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THE IMPACT OF AUTOMATION AND ARTIFICIAL INTELLIGENCE IN THE LABOUR MARKET

EL IMPACTO DE LA AUTOMATIZACIÓN Y LA INTELIGENCIA ARTIFICIAL EN EL MERCADO DE TRABAJO

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INDEX

1. Abstract 3
2. Resumen 4
3. Introduction 5
   3.1. What is Automation 5
      3.1.1. Historical Approach to Automation 5
   3.2. What is Artificial Intelligence 6
      3.2.1. Example - Google Deep Mind 6
4. Two different methodologies to measure the impact 7
5. Potential impact of Automation plus AI 11
   5.1. Impact of the Labour Markets 11
      5.1.1. Europe 11
      5.1.2. United States 13
      5.1.3. Japan 13
   5.2. Impact by Sector 14
   5.3. Demographic Impact & Equality 16
   5.4. Impact on the Productivity 20
6. Implications for Businesses 22
7. Policies 24
8. Conclusions 25
9. Bibliography 26

1. ABSTRACT

The purpose of this paper is to synthesise the most relevant aspects of the potential effect of automation and artificial intelligence in the economy and especially in the labour market using the most important authors on this matter.

This paper begins introducing the main problem that the society is facing nowadays which is the destruction of employment due to the quick technological advancements, differencing between automation and artificial intelligence, explaining their main features and lastly, exposing briefly the potential result when both work together.

Next, two methodologies used throughout the whole paper are explained and detailed in order to quantify the number of jobs that are in high risk of being automated. These two methodologies are used to study the possible impact of technology on the European, American and Japanese economies and then the same it is done by sectors. With all the information, we can see how important is the academic background in order to determine which people and what genders will be the most affected by technological unemployment. Lastly, on a social level, we measure the effect of automation and artificial intelligence when it comes to creating inequality in terms of wages and educational background.

Subsequently, it is observed the impact on a business level, the possible benefits of adopting technology and the barriers that are to be overcome to remain competitive. In a similar way, we can see the positive and stimulant effect on productivity both at the micro and macroeconomic level.

Finally, it is also important to mention the actions that government and business must carry out to prevent a polarisation of the society and ensure the sustainability of the labour market.

2. RESUMEN

Este trabajo de fin de grado tiene como objetivo sintetizar los aspectos mas relevantes del posible efecto de la automatización y la inteligencia artificial en la economía, y sobretodo, en el mercado de trabajo a través de los autores mas relevantes en esta materia.

El trabajo comienza introduciendo el principal problema al que la sociedad se enfrenta, que es la destrucción de empleo debido a los rápidos avances tecnológicos, diferenciando entre automatización e inteligencia artificial, explicando sus principales características y finalmente exponiendo de una forma breve el potencial resultado que se obtiene cuando ambos se juntan.

A continuación, se exponen y se detallan las dos principales y más relevantes metodologías utilizadas para cuantificar el número de puestos de trabajo que se encuentran en alto riesgo de automatización. A través de esas dos metodologías se estudia el posible impacto de la tecnología en las economías europeas, americana y japonesa para después hacer lo propio por sectores. A través de los anterior podemos observar la importancia de la formación académica a la hora de determinar que personas y que géneros serán más afectados por la tecnología. Por último, a nivel social, se mide el efecto que tienen la automatización y la inteligencia artificial en la desigualdad en términos de nivel educativo y salarios.

Posteriormente, se analiza el impacto de las innovaciones tecnológicas a nivel de empresa, los beneficios que traerán para la empresas, así como las barreras que han de superar para permanecer competitivas. De igual modo, se estudia el efecto positivo y estimulante que tienen a nivel de productividad tanto micro como macroeconómico.

Por último, se pone de manifiesto las acciones que los gobiernos y empresas deben llevar a cabo para prevenir una polarización de la sociedad y evitar la caída del nivel de empleo debido a la tecnología.

3. INTRODUCTION

Self-driving vehicles, 3D printers, speaking robots or self-learning are four of the most renowned technological innovations in the last years. Computers and new technologies are changing the world and at the same time raising the alarm about employees losing their jobs and being replaced by robots and other automatic processes.

Keynes in 1930 said: “We are being afflicted with a new disease of which some readers may not yet have heard the name, but of which they will hear a great deal in the years to come – namely, technological unemployment”

The reality is that Keynes failed to predict the future as technology has made important advances during the second half of the XX century and the opposite happened: technological waves brought a considerable rise in employment in the developed countries although that doesn’t mean that jobs haven’t been lost to automation, especially those with routine tasks.

However, the recent advancement in fields such as AI has fuelled the fear of a jobless future due to the fast growing and the potential side effects in terms of equality and implications for business and policymakers.

3.1 WHAT IS AUTOMATION

From an engineering and technological point of view, automation can be defined as the technology used in a process without human assistance. The process works by itself with a set of directions, data and instructions given by humans that may or may not be present, controlling what the machine does (Groover, 2010) Automation machines are usually repetitive and cannot adapt to different situations unless a human or another machine change the instructions and data specified in the computer controlling the machine.

From an economic or business administration point of view, automation is an opportunity to increase both the productivity and the efficiency and therefore the competitiveness of companies, sectors, regions or countries. It is well known that machines are more productive than human because they eliminate the potential human error factor and optimise the processes in order to produce a greater amount of product and at the same time reduce costs of time, personnel and material.

3.1.1 Historical Approach to Automation

Automation is not something new. Automation has been present in our society since the ancient times and has been one important source of economic progress and prosperity. However, it has always had a negative atmosphere surrounding it about its influence in the labour market and the potentially destructive nature when it comes to replacing people by being more effective.

In the nineteenth century, the debate about the destructive nature of automation became more intense and present in the political sphere. Machines had already begun to replace workers in many sectors, especially those with a higher amount of manual tasks, i.e transport sector, agricultural sector and manufacturing industry. At this point, the economists split into two groups, the ones that thought that automation was negative and would create unemployment in the long term without an interventionist

policy and the ones that believed that the labour market would adjust itself in the long run (Bartlett, 1984)

Over the years, it has been proven that automation has a creative-destructive nature, this is, that in the short term, the advancements of technology destroy employment and replace workers with lower qualifications that perform the easy tasks but in the long term it generates employment by creating new sectors.

In the present, the topic is still controversial. While there is consensus among most of the economists and the society, others believe that right now automation joined by other technologies such as artificial intelligence (AI) is growing faster than our economies can handle and will create inequality throughout the society (Srnicek, 2015; Frey and Osborne, 2013; Smith and Anderson, 2014).

3.2 WHAT IS ARTIFICIAL INTELLIGENCE

Artificial Intelligence is another step further in the development of technology. Artificial Intelligence is referred to all those machines that have been created artificially but show behavior that is genuinely human, this is, they react to stimuli that come from other people, other machines or from the circumstances of the environment. This kind of technology, although it's not completely new, it has been developed a lot in the last years and eventually touching most of the sectors, especially those who have historically been considered safe against the potential substitution of machines.

Inside the Artificial Intelligence field, there are some subfields but the most famous one and the one that has progressed the most is the one called Machine Learning (ML) whose aim is to develop techniques that will allow machines to learn by themselves. Through complex mathematical models, machines are able to learn from their own generate data or data collected from other machines or human activities.

3.2.1 Deep Mind

Possibly the best example of Artificial Intelligence is the research and development of the project called Deep Mind that was bought by the technology giant Google in 2014. Deep Mind is focused in a subfield of Machine Learning called Deep Learning which is much more complex and tries to create mathematical models based in the human brain and discover patrons in large chunks of data. The main objective is to make a model of the human intelligence and apply it in machines to make the world a better place (DeepMind, 2018)

The Deep Mind project became famous worldwide in 2016 through the project AlphaGo which consisted in an engine that was able to win against a former world champion of Go, a strategy the game more difficult than chess. This moment serves as an example to show how powerful can machines be compared to humans. In simple words, AlphaGo gets an insane amount of data from other games and learn through statistic models to choose always the optimum movement.

Another project that shows how far has artificial intelligence got is the one called DeepMind Health that works in the same way as the others by collecting information and data of people to make a diagnose. For example, it can be used to develop an algorithm that will be able to detect if a tissue is cancerous or healthy or to detect possible errors in the eyes of the patients. However, this project is not fully developed yet.

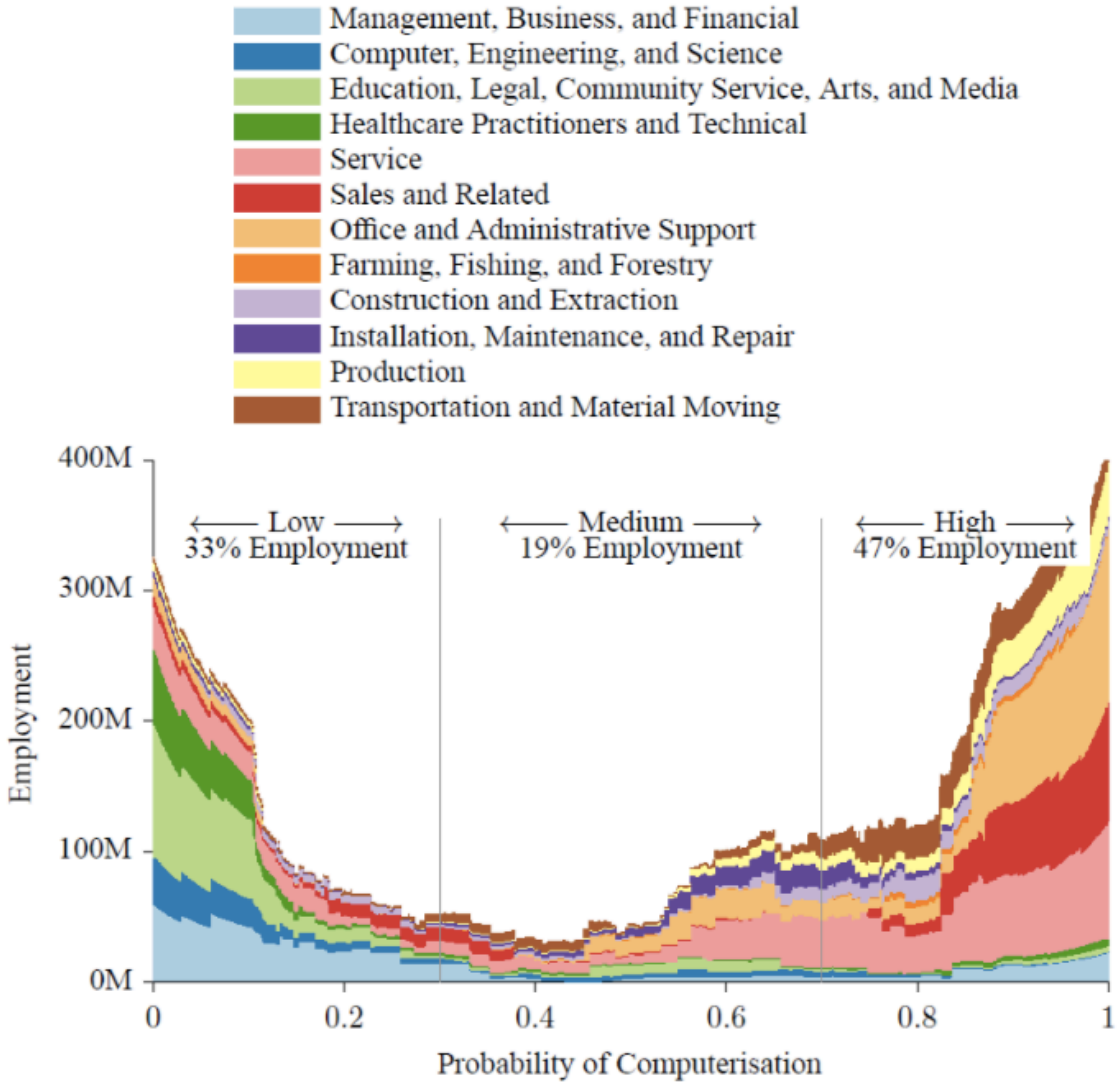
4. TWO DIFFERENT METHODOLOGIES TO MEASURE THE IMPACT

The effects of AI and automation in the labour market have been studied thoroughly in the last years by many economists. However, there are two analyses that are considered the most important ones in this field of study and lead to different results on the impact of technology on the labour market. The first analysis on this subject was carried out by Carl Frey and Michael Osborne (from now on “FO”) in 2013 and is a widely cited work which classifies the jobs according to the risk of automation (this refers to the possibility of losing a job to a machine with or without AI) in each position within the next 10 to 20 years. Although this analysis is only focused on the US job market and cannot be applied to any other countries or economies, it does serve as a foundation for further analysis for other countries.

The second methodology is an adapted and modified version of the analysis of FO and applied to the OECD economies. It was written by Melanie Arntz, Terry Gregory and Ulrich Zierahn (hereafter “AGZ”) and rejects both the results and methodology used by FO in the first analysis. One of the main points of this thesis is to show how the different methodologies used for these analyses explain the contrasting results.
In the original study by FO, a sample of occupations was taken using the O*NET platform, an online service developed by the US Department of Labor. Each one of the 702 professions was then tagged as automatable or not-automatable by machine learning experts and later divided in features and tasks. Eventually, FO used a machine learning algorithm to create the risk of automation or computerisation. This point explains more or less, the results of the analysis as each job was taken as a whole without decomposing it into tasks.

Each job in danger is then classified as high, medium or low-risk occupation depending on the probability of computerisation. According to FO, 47% of all US jobs might be at high risk of automation in the next two decades. Although the results and consequences will be discussed further, the model estimates that the sectors at higher risk are the transportation and logistics alongside office and administrative jobs and manufacturing (Frey and Osborne, 2013)

Figure 1: US Employment by Risk Category



Source: Frey and Osborne (2013), The Future of Employment: How Susceptible are Jobs to Computerization? University of Oxford.

This perspective has one main advantage that is labelling a job based on the main activity, while the secondary tasks become less relevant. For example, when analysing the job of a taxi driver, the main task would be driving which in the near future can be done by an autonomous car using AI while maybe other secondary tasks like engaging in a conversation with the passenger about the city or modifying the route are not that easy to automate.

In general, the jobs at higher risks are those which don't require a high level of education, the so-called low-skill and low-wage occupations. Even those jobs that were considered safe in previous technological shifts are not so safe now due to the advancements in machines that carry out genuinely human and non-routine tasks. (Arntz, M., T. Gregory and U. Zierahn, 2016)

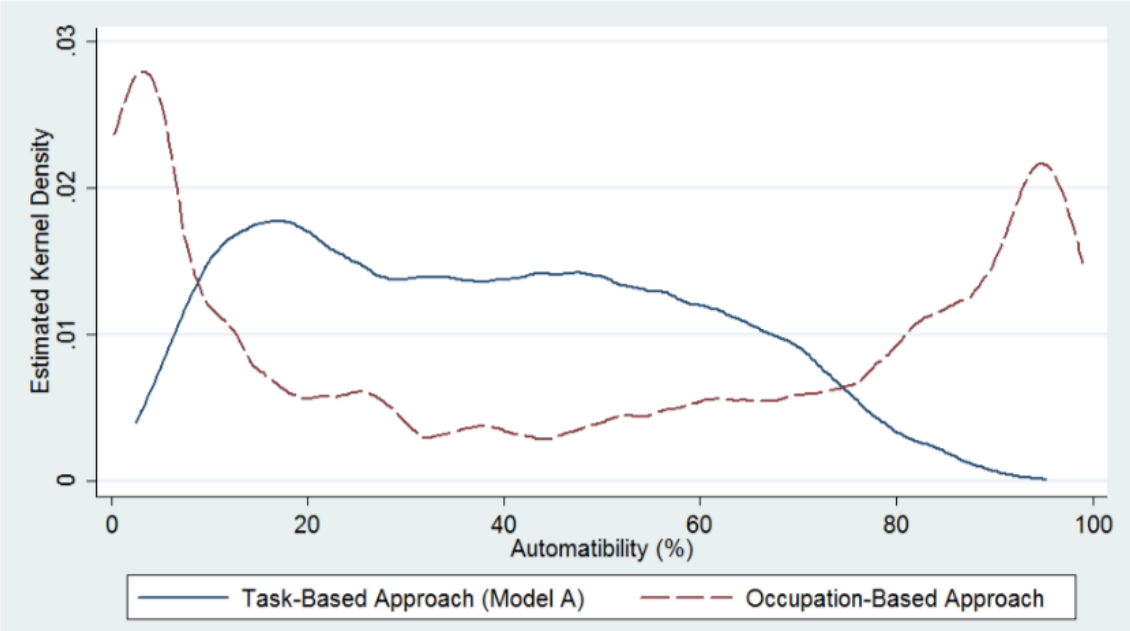
On the other side, the study made by AGZ uses a different methodology and approach to the same problem. Their data comes from the OECD Programme for the International Assessment of Adult Competencies (PIAAC) database which incorporates more details and information about each job and also about the people doing that job. The variables that will explain the analysis cover workplace tasks, gender, level of education, competences, income, and sector.

While FO use an occupation-based approach to the issue, assuming the task structures are uniform throughout all the occupations, AGZ sustain a task-based point of view as task structures vary within occupations leading to different levels of automation risk depending on the activities that each worker perform (Autor and Handel, 2013) Using data collected from individuals creates a more concrete image of the actual tasks that each worker does and it is, therefore, a better measure of worker's actual tasks.

AGZ came to the conclusion that using this method, not the whole occupation will be considered in high-risk of automation. It will depend on the tasks that configure a job, some of them may be in risk of automation while some others may not be automatable with the current level of technology, this is what we call engineering bottlenecks and will be discussed further in this paper.

As a result, AGZ found that only 9% of the individuals in the US have a job that is in high risk of automation, this is a probability of automation of at least 70%. The jobs in higher danger of being automatised are those with tasks related to exchanging information, selling or doing manual duties while those with less risk of automation are reflected on what FO called engineering bottlenecks and require cooperation and empathise with people.

Figure 2: Distribution of Automatibility in the US (Task-Based vs. Occupation-Based Approach)



Source: Arntz, M., T. Gregory and U. Zierahn (2016), "The Risk of Automation for Jobs in OECD Countries: A Comparative Analysis"

The graph compares the results obtained by both models in the US using the PIAAC statistics. We can conclude that using an occupation-based approach to this problem leads to very extreme results in which most of the jobs are either in a very low-risk or a high-risk of automation while only a few professions have medium automatibility. On the other hand, the task-based approach brings different results with less drastic results but a higher number of jobs in medium risk of automation.

This happens because FO consider in higher risk jobs whose main task can be automated while the secondary and tertiary tasks associated with the job have an interactive and non-routinary nature and therefore cannot be automated with the current level of technology. AGZ uses a much more gradual approach, considering tasks first, how important they are for the job and the possibility of the tasks of being automated. For that reason, with this approach, most of the jobs are in low or medium risk of being done by machines.

Nevertheless, it is important to assess this studies with caution as both approaches are based on the opinion of experts in technology rather than the actual use of such new innovations which may be restricted for economic, regional or legal reasons. It is also important to mention that previous technological shifts have made the market to readjust. This means that new jobs can be created or workers can adapt their tasks to complement what the machines do. Lastly, both analyses just consider existing jobs, although it is likely that new technologies will create new jobs.

5. POTENTIAL IMPACT OF AUTOMATION PLUS AI

Nowadays, it's a challenge for most of the economies to predict how the labour market is going to be affected by the AI-driven automation. This happens because AI is not just automating a certain task but more like a series of actions that go from collecting data to use it depending on the circumstances. The irruption of AI won't be felt the same way in every country nor in every sector as some jobs will be way more affected than others depending on the nature of the tasks performed.

The recent researches on this matter indicate that the irruption of AI in the labour market will follow the trend that computers and technological innovations have been leading us towards in the last decades. However, experts fail to agree on how likely and how strong are automation and AI going to influence the labour markets in both the short-term and long-term as the technological waves are occurring very quickly with no time for the market to adjust.

The main effects of the AI-driven automation will be felt in the following groups: economies as a whole, sectors, education and equality and productivity.

5.1 IMPACT ON THE LABOUR MARKETS

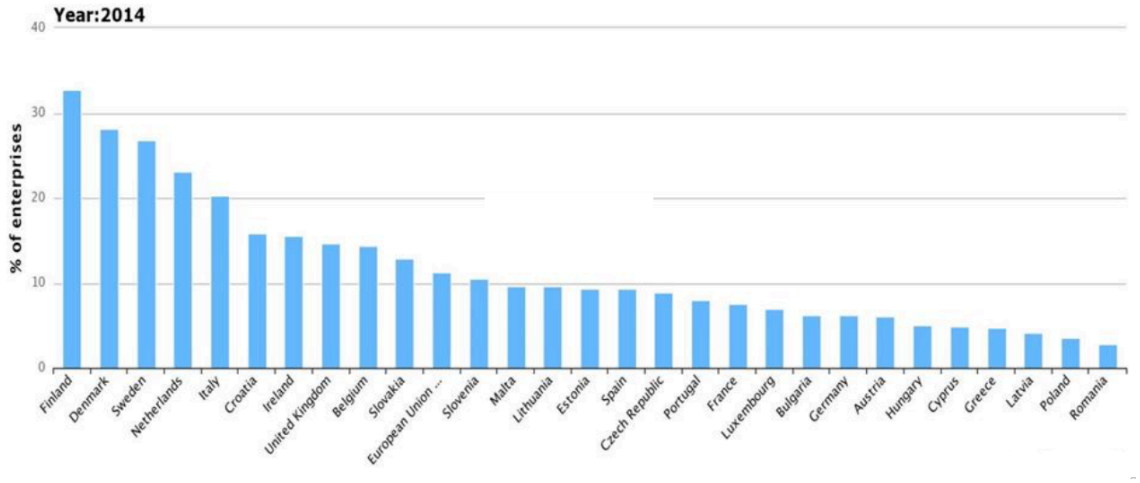
5.1.1 Europe

Europe will be one of the first economies to feel the irruption of AI as it's one of the most developed regions in the world but also one of the most heterogeneous as not all the countries have the same development nor the same social structures. In order to get the measure of this effect in the European continent, we focus on two questions: to what extent is the European labour market going to change over the next years and which countries will be the most affected by this fact.

FO (2013) and AGZ (2016) seem to agree that globalisation and technological innovation have shaped the economies of Europe and US in the last decades alongside the economic stagnation that happened ten years ago. This fact is leading the European market to a job-polarisation in which jobs are either bad paid or good paid and have low or high educational requirements. FO (2013) concludes saying that the US market (and can be extended to the European market) will have two important effects: the first one being a lower demand of employment as a whole, due to machines and taking the blue-collar jobs as well as part of the previously safe jobs which will be performed by AI robots. The second one is a consequence of the first one and means that low-skilled workers won't be needed anymore and the people will tend towards more skilled and safer jobs.

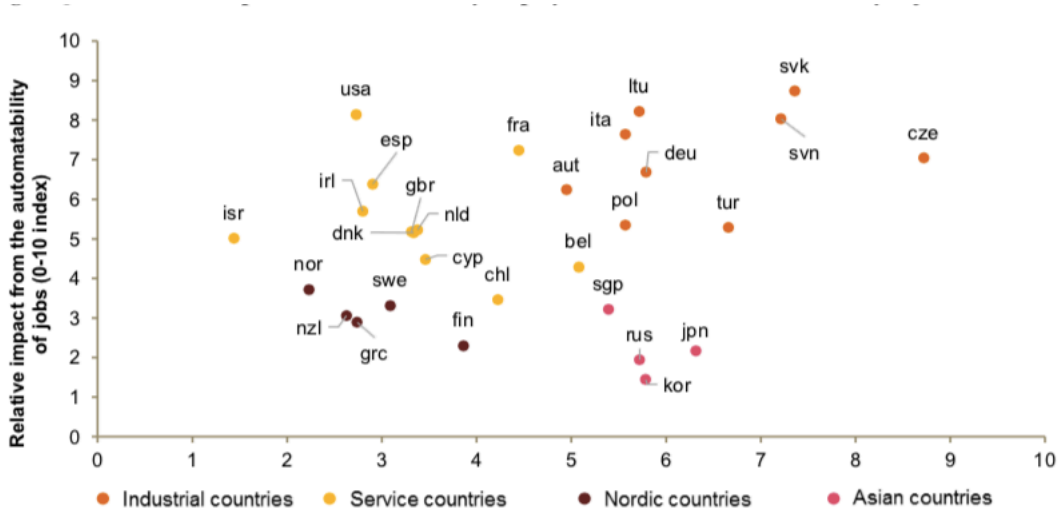
Another factor that is worth to mention is the evolution of prices in technology-related products and services. Computers and cloud services prices have been constantly shrinking, not only allowing companies to buy more computing capacity but also allowing companies to put a bigger effort on research and development and thus making innovations better (Berger and Frey, 2016) As can be seen in the graphic, this is especially important in the west-northern countries of Europe, where the investment in technological services is one of the main causes of their economic development.

Figure 3: European Enterprises buying Cloud Computing Services (2014)



Source: European Commission. A Digital Single Market Strategy for Europe - Analysis and Evidence

Figure 4: Potential impact across countries by employment shares and automatibility of jobs



Source: PIAAC data, PwC analysis (2018)

To address the second question and see which countries are going to be more affected for the irruption of AI machines we will use the report conducted by PwC UK (Hawksworth and Berriman, 2018) that is based in the previous analysis made by FO and AGZ. According to this report, Europe can be divided into three groups: industrial economies, services-dominated economies and Nordic countries.

The industrial economies, for instance, Germany, Italy or Slovakia have a higher degree of automatability due to the tasks associated with the industries. For example, in the car industry, a lot of jobs have been lost in the past due to the apparition of assembling machines. And as they become more sophisticated and less expensive, more jobs will be in danger.

On the other side, the services-dominated economies are less automatable because of the engineering bottlenecks that are activities and tasks that cannot be done by AI with the current technological development like diagnosing illnesses or because AI has not been to emulate humans, for example, when it comes to teaching children. As of today, the automation and AI are way less impactful in the health, tourism or education sectors. Countries like the United Kingdom, Spain or the Netherlands would be service-based economies.

The last one is composed by the Nordic countries and despite having a mix of both types of economy, are considered in a lower potential of automation rates due to the high education of the people which allows to adapt faster and do tasks that are difficult to do with the current level of technology.

5.1.2 United States

The labour market of the US and the labour market of Europe are similar and face the same risks. As the graphic above shows, the US has a service-dominated economy but still retains some characteristics that make it industrially strong and so, the impact of a possible substitution of workers by machines is higher there. AGZ (2016) explain that the differences across countries may reflect general differences in workplace organisation, differences in previous investments into automation technologies as well as differences in the education of workers across countries.

AGZ (2016) also say that one of the biggest differences on why the potential impact of automation and AI is higher in the US is caused by the fact that the educational background of US workers is lower than in Europe. Education in the US is expensive and therefore not everyone can access to a higher education and for that reason, they perform jobs that are considered low-skilled or medium-skilled.

In addition to this, another factor that might explain the difference between the US and other service-based economies is the difference between sectors. The report made by PwC UK (2018) explains that workers in the same sector may perform different tasks that can be more routinary. This is especially important when it comes to analysing sectors using the occupation-approach as it can lead to big inaccuracies, even in the same kind of jobs.

5.1.3 Japan

The research made by PwC UK (2018) also includes another category for Asian countries that are characterised by a less automatable amount of jobs overall but high in the industrial sectors. Another explanation for the lower risk of automation is that these countries have a higher number of machines on their daily basis and have somehow adapted already to the technological change. The workforce has already adjusted to the new market and started to work alongside robots and machines. This might have some benefits in the short-term for them as they are already getting higher productivity.

As for Japan, we find that the percentage of jobs in high risk of automation is low in comparison to other developed economies. The main reason for this is explained by the differences in work organisation and the skills required to perform these jobs. For example, one of the sectors in higher risk in Europe and United States is the retail sector which is considered easily automatable but in Japan, it demands higher qualifications, training or skills, especially when it comes to management and organisational skills.

However, when it comes to specifically Japan, the impact of technology on the unemployment rate is probably going to change as there is a shortage of workforce as a consequence of the low birth rates, the low immigration rates and that the population, in general, is getting elderly. The Japanese government is encouraging the investment in high technology as the Japanese labour market status might affect and damage the productivity and the economy of the country.

5.2 IMPACT BY SECTOR

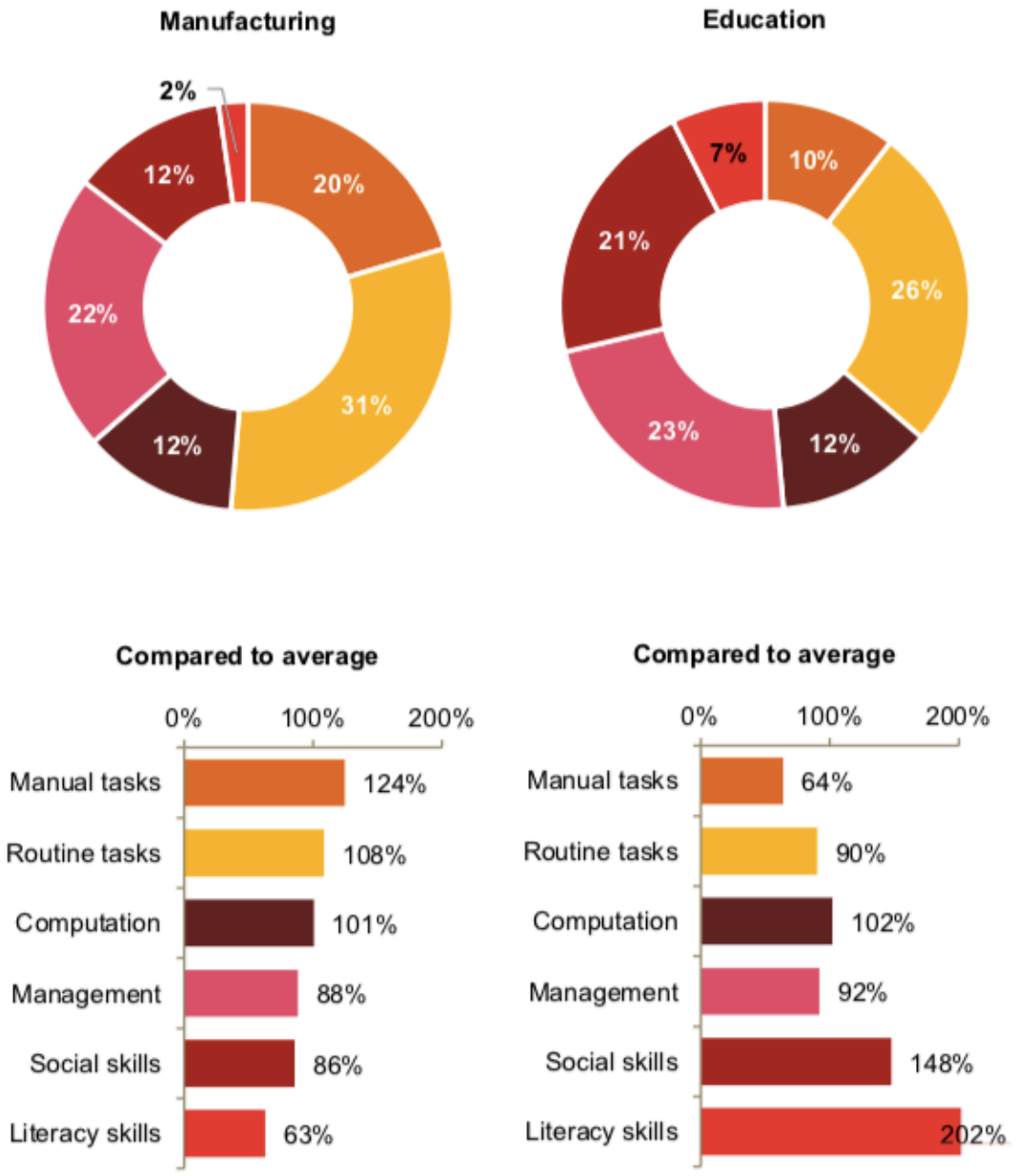
The impact of AI and automation in a sector is mainly decided by the composition of tasks involved in that sector. As it was stated before by FO (2013) and AGZ (2016), jobs with tasks that can be easily automatised will be substituted by machines before jobs that are not easy to transform into computer language. We use the same reasoning when it comes to seeing if a sector is automatable or not (Berriman, R. and Hawksworth, J., 2017)

Industries whose task composition and educational background are considered low-skilled will have a greater potential of being automated. On the other side, the industries that require more face to face tasks with the client or co-workers and are more interactive won't be in high-risk.

According to the analysis performed by PwC UK, the industries in a higher risk of automation are transportation and storage, manufacturing and construction while the ones with the lowest potential of automation are education, health care and professional, scientific and technical.

As can be observed, the differences in the task composition for a high risk and a low-risk sector are large. Manufacturing, one of the industries at higher risk of automation has a lot more manual and routine tasks than the average industries. Although some of these tasks are already being taken over by machines, in the future, it is expected to be completely done by machines. On the other hand, the education sector has a considerable amount of literacy and social skills which, as of now, cannot be done by computers or machines due to the mentioned engineering bottlenecks because they imply more empathy and creativity.

Figure 5: Task composition for manufacturing and education sectors.



Source: PIAAC data, PwC analysis (2018)

Within sectors, there are also differences. For example, in the manufacturing industry, we can find activities that will be totally automatised such as welding, cutting and soldering and other activities that are not so easily replaced such as business representatives or industrial engineers.

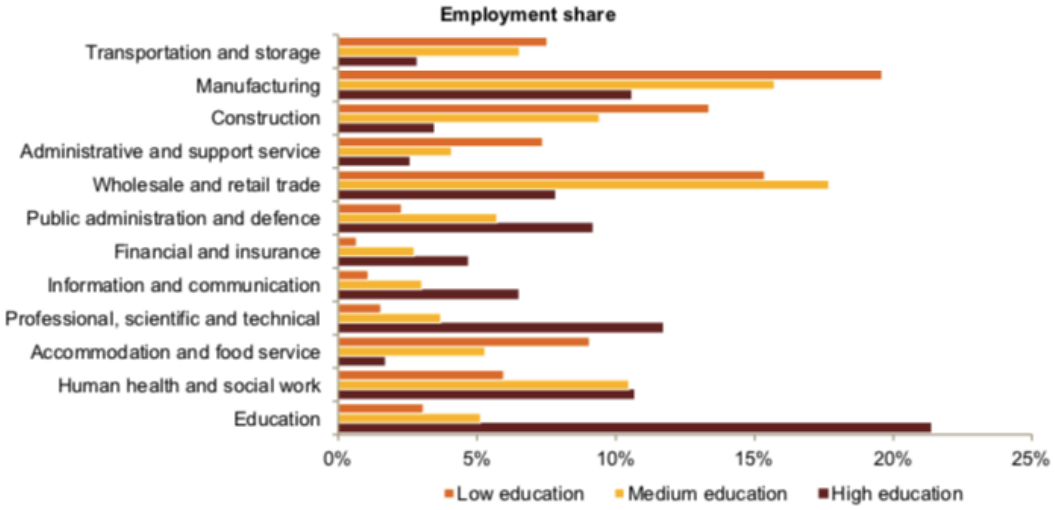
Of course, the job losses cannot be taken as net losses. Some industries might be heavily influenced by the coming technology but the change won't be immediate, it will take time and at the beginning, even machines alone won't be able to fulfil the positions as there will be a machine-human tandem. It is something that companies must predict and plan to remain competitive and efficient. On the other side, the sectors that will see an increased demand on jobs and even higher skill requirements are those in the area of artificial intelligence, computer engineerings and robotics (Berriman, R. and Hawksworth, J., 2018)

5.3 DEMOGRAPHIC IMPACT & EQUALITY

The educational level of the workers is also another factor that must be taken into account to assess the risk of automation. In general, there is a negative correlation between automation and level of education, this means that those with lower education will be at higher risk than those with a higher educational background. This is explained by the fact that most of the workers with low skills are usually found on sectors where the share of tasks which are repetitive, not complex and don't need any social interaction is higher than in other sectors.

On the other hand, high skilled workers are estimated to be in the lowest risk of automation because they are usually performing social and literacy skills or more complex tasks that are less automatable. Another factor that makes them be in lower risk is the ability to adapt to the new incoming technology and work alongside them in the future. They are, therefore, less likely to find themselves displaced or jobless because of the technology.

Figure 6: Employment shares across industries for workers across education levels



Source: PIAAC data, PwC analysis (2018)

However, this is not always the case. There are some jobs performed by low-skilled workers that are not at risk of automation and there are jobs performed by high-skilled workers that are at risk of automation. One of the most known exceptions is the case of accountants and tax advisers, workers with high educational level but whose jobs are starting to be replaced by computers programs able to calculate and recognise information and data much quicker than a person (Jensen and Koch, 2015)

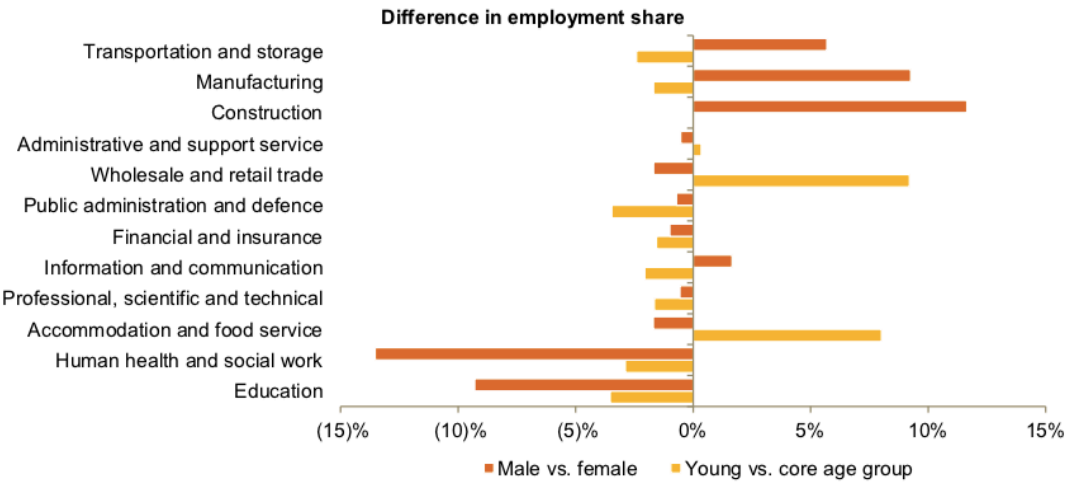
Moreover, the risk of automation is also different depending on what gender the workers are. In the long run, males have a higher risk of automation (34%) owing to the fact that they are employed in sectors which are in higher risk and perform more automatable tasks. Males usually dominate the transport and manufacturing sectors while women tend to be more active in the educational and healthcare sectors and perform less automatable tasks and thus the lower risk (26%) (Berriman, R. and Hawksworth, J., 2018)

Figure 7: Difference in employment shares across occupations for males vs. females

Source: PIAAC data, PwC analysis (2018)

Apart from the difference previously stated regarding the difference between males and females on the sectors that are more physical and manual and education and healthcare, we can see also differences in what jobs young males and young females perform within industries. For instance, that difference is quite clear in the retail and the accommodation and food sectors where young males, without doubt, dominate the market.

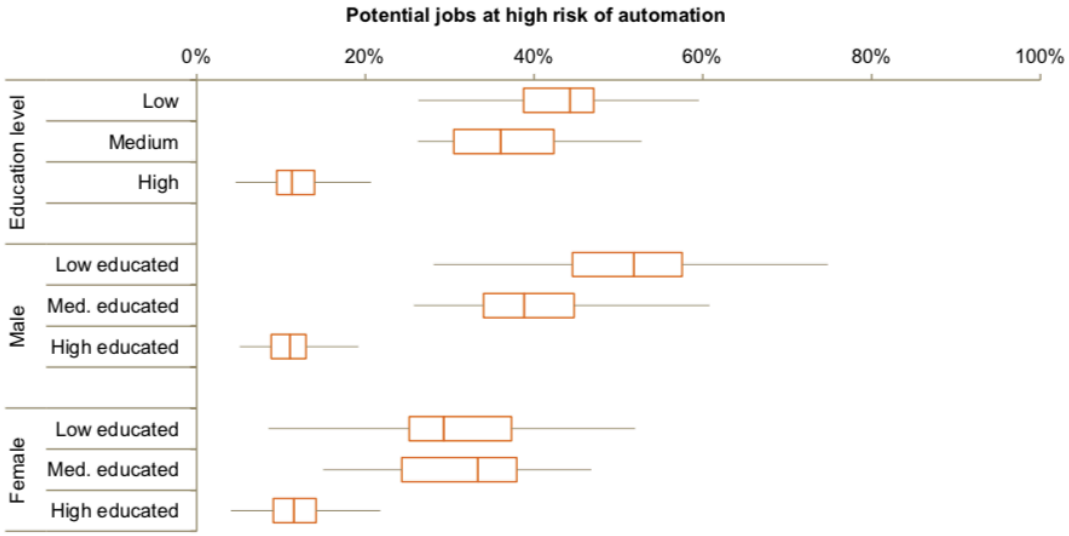
Figure 8: Difference in employment shares across industries by sex and age group



Source: PIAAC data, PwC analysis (2018)

Males and females with higher educational background have a similar and low risk of automation in the OECD countries while the difference becomes notorious when we analyse the differences between low and medium educated males and females. Males are much more in risk of losing their job due to automation than females as they usually work in positions that are more manual, usually in the manufacturing and construction industries while low-skilled women usually perform tasks that cannot be fully automatised such as sales workers, cleaners or helpers (Berriman, R. and Hawksworth, J., 2018)

Figure 9: Share of jobs with potential high rates of automation by gender and education level



Source: PIAAC data, PwC analysis (2018)

One of the main challenges when it comes to automation is effectively managing the more than likely generation of inequalities of wealth and income. Although productivity is something good for economies, in the absence of interventionist policy, it could create a “paradox of plenty” (Lawrence, Roberts and King, 2017), producing more but with a worse distribution of the wealth. Without the proper measures, the benefits of automation will be only enjoyed by the owners of capital while the workers get stuck in a polarised labour market.

As soon as automation hits, developed economies are likely to see a fall in the number of working hours. The main issue is the stagnation of wages combined with the high productivity and the lower demand for workers. So in this scenario, we find that the automation will create unemployment, at least, in the short-term, and therefore there will be a surplus of the workforce in the market, which in the end will mean a reduction in wages. In this scenario, even employers might find suitable to hire some workers because they are cheaper than machines. This is, of course, in those fields where the advantage of machines is small compared to what humans do. In conclusion, it’s important that wage policies adapt to the changing labour market in order to avoid a scenario where employment would be badly paid and the standard of living would surely be worse for many.

We can also find inequalities in the education level of the people. Technological innovations are believed to be one of the main drivers in the decline of labour share in the last four decades (Lawrence, Roberts and King, 2017) The substitution of workers by machines in low-skilled sectors has contributed to a job polarisation between the high-skilled and low-skilled workers. The cheaper investment goods (machinery, technology, equipment…) get, the faster the automation process will take place while wages and prices on consumption goods might not grow accordingly and thus leading towards big differences in wealth depending on the level of education of the workers.

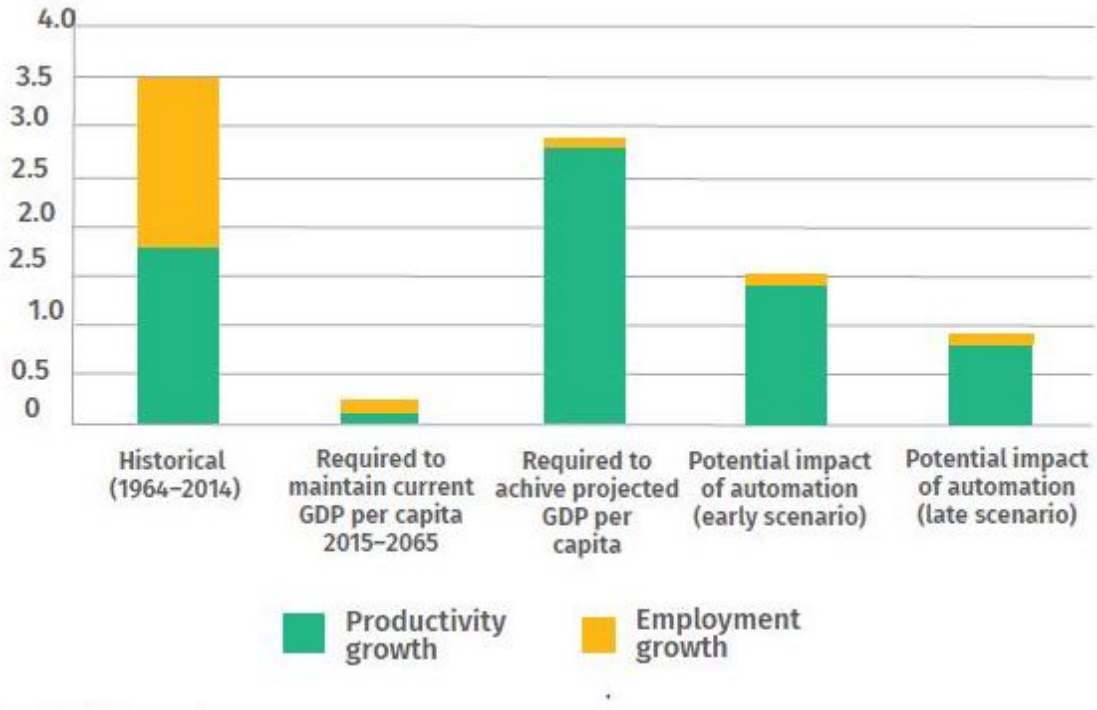
Following the analysis made by FO (2013) and AGZ (2016), it is said that AI and technology will substitute low-skilled jobs and complement high-skilled ones. As a consequence, it is expected that the level of wages for high skilled jobs is likely to increase, at least, compared to the wages for low skilled jobs. The reason for this is that complementing machines raises the productivity of the worker and thus wages grow accordingly. Moreover, as their productivity increases, they are able to perform more tasks pushing down middle-skilled workers to low skilled jobs. The new labour market, therefore, will be composed of winners and losers, all of them forced to specialise in a smaller kind of tasks (Susskind, 2017)

In short, the main challenge is reaching a much more redistributive wage system in which people with lower skills are not displaced. The inequality does not come from the destruction of jobs in the short-term but from the bad distribution of the gains originated from the higher productivity.

5.4 IMPACT ON THE PRODUCTIVITY

Automation can have considerable effects in terms of boosting the productivity, both at company level and country level and represents an opportunity to support the global economic growth (Manyika et al., 2017) In order to to contribute and meet the requirements for a steady GDP per capita growth, it is critical that governments and companies work together to assure it is done gradually and in the right direction. If managed in the right way, the positive effects of the augmented productivity are: better jobs, higher living standards, more leisure time, an increase on the demand of goods and services and more environmentally, clean and efficient ways to produce (Lawrence, Roberts and King, 2017)

Figure 10: Composition of GDP growth for G19 + Nigeria, compound annual growth rate (%)



Source: A future that works: Automation, employment and productivity. McKinsey Global Institute (2017)

As the graph shows, the economic growth (GDP) is mainly shaped by two elements: the productivity growth and the employment growth. Given the fact that the population of the advanced economies is ageing, this means there will be less population and thus with fewer inputs, the GDP per capita will get lower. It is very clear that economies must focus on productivity to ensure the prosperity and keep up with the high living standards. Although the adoption of innovative technologies has to be done progressively, it is important to motivate and speed up this process in order to not see a recession.

Automation can, in some way, correct the demographic trends. McKinsey Global Institute (2017) estimates that the automation could boost the global economy between 0.8 and 1.4 per cent of the global GDP per year with the assumption that the workers performing low-skilled occupations who are going to be replaced will stay in the labour market and be as productive as they were before. This fact will be nearly impossible to see as the skills needed to perform the new activities have to be learnt and it is very likely that most of the workers will feel displaced from the labour market.

Developed economies usually have an ageing workforce and therefore they really need to adopt automation technologies that will provide the productivity increase desired to fulfil the economic forecasts. So they must adopt automation as soon as possible to not see their economies struggle in the long-term.

While emerging economies also face this issue, some of them will need to boost their productivity to meet the requirements and maintain the GDP per capita growth but as their growth is faster than other economies, they have to complement this growth with other elements such as process transformations (Lawrence, Roberts and King, 2017)

In the case of the less developed countries with younger populations, although automation is always good to boost productivity, they can rely on the growth of population in working age to satisfy their current GDP per capita growth but their main problem will be generating new jobs.

In conclusion, automation will play an important part in stimulating and increasing the productivity that the global economy needs in the next few decades since the population in working age is diminishing. It will raise the GDP per capita growth in the developed economies but will need help from other mechanisms to meet the economic requirements in the emerging countries. As the process won’t be immediate, the governments have to be prepared to reach the opportunities and take advantage of automation and avoid the downsides of delaying its adoption.

6. IMPLICATIONS FOR BUSINESSES

The past analysis has focused in the potential impact of automation in the labour market and the employment but it is important to address the influence that the technological unemployment has for businesses and the potential benefits that AI and robotics can offer to enterprises.

Automation of activities allows businesses to improve performance by lowering the number of human errors and at the same improving quality, accuracy and speed of production. Other benefits derivate from the labour substitution such as greater throughput, improved safety, reduction of waste and high customer satisfaction (Manyika et al., 2017) Those skills are so developed that usually go beyond what humans can do, but instead of seeing the bad side of the technological advancements, business can take advantage of it to improve their performance and competitiveness in their sectors.

As discussed earlier, technology improves the productivity, not only at the macroeconomic level but also at the microeconomic level. Businesses have the opportunity to boost their benefits and achieve competitive advantages from using machines and at the same time reducing costs from the human workforce. Although the analysis seems to point out that most of the sectors and occupations will still need workers to control and complement what machines do, it is clear that there will be a reduction of personnel, especially, those that perform easily replaceable tasks. This will lead to a inequality and polarisation in the society because of the differences in wages and skills.

On a strategic level, automation allows to control, monitor and measure in a more effective way as technologies will provide new tools for managers and all the changes that might be done can happen almost instantly. One example, of a very present technology that makes this happen, is the email, all employees can be informed about changes at once.

Nonetheless, there are some restrictions that businesses have to face in order to adapt to the changing labour market. These constraints will come in 4 groups, technological, economic, legal and regulatory, and social constraints and businesses will need to get over them to enjoy the previously mentioned benefits (Hawksworth and Berriman, 2018)

Firstly, it has to be technically possible to adopt such new technologies to the businesses and the environment that surrounds them. This depends very much on the level of development of the new innovations, the sector and the speed to assimilate and change the paradigm. Adopting new technologies must be done gradually in order to avoid stopping the activity and reduce possible errors that will surely happen at the beginning. It also depends on the infrastructure of the country, sometimes, it is not efficient to boost the productivity while the rest of the industry hasn’t caught up and may lead to, for example, greater inventory costs.

Secondly, it has to be economically feasible to adopt it. Sometimes, the cost of investing in technology is way higher than, for example, relocate the industrial plants somewhere else or expanding it by using additional workforce, especially if it is flexible and low cost. Another cost is the fact that workers will have to learn how to use it or getting some qualified workers. The time that takes to fully enjoy the benefits is long and therefore might put the survivability in the short-term in risk.

Thirdly, there are legal and regulatory constraints. Machines, robots and AI need data in

order to work and therefore, businesses will have to deal with large amounts of data and all the regulation regarding protection of individual data, rights to use the data and the privacy. Also, companies have to take measures concerning the safety of the workers to prevent accidents in the workplace that might happen when working alongside machines and robots.

Lastly, employees and people, in general, must feel the advantages of working alongside machines. The acceptance of machines and robots in the society won't happen if there are risks for them, for example, the driverless cars, while innovative and work-saving, it is also risky. Employees won't accept machines if they mean lower-wages and inequality. The acceptance of new and disruptive technology will take a long time and will require help from governments.

In the end, all these four barriers will be taken down by businesses and technology will be more and more present in the workplaces. The most developed countries will be the first ones to adopt it and the first ones to capitalise the benefits and thus the distance between developed countries and those that are underdeveloped are most likely to become greater as they won't be able to catch up with the rest of the market. However, this process is slow and will happen gradually, faster in the sectors at the highest risk and slower in sectors with less risk.

7. POLICIES

It is, therefore important for the future and prosperity of the countries and the global economy to find a suitable answer to the challenges that automation is creating in regard to education, equality and the labour market. The main problem is the disruptive nature of the technological innovations and the potential loss of jobs in many industries which derives into other problems such as lack of the right skills, the polarisation of the population and displaced workers from the labour market.

The analysis above has shown that education is one of the main drivers of potential automation risk due to the lack of right skills that cope with the new technologies or because a machine will totally automate the tasks in that occupation. More educated workers will be able to adapt to the machines and complement them or even find another job in a less impacted sector. Governments must work to ensure that the population have access to education and the skills needed to perform activities alongside machines. Of course, it will complex to identify which skills are going to be needed over the next years as technology grows faster than our ability to adapt to the changes and then, this education must involve a constant training and learning in order not to fall behind.

Of course, reworking the education system is not enough to solve the unemployment problem. Although it is likely that technology will discover new sectors and thus, new jobs are to be created, in the short-term the disruption will balance out the labour market. So governments must work to make sure to try to anticipate what industries and what jobs are going to be displaced. One of the measures that might be taken is encouraging the apparition of technology startups and make agreements with them to exchange monetary resources for having a quota of displaced workers plus traineeships for them. This not only will allow relieving some pressure from the labour market but also it will help to capture the productivity benefits of automation early.

The polarisation caused by the system of winners and losers in the labour market in which workers win or lose depending on their skills creates a higher degree of inequality that transfers to inequality in wages. This issue is harder to address, some experts in this field have said that a basic universal income could be one the solution to help those displaced from the labour market and unable to get back and would be paid from the escalating taxes of those who earn more but social experts claim that it would just create functional consumers, removing social interactions and damaging self-esteem (Brynjolfsson, McAfee and Cummings, 2013).

Henning Meyer (2015) proposes using a public job guarantee with a basic income so everyone could get a job. By doing this, the public resources would be used for those who need it the most and at the same time fulfilling the social aspect of having a job.

The challenge ahead is just the beginning of the “second machine age” (Brynjolfsson, McAfee and Cummings, 2013) and governments, businesses and the society still have to figure out how to manage all the changes that are slowly entering in the everyday life. Although today, it is impossible to predict how the whole situation is going to be in the next few decades so it is very important to be prepared for it. Therefore, the policies should focus on building sustainable solutions to minimise the impact of automation and its harmful effects. Working on these three aspects, education, equality and labour market should become the main aim and should be done today without delaying it any longer, not just to be ready but also to capture the benefits of automation and become competitive.

8. CONCLUSIONS

First of all, the risk of automation varies depending on the approach chosen to analyse the jobs. If occupations are seen as a whole the risk of automation will be higher as it will be strictly considered automatable or not-automatable without considering the job structure and the task structure that compound that occupation. In opposition to this, AGZ uses a task-based approach with more information about the occupations and very different results, as some tasks cannot be automated and will require a cooperation between the person and the machine, meaning that the job is not totally lost.

Where both approaches match is in the kind of jobs that are likely to be substituted in the next decades. Those routinary job requiring more manual tasks have the highest risk of being automated than those that, because of the engineering bottlenecks are more interactive or are considered genuinely human. Usually, the kind of jobs that face a higher risk are typically performed by workers with low educational background while people with higher studies perform tasks that are less automatable, thus the educational background plays a crucial role in deciding which people are most likely to be displaced from the labour market.

This can also be applied to the countries as countries that are more industrialised will face a bigger threat as those industries are more likely to use more machines rather than humans in the future whereas service-focused economies will suffer less. The differences between Europa and America are merely based on the difference in the job structures and the type of tasks involved. As for Japan, it’s a mix of the already present machines and the need for them to maintain the competitiveness.

Automation will boost the productivity and it is important for the countries to get the benefits as early as possible to remain competitive in a global environment and will be especially needed in the developed countries in order to keep the living standards as they are facing a shortage of population in working age. The implications at micro-level are similar for businesses, they can use machines to become more competitive, reducing human costs and adapting to the new paradigm but the barriers must be broken in both cases with help from government policies.

Inequality will become the main problem of automation in three fields, educational level, wages and labour market. The society will be polarised into two groups: the ones with a high educational background which will, of course, have a well-paid job and will be able to adapt to different circumstances and thus maintain a job. On the other side, we will have people with a low educational background that will have problems to adapt to the new labour market and will be jobless or will perform tasks complementing machines, during fewer hours and with lower wages. Governments must work to prevent this and make sure that the people most impacted by the automation have access to the right resources.

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