it implies that knowing more than other people provides a comparative and strategic advantage. In a knowledge-intensive economy where information is abundant, this classic phrase might be reformulated as "learning is power". If jobs are bundles of tasks, some of which are gradually automated, this requires people to either improve their skills in the remaining tasks or to learn how to perform new tasks. This puts heavy emphasis on the ideal of lifelong learning, and the need to learn how to learn. This becomes even more evident in the face of rapid developments in machine learning and artificial intelligence. Along this vein, Avent (2016, p. 41) states that:

> *"A capability threshold has been crossed. And while humans sort out how to exploit new machine capabilities to their fullest, machines are being made more capable still. The main protection human workers now have against machines is that the machines are not very smart; they write dry, boring news stories, for instance. But that is no protection; machines are much better at becoming smarter than people are."*

What Avent implicitly points out is that in the future economy, both machines and people will be dependent on interacting with each other through continuous, adaptive learning. In essence, digitization is bringing about a learning shift in the economy and on the labour market.

This furthermore begs the question of how the challenge of education should be framed and valued from a labour market perspective. In the wake of industrialization, there was demand for a workforce with homogeneous skills and, by extension, interchangeable workers. Even at universities, education has been packaged in standardized programs to match specific occupations and professions, sometimes giving universities themselves an assembly-line factory character. Yet, if jobs are bundles of tasks that are being reorganized in response to accelerated automation and technological progress,

16 https://digital.di.se/artikel/atta-av-tio-styrelsemedlemmar-saknar-digital-kompetens
https://www.va.se/nyheter/2014/11/26/digital-utmaning/
ttps://internetworld.idg.se/2.1006/1.663791/styrelser-svaga-digitalisering
https://digital.di.se/artikel/underkant-storbolagens-digitala-kompetens-sjunker
17 http://ec.europa.eu/social/main.jsp?catId=1223&langId=en

18 https://www.theguardian.com/commentisfree/2017/feb/15/robots-schools-teaching-children-redundant-testing-learn-future?CMP=twt_gu
http://learning-reimagined.com/

prompting continuous adaptive learning for the duration of a normal career, should the skill distribution of the workforce become more specialized (homogeneous) or more diversified (heterogeneous)? Should people be educated into professions if professions themselves are changing or even dissolving (Susskind and Susskind 2015)? Assuming that there is a greater uncertainty as to the future direction of the labour market and technological progress, a homogeneous workforce will be more prone to volatility if key tasks corresponding to the workforce's joint skill set are automated, while the effect could arguably be smaller for a workforce with more diversified skills.

For the educational system, this provides three basic challenges: First, students must be taught not just *what* to learn but *how* to learn in order to be equipped with the tools to continue learning new skills and acquiring new knowledge throughout their careers and lives. Second, higher education and vocational training needs to be reorganized to cater not just to young people in between high school and entering the labour market, but to interact with them throughout their careers. Third, it can no longer be taken for granted that the quality of higher education (or any education) can be determined solely from its ability to fit students into a profession-shaped mould.

Adoption or adaptation

While digitization in school and education remains a high priority among policy-makers and educators, it is oftentimes reduced to a question of *adopting* new technologies rather than *adapting* to them (Top of Digital Europe 2015a). Introducing new technologies into the classroom makes for a visible gesture, but the impact might be mute unless it's taken into consideration how these technologies can be leveraged in teaching and learning.

The entire educational system, from elementary school to university programs, is structured around industrial era scale economies of knowledge transfer, i.e. that everyone receives the same information in the same way and hopefully accumulate it at least to a similar degree.[19] That is, this was the efficient way to teach as many people as possible in as short time as possible, especially since interaction and feedback from the teacher was a bottleneck. This is no longer necessarily the case. A growing number of EdTech companies are providing alternative ways to use data-driven technologies for individualized feedback and learning aids, for instance in mathematics.[20] This is an example both of how tasks within the teacher's work are being automated (in this case, providing individual feedback to a large number of students is also organized more efficiently by software than by a teacher interacting sequentially with the students one at a time) and of how new scale economies in education can be found in individualized, adaptive learning software tools powered by machine learning.

In other words, developments in machine learning and artificial intelligence may pave the way for what The Economist describes as "*software that tailors courses for each student individually, presenting concepts in the order he will find easiest to understand and enabling him to work at his own pace*".[21] It might be that the teacher is still the bottleneck, but the difference between then and now is that teachers need to be given the resources and skills to leverage technologies in the classroom.

At the university level, Massive Open Online Courses (MOOCs) and platforms like Coursera, Udacity or edX provide a growing catalogue of courses that match students across the world with teachers who are world-leading in their subjects.[22] In 2011, two Stanford professors made their courses in artificial intelligence and machine learning freely available online and got a total of 260,000 enrolled students from at least 190 countries, out of which 26,000 students completed their course.[23]

At the same time, universities are geared predominantly towards full-time students to which they offer more or less strictly curated programs of predefined courses, not towards full-time employees gradually improving their skills over the duration of a career. University programs are in turn standardized, such as the Bologna framework, in order to, for example, assure quality and improve recognition of qualifications.[24] There is a trade-off between two ideals here: the ideal of tailoring university education into programs directed towards specific occupations, and the ideal of on-demand lifelong learning. Furthermore, packaging university educations in standardized programs imbue them with additional inertia and makes it harder to adapt them to new technological developments. This is a preserving rather than adapting system, and that might be turning into a problem. In comparison, the online education start-up Udacity uses the concept to "nano degrees" to package in-demand skills in courses that stretch a couple of months.

Signalling or learning?

How is the learning shift manifested in the labour market? First, employers play a key role in the learning shift that follows from exponential technological progress and increased uncertainty about the development in the labour market. There are two dimensions to the value of an educational degree in the labour market. The first is the knowledge and skills that the student has actually acquired as a result of their education. The second is the signal that the student managed to get through an educational program regardless of its actual contents. This implies that they have the discipline and tools to learn and to complete assignments i.e. traits that suggest that they will be productive.

With respect to signalling, a university degree or a vocational degree acts as a sort of entry ticket to the labour market, even if what the student has studied is not immediately applicable in the job she or he applies for. By extension, degrees from established universities or programs gain a specific status and function as a coordination tool for employers trying to identify potentially productive applicants. This is for example why a philosophy major from Oxford or Cambridge may be recruited as a highly paid investment banker, because employers know that it takes a lot to get that degree. Yet, this implies that online courses and non-traditional ways of acquiring skills and knowledge may automatically be at a disadvantage precisely because they are new, reinforcing traditional institutions through habit. If, however, there will be an accelerating turnover in skills within the workforce, employers may need to put greater weight on applicants' actual skills, and even more so on their ability to learn and develop those skills. This calls for new ways to identify and evaluate relevant applicants, not just at entry-level jobs.

Furthermore, consultancies, especially those in knowledge-intensive business services, may act as a buffer for learning in the labour market. New graduates are hired and receive

19 http://www.mynewsdesk.com/se/sydsvenskahandelskammaren/documents/mot-baettre-vetande-62820

20 See for example https://www.edqu.se/

21 https://www.economist.com/news/special-report/21700760-artificial-intelligence-will-have-implications-policymakers-education-welfare-and

22 https://www.coursera.org/
https://www.edx.org/
https://www.udacity.com/

23 https://www.economist.com/news/special-report/21700760-artificial-intelligence-will-have-implications-policymakers-education-welfare-and

24 http://ec.europa.eu/education/policy/higher-education/bologna-process_en

on-the-job training from their employer while they are exposed to a number of client firms within and across sectors of the economy. They also act as agents of knowledge accumulation and transfer between client firms. Interestingly, knowledge-intensive business consultancies will oftentimes hire the type of skills that their clients have not yet internalized, making them a potential proxy for how the demand for different skills develop within and between sectors.

3.4 ADAPTABILITY

Shifting conditions

The main concern with automation is not that computational technologies develop faster than previously thought possible, or that this allows machines and software to perform increasingly advanced tasks and cause a reorganization of tasks and jobs in the labour market. The main concern with automation should be our ability to respond to it. The combination of exponential technological change and growing uncertainty about the future development of the labour market implies a need for system-wide adaptability to leverage the benefits of the automation while also countering its setbacks. This requires adaptability within institutional and regulatory frameworks. Along this vein, Herbert Simon (1966) argues that economic institutions, much more than technology, impacts employment:[25]

> *"Workers have been displaced from agriculture and manufacturing. Agreed: The essence of automation and any kind of technological progress is to permit fewer to produce more. But on balance, workers have not been displaced from the labour market. At the end of a half century of rapid technological advance, at nearly the same pace as at present, unemployment is below 4 per cent and dropping. Thus, facts support theory in showing that economic institutions, not technology, determine the level of employment."*

Putting aside discussions on what a good institution is for the moment, the function of any institution changes or risks changing with technological development because the conditions and assumptions it operates on are altered. In light of what has been presented here, there are two such changes that need to be taken into account: the time frame for adaptation is shortening and the predictability of future demand in the labour market is shrinking.

For example, different types of long-term prognoses that are oftentimes used to predict the future need for different skills in the labour market (e.g. Cedefop 2016). These predictions are used to allocate resources across different types of university educations and vocational training programs, but also to try to motivate people to gravitate towards occupations where they will hopefully find jobs. This may work well enough as long as the development in the labour market is to some degree linearly predictable and adaptation can be carried out over the time it takes for a new generation to apply for, go through and graduate from the educational programs in question. In the face of growing uncertainty in the organization of tasks in the labour market and accelerated technological progress, however, this approach is fundamentally challenged: It becomes harder to make long-term prognoses and centralized coordination of educations as occupations become unfeasible over short time frames.

In light of changes like the ones described here, there is a growing interest in policy approaches that shift attention to bottom-up approaches rather than top down (Colander and Kupers 2014). In the absence of viable centralized planning based on a long-term prediction of labour market demand, there is a need for decentralized coordination around short-term predictions. This way, adaptability is derived from the aggregation of a myriad of individual-level decisions rather than from one centralized plan. This, in turn, requires an educational system and institutional frameworks that allows individuals to change their minds and to make repeated choices. This is what makes the system as a whole adaptive. This ties back to the need to reorganize education for actual lifelong learning and continuous interactions between the labour market and different forms of education as the turnover of skills increases. McAfee and Brynjolfsson (2017) describe these changes as a rebalancing - centralized control is not being replaced by decentralized coordination but the balance between the two are shifting.

Adaptive capacity included

Interestingly, the technological development not only calls for, but also enables adaptability in a wide range of different ways, some of which have already been hinted at.

Perhaps most importantly, technological development is in and of itself promoting learning and adaptability. Developments in computational technologies allow a wider range of people to perform tasks that require computational analytics, if they have the skills to utilize the technology. That is, technology may remove certain tasks from human jobs, but they could potentially also add new tasks to old jobs because new technology allows people to do things they otherwise did not have the skills for. In addition, advances in machine learning and data-driven applications are contributing to adaptive learning software, which in turn enables individualized education that is tailored for and responds to every student's needs. Combining this with online education platforms makes for powerful tools for learning that is decentralized in space and can occur at any time. These developments together have the ability to redefine how we think about education, *if* they are balanced by institutional frameworks that leverage these opportunities. This includes the educational system, but also the regulations for investments in intangible assets, as well as how employers identify relevant applicants in the labour market. It is against this backdrop that educational policy and re-training initiatives should be approached in the ongoing automation debate.

Furthermore, digitized cities and networks of cities, as well as the emergence of urban digital markets (Top of Digital Europe 2016; Wernberg and Dexe 2016) contribute to learning and adaptability in several ways. First, the concentration of people, activities and knowledge facilitate agglomeration economies, that promote entrepreneurship, innovation and by extension, productivity and growth. Second, cities concentrate demand/capita in a way that allows new trends, business models and skills to reach critical mass. Some types of services and business models simply would not be possible to sustain in sparsely populated areas. This also makes cities potential hotbeds for start-up activities. Third, the concentration of people as well as social and economic activities enables the organization of tasks into smaller or niched (personalized) bundles of work. The so-called gig economy, micro-capitalism or (commercial) sharing economy are typical examples of this.

Ideally, using a wide variety of platform economies, any individual can add tasks to the work they perform in a workday on a case by case basis, like being an Uber driver on their way to and from their

25 http://www.nybooks.com/articles/1966/05/26/automation-3/

workplace. Conversely, it would also be possible to put together a job completely from such tasks. It should be noted that the conditions for workers who rely heavily on this gig economy is the subject of heated debate, and in some cases certain tasks are limited to specific groups of people. For instance, in a number of countries only people with taxi licences are allowed to be Uber drivers. All such controversies aside, this de-bundling of tasks and work potentially contributes to labour market adaptability by making a wider range of tasks available to a larger group of potential workers. What should be debated is perhaps not *if* this development should be allowed, but *how* the institutional framework in the labour market can be adjusted to enable it while providing decent conditions for these workers. Empirical evidence suggests that while automation is unlikely to destroy most jobs, the impact of new technologies will be unevenly tilted to hit the low-qualified share of the workforce (Arntz et al 2016). This group faces the highest thresholds for getting back on the labour market if they lose their jobs. Adding the alternative of compiling small bundles of tasks into part-time jobs provides what may turn out to be an important economic buffer for this group even if they go through re-training.

Zooming out, the advances towards a single digital market are not limited to ones and zeroes crossing the borders. Just as important is the corresponding integration of labour markets and the mobility of skills and workers in the digitized economy. There is a need for a cross-border human capital ecosystem (Top of Digital Europe 2015a). A larger integrated labour market improves the potential for workers to leverage their comparative advantages to find jobs and for employers to find employees with the right qualifications. This is essentially true both for employers looking for people with advanced digital skills and for people adjusting to automation. Neither of these issues is solved better in isolation.

3.5 THE BALTIC SEA REGION - CURRENT SITUATION AND IMPLICATIONS

As a base to discuss the current situation as well as implications for the BSR in the context of labour markets, automation and learning, we will present data and discuss four main areas of interest:

1. Education
2. Business - investments in knowledge and learning
3. Labour markets
4. Automation - potentials and risks

Education

A conclusion from the literature is that with the rise of computational technology, in particular improved machine learning and advances in artificial intelligence at large, the need for strong educational efforts and lifelong learning will increase.

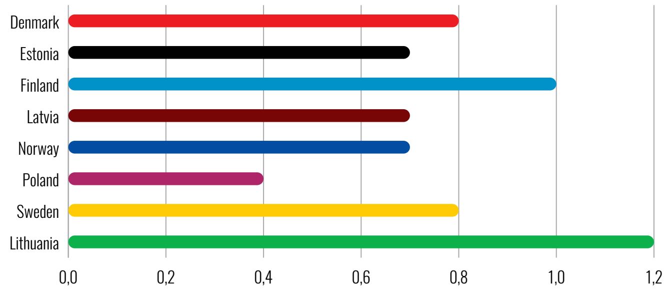
To begin, we study data on education in terms of production of new graduates in natural sciences, mathematics, statistics and engineering, as well as the number of students in vocational secondary education. The former is a measure of education that typically prepares for non-routine work, whereas the latter refers to education that is less 'academic' and prepares for immediate entry into the labour market. In general, vocational education prepares for work in a trade or craft.

Figure 1 shows the number of new graduates in natural sciences, mathematics and engineering produced in each country in the BSR 2013-2015 as a percentage of population. There are no distinct patterns in the figure that separates e.g. the Nordics from the Baltics. It is clear from the figure that Lithuania has the largest intensity of production of graduates (1,2%) followed by Finland (1%). Norway, Latvia and Estonia are on similar level (about 0.7%), whereas Poland lags behind significantly. In Poland, the production of graduates amounts to less than 0.4% of the population. However, it is important to note that in terms of sheer numbers, Poland is a large producer of graduates (see Top of Digital Europe 2015a).

FIG. 1

New graduates 2013-2015 as % of population

(EUROSTAT)



* Graduates in natural sciences, mathematics, statistics & engineering, manufacturing, construction & engineering and engineering trades

Looking at vocational secondary education (figure 2), we see that Poland dominates in terms of the number of students involved, but that the numbers fall between 2002 and 2015. In fact, in most countries in the BSR, we see a trend of stagnant development of the number of students in vocational secondary education. The only exceptions are Finland and Sweden which show significant increases around 2012/2013. In general, the stagnant development in vocational secondary education could reflect that students increasingly aim to prepare for tertiary education. Figure 3 presents the same data as Figure 2 but excludes Poland, because the patterns in the Nordics and Baltics are somewhat obscured in relation to the much bigger Poland.

FIG. 2

Students in vocational secondary education 2002-2015

(OECD)

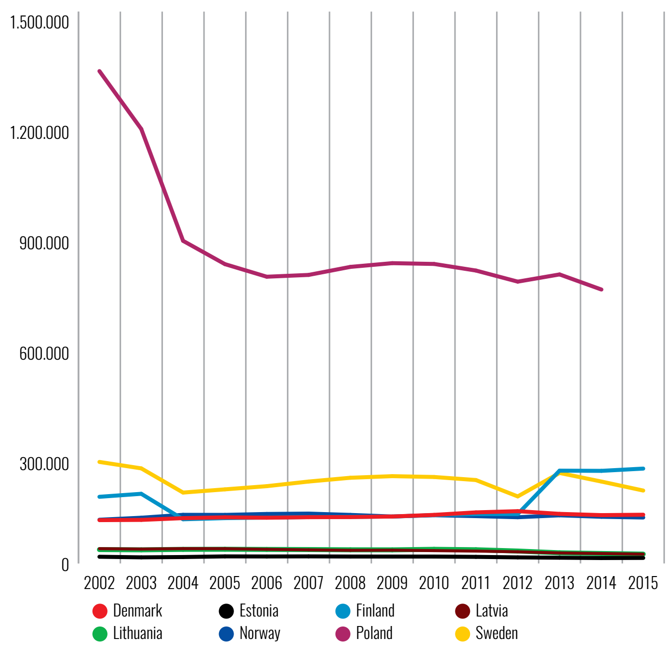
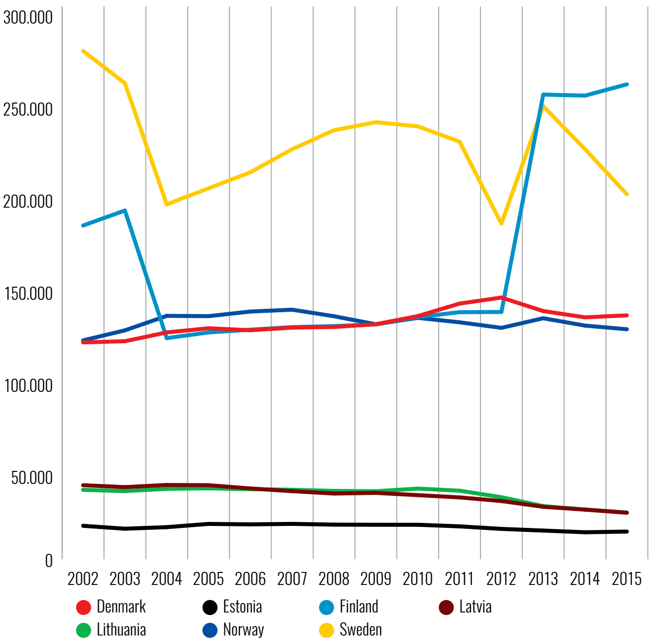


FIG. 3

Vocational secondary education in the Nordics and Baltics 2002-2015

(OECD)



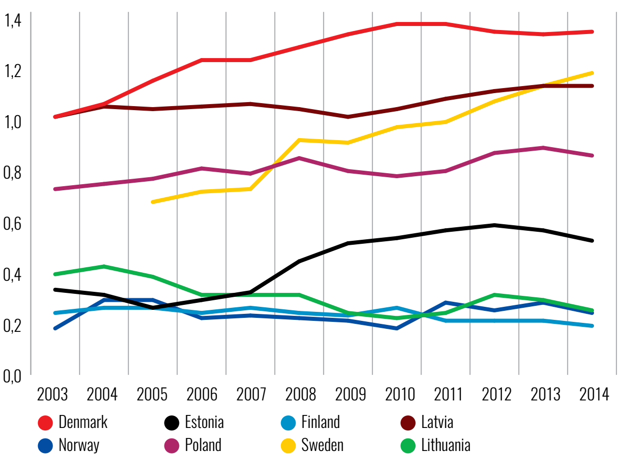
A third measure is participation in education and training by working adults. One of the key messages of this report is that the technological developments raises the need for continuous learning, and puts issues like "lifelong learning" at centre stage. There are no established ways to measure lifelong learning, but data on the engagement of working adults in education and training is one way to provide an indication of education and learning during working life.

Figure 4 shows that there are rather significant differences across the BSR with regards to the extent by which working adults are engaged in education and training. Denmark is on top where over 1,2% of the working adults were engaged in education and training by 2014. Sweden and Latvia follow with just over 1%. In Poland, the fraction of working adults engaged in education and training is close to 1%.

FIG. 4

Participation in education and training by working adults 2003-2014 (%)

(OECD)



Estonia shows a rather strong increase since 2007, but starts from a low level. In Lithuania, Norway and Finland, participation in education and training by working adults is low and the data shows no trend of any increase during the period considered in the figure (2003-2014).

However, it needs to be emphasized that the available data are rather uninformative about what type education and training that is referred to and what segments of working adults are involved. Data on lifelong learning and education are generally not well developed, and it is unclear to which extent data are reported in similar ways across countries. Just as was identified in Top of Digital Europe (2015a) concerning the need for better data on adaptation to digitalization in schools, we here emphasize a significant need for better comparable data on lifelong learning and education and training over the course of individuals' labour market careers.

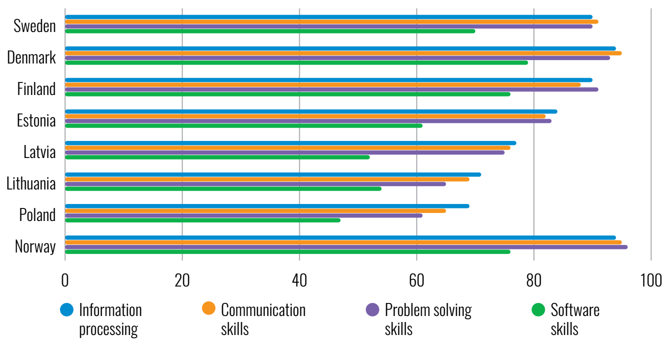
Figure 5 shows the share of individuals with basic or above digital skills in 2016. This measure is included to capture the underlying need for education and training digital skills across countries in the BSR. The figure makes a distinction between four types of digital skills: (i) information processing, (ii) communication skills, (iii) problem solving skills and (iv) software skills.

It is clear from the figure that in most countries, software skills are the least developed whereas information processing and communication skills are most developed. Looking at differences between the countries, we see that on average, the Nordics are ahead of the Baltics and Poland.

FIG. 5

Share (%) of individuals with basic or above basic digital skills 2016

(DESI)



Information processing skills refers to the ability to identify, locate, retrieve, store, organise and analyse digital information, judging its relevance and purpose.

Communication skills refers to communicating in digital environments, share resources through online tools, link with others and collaborate through digital tools, interact with and participate in communities and networks, cross-cultural awareness.

Problem solving skills refers to the ability to identify digital needs and resources, make informed decisions as to which are the most appropriate digital tools according to the purpose or need, solve conceptual problems through digital means, creatively use technologies, solve technical problems, update one's own and others' competences.

Software skills for content manipulation refer to the ability to create and edit new content (from word processing to images and video); integrate and re-elaborate previous knowledge and content; produce creative expressions, media outputs and programming; deal with and apply intellectual property rights and licences.

However, Estonia shows a stronger score on digital skills than its Baltic neighbours as well as Poland. In Estonia, over 80% of the population shows basic or above skills when it comes to both information processing, communication skills and problem-solving skills. This reinforces the picture of the strong development in Estonia, and that the country will soon catch-up with the Nordics.

We now turn to study investments that businesses in the BSR undertake in order to upgrade their skills and knowledge.

Business - investments in knowledge and learning

Businesses play an important role in facilitating development of skills and continuous learning of its employees. They can for example invest in training of their workers and invest in intangible assets. Figure 6a shows the fraction of business in each country in BSR that provide training to upgrade ICT skills 2012-2016. Figure 6b shows for 2016 how provision of such training varies by firm size.

It is clear from Figure 6a that Finland and Norway are on top but that they "lag ahead". In these countries, around 40% of businesses provide training to upgrade ICT-skills. However, the development in both countries during the period is that the fraction of firms is falling. Sweden and Denmark have a middle position in which about 30% of the firms provide training to upgrade ICT skills. The Baltics and Poland lag behind significantly. Only about 10% of the firms provide training to upgrade ICT skills. This is a significant gap compared to the Nordics. It is also worrisome as the data on the share of individuals that have basic or above digital skills show that it is in the Baltics and Poland (with the possible exception of Estonia) that training of ICT skills is most important.

FIG. 6A

Share (%) of enterprises providing training to upgrade ICT skills 2012-2016

(EUROSTAT)

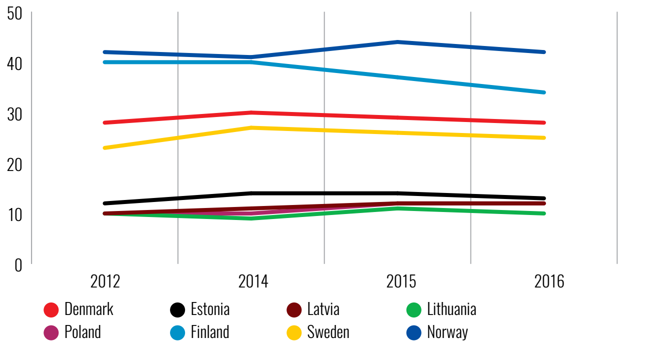
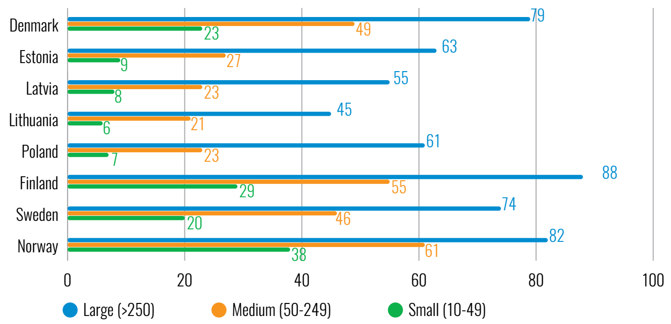


Figure 6b further shows that the gap between the Nordics and the Baltics and Poland is present across firms of all size classes. In all BSR countries, the general pattern is also that large firms are in general more likely to provide ICT training than small firms.

FIG. 6B

Share of enterprises providing training to upgrade ICT skills 2016

(EUROSTAT)



Finally, we look at intangible assets. Intangible assets are assets that do not have a physical or financial embodiment. OECD has classified intangible assets into three types:[26]

1. computerised information (such as software and databases)

2. innovative property (such as scientific and non-scientific R&D, copyrights, designs, trademarks)

3. economic competencies (including brand equity, firm-specific human capital, networks joining people and institutions, organisational know-how that increases enterprise efficiency, and aspects of advertising and marketing).

As computational technologies continue to develop, it is likely that intangible assets will rise in importance in many firms.

Figure 7 and Figure 8 show data on investments in intangible assets since the beginning of the 2000s in the BSR-region. This data shows that Sweden, Finland and Denmark are in a clear lead in the BSR-region. In 2016, for example, investments in intangible assets in Sweden and Denmark amounted to about 25% of gross fixed capital formation. In Finland, the same figure was about 20%. Norway is lagging behind the other Nordic countries and in 2016, both Estonia's and Norway's investments in intangible assets amounted to about 10% of gross fixed capital formation. While we also here see a gap between the Nordics and the Baltics and Poland, it is clear that Estonia, in terms of fraction of gross fixed capital formation, show a rather strong development since 2007.

FIG. 7

Investments in intangible assets as share (%) of gross fixed capital formation 2000-2016

(OECD)

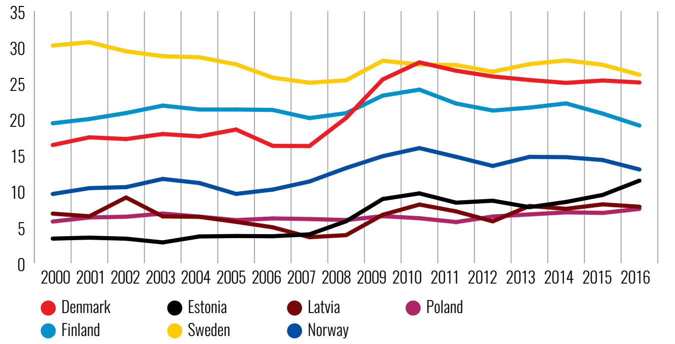
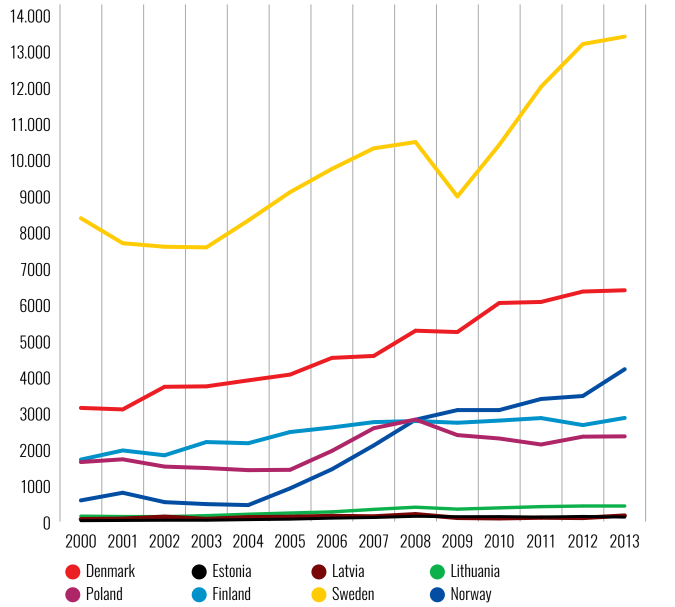


FIG. 8

Investments in intangible fixed assets (Million €) 2000-2013

(EUROSTAT)



26 See e.g. http://www.oecd.org/sti/inno/newsourcesofgrowthknowledge-basedcapital.htm and https://www.oecd.org/sti/inno/46349020.pdf

Labour markets

A main conclusion from the previous sections is that recent technological change has fuelled job polarization in many countries, such that there is a simultaneous growth of high-education/high-wage jobs and low-education/low-income jobs at the expense of middle-education/middle-wage jobs. Furthermore, there is increasing empirical evidence suggesting that recent advances in computation technology, like artificial intelligence and machine learning, imply a greater risk of creating problems for the low-qualified share of the workforce, a group that will arguably have a harder time to adapt to the development.

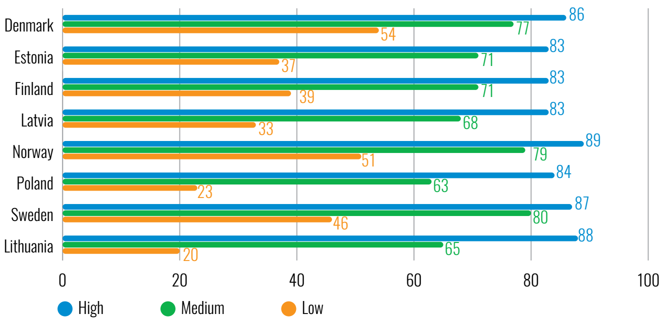
Against this background, this section studies characteristics of the aggregate labour markets in the BSR countries. We will study employment rates of workers by skill, importance and development of employment in occupations with arguably low susceptibility of automation as well as growth of employment in computer programming and consultancy, i.e. a business segment that is arguably top of digitalization.

Figure 9 shows the employment rate by skills in 2014 in the BSR-countries. It is evident from the figure that the differences between the BSR countries when it comes to the employment rate is rather small when we study the group of high-skill workers. The employment rate is over 80 % for this group in all the BSR countries.

FIG. 9

Employment rate 2014 by skill, %

(OECD)



There is still divergence when looking at workers with lower skills. For example, in Denmark, Norway and Sweden, the employment rate among low skilled workers is close to 50%. In Lithuania and Poland, the employment rate in the same group of workers is almost 30 percentage points lower. In Estonia and Latvia, it is somewhat higher, 37% and 33%, respectively. Among the Nordics, Finland shows a comparatively low employment rate of low skilled (39%).

The low employment rate of the low skilled represents a significant challenge. First, what we know so far about the direction of technological change suggest that it may be tougher in the future to secure employment of low skilled workers in the economy. Second, increasing polarization on the labour market may feed into divergence in political views and create instability. This alone provide arguments for seriously thinking about measures of skill upgrading, learning and adaptation of education systems and labour market regulations to accommodate the realities of current labour markets.

In fact, the data presented so far suggest that the BSR face a risk of "dual polarization". With this we mean that:

1. There is a significant risk of further polarization between high and low skill workers *within* individual BSR countries. Judging by available data on employment rates, this appears to be especially the case for the Baltics and Poland.

2. Unless Lithuania, Latvia and Poland start to follow in the footsteps of Estonia, there is a risk of further polarization *between* BSR countries. The Nordic countries are still ahead of the other countries in the region, but Estonia's development is strong and if it continues at its current pace, it will soon catch-up with, or even surpass, the Nordics. If Poland, Latvia and Lithuania do not pick up pace, this means that there will be further polarization between the countries in the BSR.

We now turn to more detailed data on the structure of the labour markets in the BSR countries. We will here focus on employment by occupation and by types of economic activity associated with the "new economy" and that by and large should be associated with lower risk of being susceptible for automation.

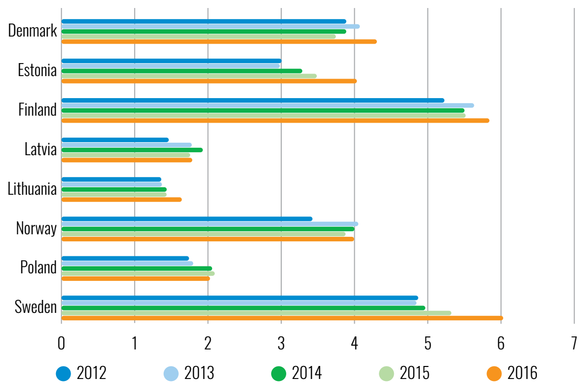
In looking at data on the occupational and industrial structure of the labour markets in a country, it is important to recognize that such data in principle represent the extent to which the economy provides "learning opportunities" for workers and "access to skills" for firms. For example, Hidalgo (2015) argues that knowledge and knowhow need the presence of industries to be developed, at the same time as industries need the presence of knowledge and knowhow to develop. For example, a software-developing firm needs experienced software developers, and software-developers need presence of software-developing firms to develop experience, train and learn new industry skills. In other words, the presence of an industry in a country or region can be seen as an expression of the knowledge, skills and know-how present in the country. On the other hand, industries also represent the structures needed for individuals to develop and accumulate knowledge and know-how, i.e. they represent learning opportunities.

Figures 10, 11 and 12 present employment by occupational categories. Figure 10 starts by showing the fraction of ICT professionals in the workforce. ICT professionals constitute a rather small group, but it is a core occupational group in the digital economy. It includes for example people working as *Software developers* and *Web and multimedia developers*.

FIG. 10

ICT professionals, % of workforce

(ILO, EU LABOUR FORCE SURVEY)



It is evident from the figure that Finland and Sweden have the strongest position in the BSR with 6% of the workforce having an occupation classified as ICT professional. Denmark and Norway follow with a fraction around 4%. The figure also shows the tremendous development in Estonia. Between the whole period (2012-2016), Estonia shows a significant increase in the fraction of workers that are ICT professionals and by 2016, Estonia is on par with the situation in Norway. However, at the same time the figure also shows that the development in the rest of the Baltics and Poland is rather sluggish and not close to be such that it shows signs of catching up with the rest of the BSR. The only possible exception is Lithuania that, though still on a low level, shows a significant increase in 2016.

Figure 11 shows the fraction of workers with an occupation classified as "Technician and associate professional". This is a group of occupations that ILO (International Labour Organization) describes as follows, performing "*mostly technical and related tasks connected with research and the application of scientific or artistic concepts and operational methods, and government or business regulations, and teach at certain educational levels*". They also state that tasks typically include "*undertaking and carrying out technical work connected with research and the application of concepts and operational methods in the fields of physical sciences including engineering and technology, life sciences including the medical profession, and social sciences and humanities*". On this indicator, Figure 11 shows that there is a rather stable gap between the Nordics and the Baltics and Poland. All the Nordic countries are above 15% whereas all the Baltic countries and Poland are significantly below and employment share of 15%.

FIG. 11

Technicians and associate professionals, % of employment

(ILO, EU LABOUR FORCE SURVEY)

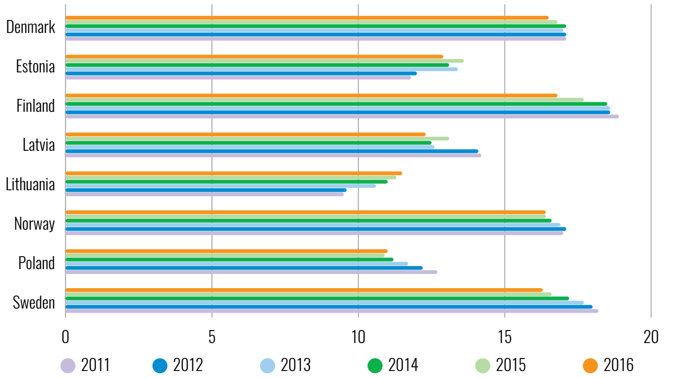


FIG. 12

Professionals, % of employment

(ILO, EU LABOUR FORCE SURVEY)

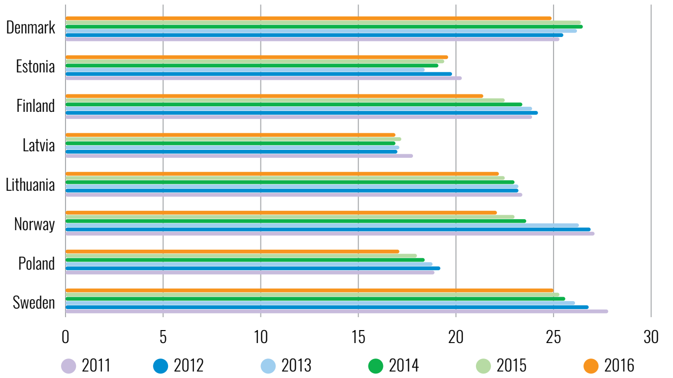


Figure 12 shows the results for professionals. Professionals are described by ILO as workers who "*increase the existing stock of knowledge, apply scientific or artistic concepts and theories, teach about the foregoing in a systematic manner, or engage in any combination of these activities*"[27]. Professionals are thus a group in which we find many high-skill non-routine work. Here we see a similar pattern as in Figure 11. The Nordics (especially Sweden, Norway and Denmark) are in a top position with the Baltics and Poland lagging behind.

Shifting the lens to study employment by types of economic activity instead of by occupation, a similar pattern emerges. In Figure 13, we see that the fraction of employment in Information and Communication activities is high in the Nordics and substantially lower in Lithuania, Latvia and Poland. Estonia shows a significant reduction in the fraction of workers in this activity, but that is most likely a result of that other sectors in the economy that use ICT are growing rapidly. Nevertheless, compared to the other Baltic countries and Poland, Estonia still shows a stronghold in this type of economic activity. Looking at economic activity classified as "Professional, scientific and technical activities" (Figure 14) we also see that there is a stable gap between the Nordics and the Baltics and Poland. Interestingly, when studying this broader aggregate, Estonia does not show a stronger position than its Baltic neighbours. Estonia shows a stronger position once we zoom in at the digital economy.

FIG. 13

Information and communication, % of employment

(ILO, EU LABOUR FORCE SURVEY)

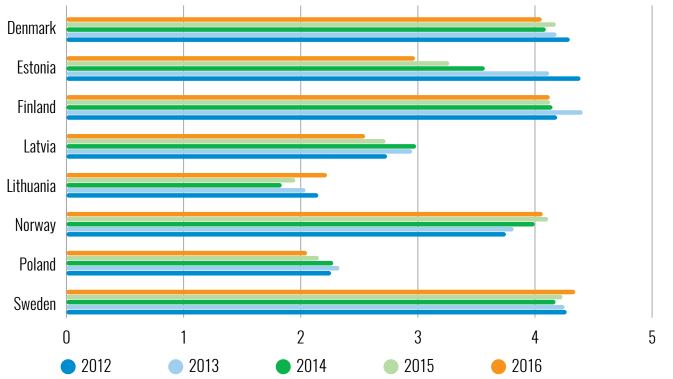
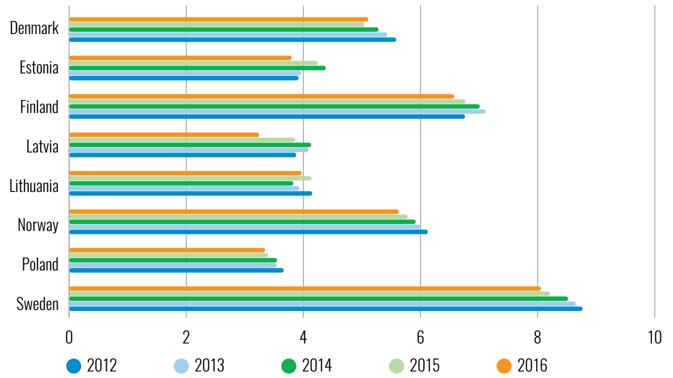


FIG. 14

Professional, scientific and technical activities, % of employment

(ILO, EU LABOUR FORCE SURVEY)



Finally, we study employment levels and growth in "Computer programming, consultancy and related activity", i.e. an industry representing a segment in the economy that may be argued to

27 http://www.ilo.org/public/english/bureau/stat/isco/isco08/

be on top of digitalization and increasing automation. Figure 15 shows levels of employment 2012-2016 and Figure 16 shows the corresponding employment growth (index: 2008=100) from 2008 to 2016. What emerges from these figures is that the sheer size of the industry follow closely the size of the individual countries. Poland has the largest amount of people employed in the industry and also shows a strong development in recent years. Estonia is on par with Latvia and Lithuania, even though they are known as digital pioneers compared to their Baltic neighbours. Looking at the employment growth, the industry shows the strongest development in Poland, Estonia and Lithuania.

FIG. 15

Employment in Computer programming, consultancy and related activities, thousands

(EUROSTAT)

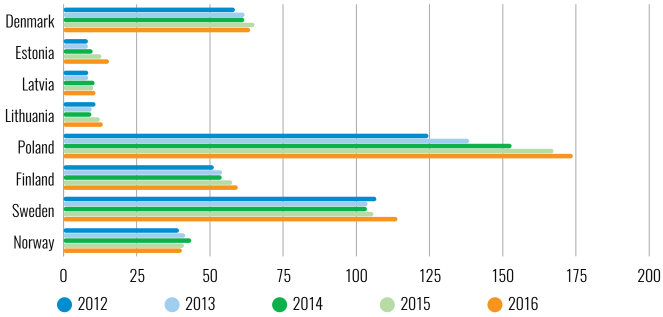
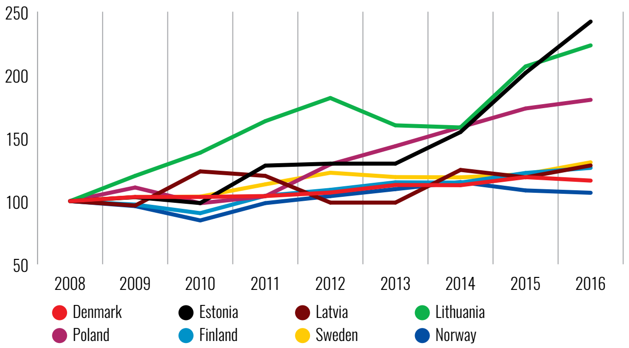


FIG. 16

Employment growth in Computer programming, consultancy and related activities, index=100

(EUROSTAT)



The patterns reported in the figures provide a good example of the fact that two countries which show rather weak scores on aggregate indicators for education, business investments and labour markets, may at the same time show significant development on specific indicators that capture parts of the economy. In other words, digitization is unevenly distributed. This is especially relevant in the context of growing polarization in the labour market and the economy, since it implies that individual indicators do not tell the whole story. Remember from chapter 2 that Latvia may at once be the country with most start-ups per capita, but is it also lagging behind on several other indicators of digitization. One indicator does not make a story.

Automation - potentials and risks

In section 3.2 on the direction of technological change, we cited two studies that have made explicit calculations of the risk of automation at the level of countries. These calculations included several BSR countries. BRUEGELs calculations based on the data from Frey and Osborne (2013) showed that all the countries in the BSR, except Poland, are below the EU28 average of 54% of jobs being at a significant risk of being automated. At the same time, in the revised calculations by the new OECD study (Arntz et al 2016), Estonia and Poland have an automation risk on par or lower than the Nordics. Most countries included in the BSR are also below the OECD average of 9% of jobs being automatable. What can be concluded for the BSR based on these data?

First, as already mentioned, new computational technology increases the risk that the employment gap between high and low skill workers rise. This is a challenge that is especially large for the Baltics and Poland. These are countries in which the gap in the employment rate between high and low skilled is already substantial.

Second, the fact that available evidence indicates that the automation risk is comparatively low in the BSR region, could be seen as a reflection of several underlying characteristics. The OECD study give two plausible reasons for why the fraction of jobs that are automatable differs across countries. One is that workplace organization differs, for example, such that some countries have a stronger focus on communicative tasks than others. Another reason is that countries differ in adoption rates of new technologies. If adoption rates are high, then new automation technologies may have already replaced labour. They also show that in countries that already have invested significantly in ICT, the risk of automation is lower.

In general, countries that develop and catch up can "leapfrog". This means that they can directly invest in new technologies and are not bound to old machinery and equipment to the same extent as countries who invested earlier. This, together with indications of countries in eastern Europe investing heavily in industrial robots may be one factor that reduce risk of automation in the especially the Baltics and Poland. For example, the International Federation of Robotics (IFR) has reported that the strongest growth figures for sales of industrial robotics in Europe were in the Central and Eastern European states. They also report that half of the top 10 nations with the most industrial robots per 10,000 employees belong to the European Union.[28]

This could suggest that the adoption argument may explain the comparatively low figures of jobs that are automatable in the Baltics and Poland. However, the uncertainty around these figures are high and there is a lack of data and established methods to undertake comparable calculations of the consequences of automation on labour markets. Most firms evidence point in the direction that the main challenge for the BSR concerns issues associated with job polarization and a potentially growing dual gap; within as well as between countries.

28 http://www.laserfocusworld.com/articles/2016/09/ifr-says-industrial-robot-installations-rising-rapidly.html

4 POLICY PROPOSALS

This report has outlined a perspective that describes automation and education as part of a larger learning shift in the digitized economy, driven by exponential technological change, growing uncertainty about the future development of the labour market and an increasing need for adaptability among workers, employers and policymakers alike. What this describes is a world that is changing faster and in less predictable ways. Formulating policy recommendations against this backdrop puts emphasis on adaptability and learning that can be strengthened in cross-border macro-regional collaborations.

A BSR-WIDE TESTBED FOR REINVENTING EDUCATION

There is a growing number of EdTech start-ups around the world that are working to improve education with technology (i.e. to adapt to rather than just adopt technologies in the classroom on different levels of education). Policymakers in BSR countries should work together to leverage these developments by providing a joint harmonized testbed for reinventing education, from elementary school to on-the-job training. This ambition can be advanced in several ways:

■ Develop teacher training initiatives that put teachers ahead of the technological development rather than lagging behind it.

■ Provide environments for developing and testing personalized education or adaptive learning software, i.e. a cross-border EdTech testbed.

■ Providing internationalization of EdTech start-ups within the BSR so that they gain access to the eight markets in the region just as easily as their own domestic market.

■ Cross-border evaluation and benchmarking school reforms related to adapting to new technologies.

INSTITUTIONS FOR A DIGITIZED LEARNING ECONOMY

While technological progress is speeding up and labour markets are undergoing profound changes, the institutional framework of educational systems remains surprisingly static in its structure. Yet, with accelerating turnover of skills and knowledge as well as gradual automation of tasks, there is a need for educational institutions that can cater to individuals throughout their careers. This ambition can be pursued for instance in the following ways:

■ Adapting higher education and vocational training to make it possible for more people to participate in further education continuously for the duration of their careers and not just at the very beginning of it. The ambition could be to provide small portions of education in time, rather than huge overhauls in university educations as a delayed response to changes in the economy. This could for instance be approached using experimental policy and cross-border collaboration to target key groups of workers and specific industries individually.

■ Benchmarking vocational training within the countries analysed (but also against countries like Germany) to develop a system that promotes re-training as well as further education as part of an ongoing career.

■ Introducing tax cuts to investments in human capital and intangible assets to increase market adaptation to the increasing turnover of knowledge and demand for new skills.

RIGGING THE ECONOMY FOR NEW JOBS

Many of the regulations and institutions that govern the labour market are based on the notion that there should be one job per worker. While most people will opt for the security of being fully employed if given the opportunity, there is a growing number of individuals who run businesses on the side, who participate in the sharing economy or otherwise engage in different forms of part-time micro-capitalism. These activities could potentially act as a buffer in the reorganization of tasks that follows in the wake of technological progress, but this requires institutional adaptation.

■ Measuring and sharing knowledge on the reorganization of tasks and jobs. There is a need for cross-border knowledge exchange, collection of new statistics and insights, as well as open-ended investigations into the learning shift in the digitized economy.

■ Introduce local policy experiments in cities and city regions to explore how policy can enable and promote new type of jobs and organization of jobs.

■ Investigate the potential for tax reforms that makes it easier for people to engage in micro-capitalistic exchanges, but also to use their earning to further educate themselves.

■ Explore reforms to improve mobility in the labour market, entrepreneurship and getting small firms to become employers.

REFERENCES

Arntz, M., Gregory, T., & Zierahn, U. (2016). The risk of automation for jobs in OECD countries: A comparative analysis. *OECD Social, Employment, and Migration Working Papers*, (189), 0_1.

Autor, D. (2014). *Polanyi's paradox and the shape of employment growth* (Vol. 20485). Cambridge, MA: National Bureau of Economic Research.

Autor, D (2015). Why are there still so many jobs? The history and future of workplace automation. *The Journal of Economic Perspectives, 29*(3), 3-30.

Autor, D. H., Levy, F., & Murnane, R. J. (2003). The skill content of recent technological change: An empirical exploration. *The Quarterly journal of economics, 118*(4), 1279-1333.

Avent, R. (2016). *The Wealth of Humans: Work, Power, and Status in the Twenty-first Century.* St. Martin's Press.

Bauman, D., Lindblom, P., Olsson, C. (2016). *Blockchain – Decentralized Trust*, Näringspolitiskt forum rapport #15, Swedish Entrepreneurship Forum

Brynjolfsson, E., & McAfee, A. (2011). Race against the machine. *Digital Frontier, Lexington, MA.*

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies.* WW Norton & Company.

CEDEFOP, E. ILO (2016): Developing skills foresights, scenarios and forecasts. *Guide to anticipating and matching skills and jobs, 2.*

Colander, D., & Kupers, R. (2014). *Complexity and the art of public policy: Solving society's problems from the bottom up.* Princeton University Press.

David, H., Katz, L. F., & Kearney, M. S. (2006). *The polarization of the US labour market* (No. w11986). National Bureau of Economic Research.

Frey, C. B., & Osborne, M. A. (2013). The future of employment. *How susceptible are jobs to computerisation?*

Gathmann, C., & Schönberg, U. (2010). How general is human capital? A task-based approach. Journal of Labor Economics, 28(1), 1-49.

Goos, M., & Manning, A. (2007). Lousy and lovely jobs: The rising polarization of work in Britain. *The review of economics and statistics, 89*(1), 118-133.

Goos, M., Manning, A., & Salomons, A. (2009). Job polarization in Europe. *The American Economic Review, 99*(2), 58-63.

Heyman, F., Norbäck, P. J., & Persson, L. (2016). Digitaliseringens dynamik–en ESO-rapport om strukturomvandlingen i svenskt näringsliv. Rapport till Expertgruppen för studier i offentlig ekonomi, 4.

Hidalgo, C. (2015). Why information grows: The evolution of order, from atoms to economies. Basic Books.

Kalakoski, V., & Saariluoma, P. (2001). Taxi drivers' exceptional memory of street names. *Memory & Cognition, 29*(4), 634-638.

Kurzweil, R. (2005). *The singularity is near: When humans transcend biology.* Penguin.

Maguire, E. A., Gadian, D. G., Johnsrude, I. S., Good, C. D., Ashburner, J., Frackowiak, R. S., & Frith, C. D. (2000). Navigation-related structural change in the hippocampi of taxi drivers. *Proceedings of the National Academy of Sciences, 97*(8), 4398-4403.

Levy, F., & Murnane, R. J. (2004). The new division of labor: How computers are creating the next job market. Princeton University Press.

Maguire, E. A., Woollett, K., & Spiers, H. J. (2006). London taxi drivers and bus drivers: a structural MRI and neuropsychological analysis. *Hippocampus, 16*(12), 1091-1101.

McAfee, A., & Brynjolfsson, E. (2017). Machine, Platform, Crowds: Harnessing Our Digital Future.

Oxford University,
< http://www. oxfordmartin. ox. ac. uk/ downloads/academic/The_Future_of_ Employment. pdf> [15/6/2015].

Schumpeter, J. A. (1931). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle.* Harvard University Press (1961, translated).

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy.* New York

Susskind, R., & Susskind, D. (2015). *The future of the professions: How technology will transform the work of human experts.* Oxford University Press, USA.

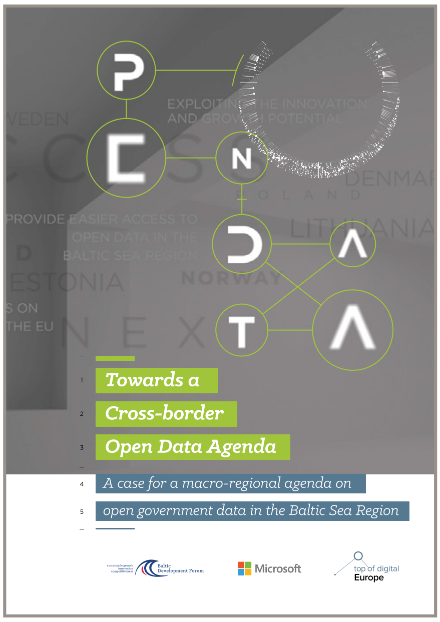
Top of Digital Europe 2015a: Lundblad, J., Andersson, M. *State of the Digital Region 2015: Leveraging a digital Baltic Sea Region*, Top of Digital Europe, Microsoft and Baltic Development Forum 2015

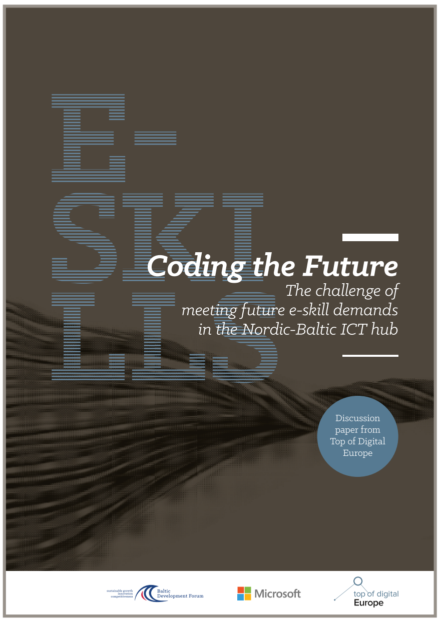
Top of Digital Europe 2015b, *Coding the Future - The challenge of meeting future e-skill demands in the Nordic-Baltic ICT Hub.* Top of Digital Europe, Microsoft and Baltic Development Forum 2015

Top of Digital Europe (2016): Wernberg, J., Andersson, M. *State of the Digital Region 2016: Cities connecting the digital economy in the Baltic Sea Region*, Top of Digital Europe, Microsoft and Baltic Development Forum 2016

Wernberg, J., & Dexe, J. (2016). Rewiring Europe. *J. Dexe. -Brussels: Wilfried Martens Centre for European Studies.*

TOP OF DIGITAL EUROPE PUBLICATIONS





The publications are available on www.topofdigital.eu and www.bdforum.org

ABOUT THE AUTHORS

MARTIN ANDERSSON

Martin Andersson is a professor of Industrial Economics at Blekinge Institute of Technology (BTH) and also professor of innovation studies at Lund University. He is also affiliated to the Research Institute of Industrial Economics (IFN) in Stockholm. His research focuses on the interplay between innovation, technology and entrepreneurship, as well as on cities, agglomeration economies and local labour markets.

martin.andersson@bth.se

JOAKIM WERNBERG

Joakim Wernberg is a research scientist at the Swedish Entrepreneurship Forum, focusing on the economic impact of and interaction between global macro trends. His primary research interests are complex adaptive systems, technological change, regional and urban economics. Joakim has a PhD in Economic Geography from the Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE), Lund University. He is affiliated to Lund University Internet Institute (LUii) and he is on the scientific advisory board of the Federation of Swedish City Centers (Svenska Stadskärnor). Joakim has a background in Engineering Physics, and he has several years of experience working as a public policy analyst and public affairs consultant.

joakim.wernberg@circle.lu.se

Edited by Baltic Development Forum
Flemming Stender
Torben Aaberg
Christopher Reeves

Year:	2017
Published by:	Baltic Development Forum (BDF)
Contact:	Baltic Development Forum Nytorv 3, 1st Floor DK-1450 Copenhagen K, Denmark Phone: +45 70 20 93 94 Email: bdf@bdforum.org www.topofdigital.eu www.bdforum.org
Designed by:	OZOLS IR, Latvia

top of digital
Europe

ICT Think Tank
for the Baltic Sea Region

Top of Digital Europe is an independent, non-profit think tank that promotes the Baltic Sea Region as a leader in the ICT sector. Top of Digital Europe facilitates cross-border dialogue and public-private initiatives with the ambition to strengthen the digital economy in the Baltic Sea Region. Top of Digital Europe is a joint initiative of Baltic Development Forum (BDF) and Microsoft. We are welcoming new partners.

www.topofdigital.eu