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**"HOW DOES BREAKTHROUGH INNOVATION IMPACT THE LABOR
MARKET? THE CASE OF DRIVERLESS CARS"**

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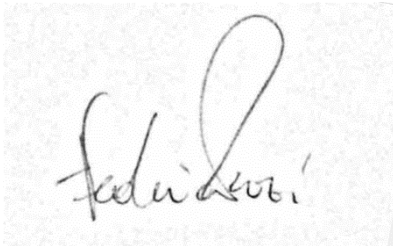
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A handwritten signature in black ink on a light-colored background. The signature is written in a cursive style and appears to read "Federico Pozzi".

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1. Introduction

Innovation is often described as a stream, something which is ineluctable (Hundt, 2004). On the one hand innovation brings progress, but on the other hand it could be a tide that overwhelms you if you are on its way.

Since the beginning of capitalism, innovation has been something the working class has been afraid of. From the Luddite movement at the end of the eighteenth century, which used to destroy the machines the proletarians worked with, to the modern era in which artificial intelligence or others cutting edge technologies frighten the taxi-drivers, the receptionists or even the college professors in the fear of being replaced.

According to Crafts and Mills (2017), *techno-optimists* (Crafts and Mills, 2017), the ones who believe that technology has weighted more the positive side of innovation, have always answered to these fears saying that technological progress has never lessened the overall employment: for an obsolete job to replace there were more created by the new industries which appeared thanks to the innovation itself.

Data demonstrate that so far *techno-optimists* are right: from the four technological revolutions the economic literature describes (Schwab, 2016), none has augmented the unemployment rate: the data collected demonstrated that the job balance between the job created and the job destroyed has always been positive (paragraph 2.3.1).

Through the collection of several data and analysis, Mario Pianta (2005, p. 576) summarizes the evidences of the quantitative research: “The evidence on the overall employment impact of innovation at the level of firms tends to be positive: Firms that innovate in products, and also in processes, grow faster and are more likely to expand their employment than non-innovative ones, regardless of industry, size, or other characteristics. The variety of innovative strategies, job creation, and destruction patterns have been highlighted in such studies, together with the firms’ characteristics (structural factors, flexibility, competences, etc.) that tend to be associated with better performances”.

But what if the technological revolution we are living in, the so called 4th technological revolution (Schwab, 2016), is different? The current technological revolution is characterized by something different: the speed of innovation (Paragraph 4.1.1). The environment evolves faster and faster and the peril is that the employees will not be able to keep abreast of that velocity. New industries are created and old ones become obsolete, but what happens to the employees of the old industry who can not find a job in the new industries, either because they are too old or too unskilled to reach the sufficient level of technical abilities?

This thesis investigates the impact of breakthrough innovation on the labor market from the qualitative point of view, trying to answer these interrogatives.

Although the qualitative analysis proposed in the thesis, based on experts’ experience, highlights key elements of the innovation process, hypothesis testing based on empirical analysis is desirable for a more comprehensive investigation. However, this is beyond the scope of this thesis.

2. Literature Review

Before analyzing the literature about the impact of breakthrough innovation on the labor market, we need to define what a breakthrough innovation is. A precise definition will help us to make clear to the reader what specific kind of innovation we want to analyze.

Once defined how breakthrough innovation is considered by the literature, we focus especially on how it impacts on the labor market. Indeed, the literature describes four types of impact: the job creation, the job destruction, the job change and, finally, the job shift due to the introduction of breakthrough innovation.

2.1 What is breakthrough innovation?

As exposed by Colarelli O'Connor and Rice (2001, p. 105), *breakthrough innovation* is “the creation of a new line of business. New both for the firm and the market. By “new” we mean a product or process either with unprecedented performance features or with already familiar features that offer potential for 4 to 10 times (or greater) improvement in performance, or 30-50% (or greater) reduction in costs”.

Analyzing this definition we can extract two essential elements: (1) the newness of the business both for the firm and for the market and (2) the improvement this business makes either in terms of cost reduction or in terms of enhancement of performances.

According to this definition and, as we will see later, according to the results of our interviews, the autonomous car business respects all the criteria cited to be defined as a breakthrough innovation (Colarelli O'Connor, Rice, 2001). Indeed, the business can be defined innovative both for the first firm that will implement it and the market, as there is no autonomous car available for sale so far. Moreover, the impact on the increase of performances can be analyzed by different perspectives. The most important and evident one is the fact that, as the driver is freed from driving, in terms of driving experience the performances increase exponentially.

Moreover, the difference from the traditional definition of innovation is the timing of the innovation itself: the breakthrough innovation tends to revolutionize the industry where it appears, changing the attitudes of customers very quickly. They indeed leave the old technology, which can be considered obsolete, and start adopting the new one. The change involved in this process is also comprehensive: the market segment of the old technology is close to zero and it often refers to the segment of the market which is reluctant to change for emotional attachment or other reasons (individuals do not want to spend time learning how to use the new technology). A good example of breakthrough innovation is the smartphone: from the launch of the iPhone in 2007 it took very few years for the mobile phone's market to sell the Smartphone massively, especially among young customers (52% of 18–29 year olds owned a smartphone in 2011 (Lee, 2013).

2.2 Different perspectives of innovation and the labor market

The literature about the consequences of innovation is abundant and it holds two extreme views at the edges of the spectrum:

2.2.1 The techno-optimists

The techno optimists are the ones who believe that the overall effect on innovation is positive for everyone (during this research we will face several examples of techno-optimists). They argue that for an amount of job positions destroyed by the innovation process, there is a bigger amount of jobs that are created because of innovation. They think, thus, that the people who remain unemployed in a particular sector could be hired in a new sector, with a surplus of job positions created by the innovation process (Crafts and Mills, 2017). As defined by Schumpeter (1942, p.1), they held this view because they think innovation is a “creative destruction”. It means that innovation destroys idiosyncratic job position, while it creates new ones. They have a solid background: history teaches that they were right in all the technological revolution we have seen so far. They believe to be right also in the technological revolution we are living now, the so called 4th technological revolution (Schwab, 2016), because in the big picture the patterns of the past are going to repeat themselves. This party has a huge number of different shades and positions. However, we are considering the only ones which are strictly correlated with this thesis: the ones about the consequences of innovation on employment.

2.2.2 Techno-pessimists

This view is commented by Fabio Gramazio and Matthias Kohler (2014, p.36) as “not that prevalent. It is largely limited to domains like literature and philosophy. You have only to think of the condemnation of railways by so many 19th-century writers, or the distrust expressed by 20th century phenomenologists, such as Martin Heidegger, in the power of technology to improve the human condition”.

From this view we can extract two main concepts: the techno-pessimist view is minor in comparison with the techno-optimist one, and the fact that the perspective of technology by these authors is built up on fear of the future.

A movement came out of this view during the first industrial revolution and it referred to Ned Ludd, the chief of the riot which emerged in the 1810s in contrast with the mechanization of the factories (Randall, 1986). This movement is famous nowadays as the first revolt against technology and, in order to prove their disapproval, the rioters used to break the machines which they used to work with. From Ned Ludd to nowadays we had four industrial revolutions, but the fear of technology has always

remained, stronger or weaker, in our society. It has also swung, during the harshest period against technology, to conspiracy theory, which claimed that the computers would have replaced the humans.

2.3. How does innovation affect the labor market? The economic aspect.

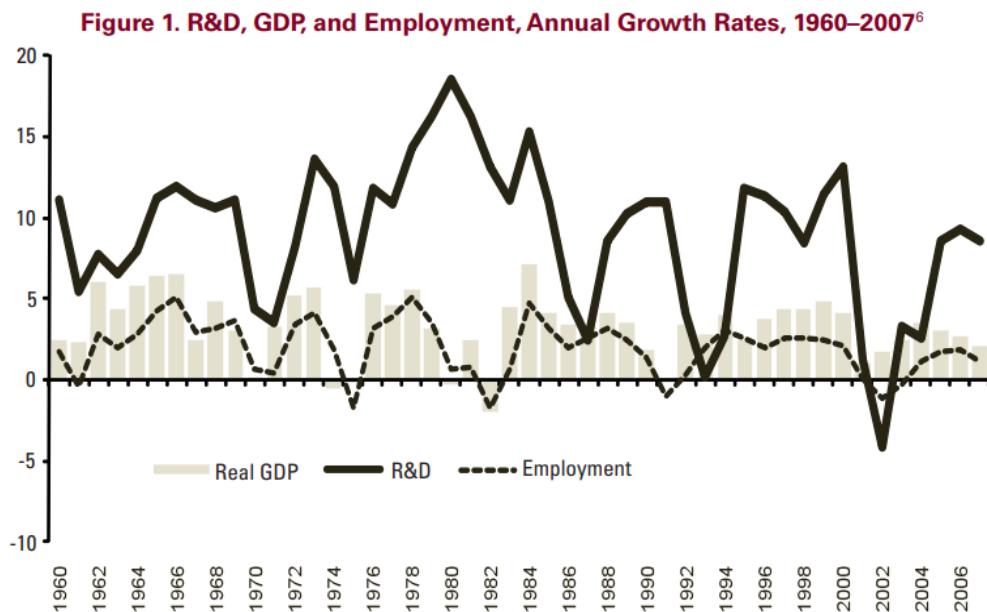
First of all, we have to delineate the areas of impact of innovation on the job market. As pointed out by Degryse (2016), this impact could be segmented into four different aspects:

1. job creation: new sectors, new products, new services;
2. job change: digitalisation, human/intelligent machine interface, new forms of management;
3. job destruction: automation, robotization;
4. job shift: digital platforms, crowd sourcing, ‘sharing’ economy.

2.3.1 Job creation

Citing the famous sociologist Schumpeter (1942), innovation is a creative destruction. In this paragraph we want to analyze the creative aspects of innovation, the ones which create job positions.

To pursue our analysis, we use R&D research as a measure for innovation. The relationship between R&D and innovation is widely used in the literature as a common parameter for innovation. In particular, it is used by Nam D. Pham (2010) to justify the effects of innovation on jobs and wages.



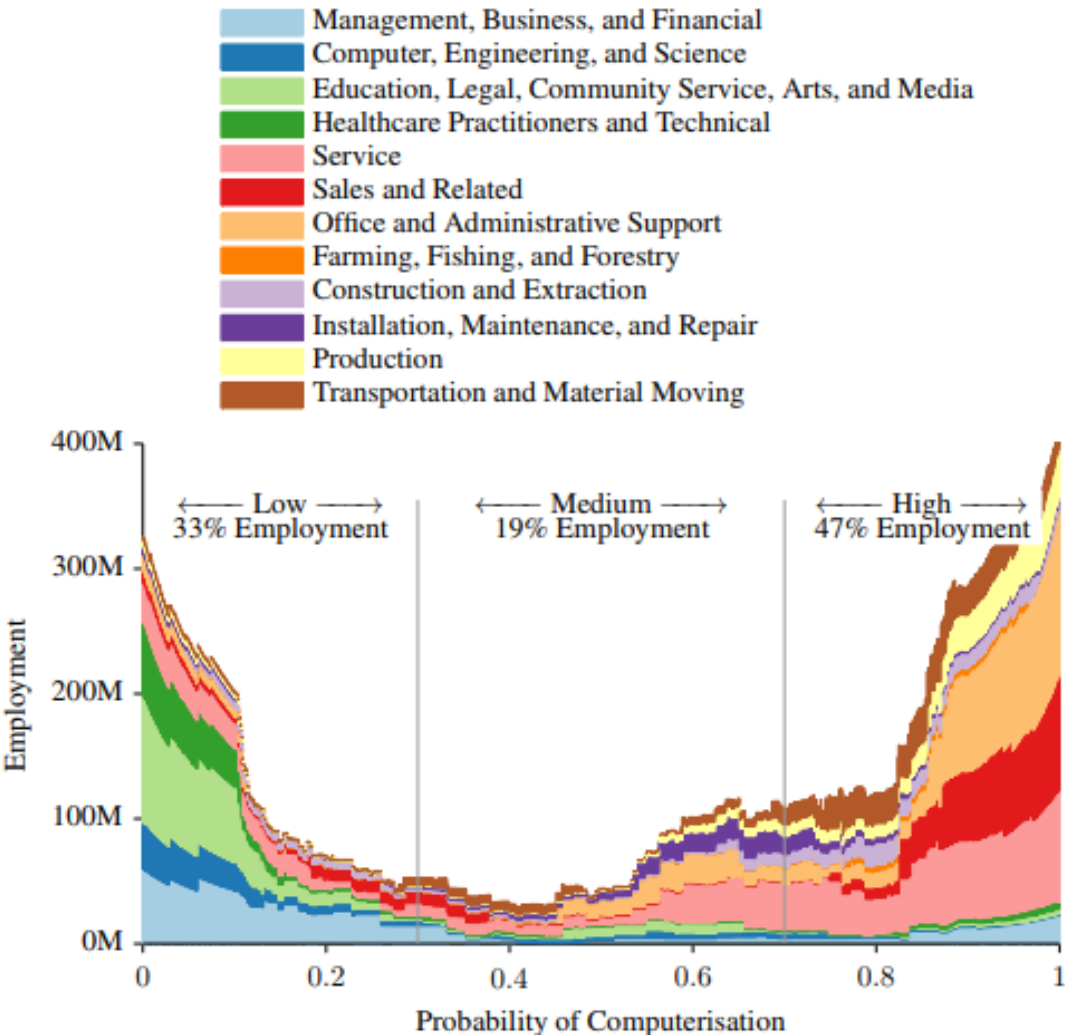
Source: Nam D. Pham, *The impact of innovation and the Role of Intellectual Property rights on U.S. Productivity, Competitiveness, Jobs, Wages and Exports*, 2010.

From this chart we can infer one of the most famous arguments of the techno-optimists: the historical view of the effects of innovation on employment. The two are strictly correlated: when R&D goes up, employment follows and vice-versa. We can also infer that R&D is a lot more volatile than employment: that is normal. When there is a crisis deriving from exogenous causes, employers prefer to cut costs such as R&D rather than fire employees. When the dotcom bubble burst at the beginning of the 21st century, for instance, the R&D plummeted, while the decrease in the employment rate has been slighter. What we do not see in this chart, however, is the so called technological unemployment: the unemployment due to innovation. If it was the case, we should see a decrease in the employment rate at the same time of an increase in the R&D research. Neither we see a positive effect on the employment rate due to a decrease of the R&D rate.

2.3.2 Job destruction

On this topic the literature is rich of arguments: one of the most famous is the research conducted by Frey and Osborne (2013) on the probability of digitalisation for job category.

The two researchers assess that:” According to our estimate, 47 percent of total US employment is in the high-risk category, meaning that associated occupations are potentially automatable over some unspecified number of years, perhaps a decade or two. It shall be noted that the probability axis can be seen as a rough timeline, where high probability occupations are likely to be substituted by computer capital relatively soon”.



Source: Frey and Osborne, The future of employment: how susceptible are jobs to computerisation?, 2013.

At the industry level, the impact of innovation depends on the type of innovation, according to a collection of research made by Mario Pianta (2005, p.579): “Studies on industries show that the employment impact of innovation is positive in industries (both in manufacturing and services) characterized by high demand growth and an orientation toward product (or service) innovation, while process innovation leads to job losses. The overall effect of innovative effort depends on the

countries and periods considered, but, in general, the higher the demand growth, the greater the importance of innovative industries (both in manufacturing and services) and the greater the orientation of firms within an industry toward product innovation is, the more positive the employment effects of innovation are”.

2.3.3 Job shift and job change

Historically, this automotive industry has been particularly interesting from a technological view: it has been the landscape of the second industrial revolution, with the invention of Taylorism.

The first industrial revolution took place in the United Kingdom at the end of 18th century. According to The Economist (2012), first tested in the textile industry, it moved millions of farmers from the countryside to the urban cities, in which they could find a job with higher salaries in companies which produced any kind of good: the factory was invented.

Then the economic environment faced the second technological revolution, which most of the scholars associate with the production of the Ford model T, produced from 1908 to 1927, which is worldwide recognized as the first affordable car. This process has been made possible through the Scientific management, through which the workers were responsible for easy and very specific tasks. Before the Scientific management, the cars were made by artisans or group of workers which had a more comprehensive, but also a lot more expensive, way of producing the good.

The scientific management had a lot of different implications, but the one we are most interested in this thesis is the easiness of the task for each employee: due to the Taylorism, a lot of unskilled workers could move from the countryside to the industrial cities in which they could find a job with a few days or even few hours training. As pointed out by Tom Snyder (1993), even illiterate people could find a job: in 1910, the percentage of illiteracy was 7.7% in the USA, because their task was so easy, specific and repetitive that low paid jobs didn't require literate workers.

3. Methodology

3.1 Presentation of the inquiry method

To achieve both practical and theoretical results, we chose a qualitative method.

According to Shazia Jamshed (2014, p.87), the qualitative method “is considered to be suitable when the researcher or the investigator either investigates new field of study or intends to ascertain and theorize prominent issues”.

Qualitative method is, thus, a research tool tailored to investigate a specific subject through several interviews. From the definition stated before the second part of the statement is particularly important: “to ascertain and theorize prominent issues”. Our research question concerns the employment of potentially millions of workers. It is thus necessary to understand a such prominent issue from different and sometimes opposite point of view to investigate the issues correlated with this subject.

The choice of each expert has been made through the analysis of their particular knowledge and experience. We privileged experts who had at least twenty years of experience and who had faced different aspects related to the issue. Another parameter we used is the experience in the sector of the automotive industry to discuss about the particular case of driverless cars. These experts, indeed, come from different backgrounds (academic, entrepreneurial and managerial) to face the issue with different ideas and sources of inspiration.

We chose to interview a professor who could provide us with the theoretic background to face the issue of the impact of breakthrough innovation on the labor market. The interviews with academics helped us to analyze, in particular, the definition and different interpretations of breakthrough innovation. They also made us understand the different implication on the labor market for all the possible job categories. They gave us a basis on which we could build up our research and a theoretic perspective of practical issues.

We also decided to interview an entrepreneur who had broad and deep experience of the automotive industry and of breakthrough innovation, Antonella Rubicco, CEO of A3Cube, firm specialized in artificial intelligence. We believe that a practical point of view on how the business faces breakthrough innovation was essential to understand comprehensively the issue. As an entrepreneur,

she explained me the factual implications of the issue, with a complementary perspective to the one I received from the academics.

We also wanted to go in depth in the issue with a managerial point of view, helped by a human resources expert. Luca Vignaga, CEO of Marzotto LAB S.r.l. contributed to this research analyzing the managerial implications of this global trend and how the companies should react to the change. The managerial point of view also gave us a perspective on how the companies are aware of the change and what they are doing to manage it.

The qualitative method could give us a direct experience of the problem: we needed to analyze the issue with experts who are already facing the problem. Furthermore, the number of possible implications makes the analysis very complex and it would have been impossible to analyze properly all the results of this change. We also did not have the knowledge to manage complex mathematical tools which are peculiar of master or PhD students, this research, thus, doesn't claim to be exhaustive on the issue. Another reason why we didn't choose the quantitative method is the geographical restrictions: we did not want to narrow our subject geographically because we would have been partial, while the impact of breakthrough innovation on the labor market can be measured significantly worldwide.

We could also choose to investigate our subject through secondary research. However, this method would not have allowed us to assume different perspectives and to study direct experiences of the issue, as it would have been impossible to interview an entrepreneur with such specific experience on the subject. Moreover, the background theory we acquired with the qualitative method would have been too broad: thanks to the qualitative method I had the opportunity to ask academics specific questions related to our subject. It would have been impossible with the secondary research method.

3.2 Data collection

3.2.1 Interview number one

Antonella Rubicco, CEO and co-founder of A3Cube. From her LinkedIn profile: "Antonella Rubicco has been at the forefront of high-performance computing for more than 15 years and has led several companies to international prominence with her experience and knowledge about the markets, strategies, and trends driving the industry". She has been also awarded by Dell in the "Founder 50 club" which comprises the best people from Accelerator, VC or digital entrepreneur. She lives in San

Jose, in Silicon Valley and she is an expert of breakthrough innovation. She works for a very innovative company and she has a great experience of autonomous vehicles, as she worked with several companies in the autonomous vehicles industry.

We chose to interview her for her prominent experience on breakthrough innovation and for her enormous knowledge of autonomous vehicles. She also gave the entrepreneurial perspective we needed for our research, as stated in the description of the method.

Due to the distance between Montpellier and the Silicon Valley, the only way to contact her was through a Skype call. The interview took place the 31st of March and it has been one hour and twenty three minutes long. At the beginning of the interview she answered to our question in a semi-structured way: there were some prepared question and some other aspects of the interview which came out following the most interesting points of the answers.

3.2.2 Interview number two

Alejandro Allera, International Business Professor at Montpellier Business School. Alejandro Allera has more than twenty years of experience in International Business, working in more than thirty countries helping SME to do Business Globally. He has been the professor of International Economics and Strategic Management during the experience of Double Degree at the Montpellier Business School.

We chose to interview him because of his knowledge of management of innovation, his international experience and his theoretical knowledge of business in general. He helped us to develop an academic perspective of the subject.

The interview took place in Montpellier at the Montpellier Business School Coworking Area the 9th April and it lasted twenty seven minutes. The interview has been semi-structured: he answered to our question and if there was some particular point we wanted to go deep in, we asked him further specification.

3.2.3 Interview number three

Luca Vignaga, CEO at Marzotto LAB S.R.L. He is a great expert of human resources, as he has been HR director at Marzotto Group for more than ten years and he published in 2012 “HR 2020, history and perspectives”. He is also often a discussant in various conferences about innovation and in particular about Industry 4.0.

We chose to interview him because of his managerial experience of both human resources and innovation. He gave us a perspective of how companies face the issue and the different approaches. We had a phone call interview which lasted thirty minutes. We followed a semi-structured scheme in which he answered the questions we posed, focusing the attention on the themes which he was more concerned about.

3.2.4 Interview number four

Luca Bauckneht, HR director at FAAC Group. Experienced HR Professional based in Bologna (Italy), having worked across a wide span of disciplines within the HR field at both the Headquarters and Operating Unit level. Significant M&A, Organizational Design, Comp&Ben, Litigation expertise. Proven competency in Leadership Development, Succession Planning and HR Management.

We chose to interview him because of his experience in a company which has a strong component of automation at it is vulnerable to breakthrough innovation, having all the characteristics of a company which is exposed to the revolution of the autonomous vehicles industry from the perspective of the impact on the labor market. He provided the research with a point of view which is strictly correlated with the labor market.

The interview took place in Padua, Italy the 27th of April. We had a face to face interview which lasted thirty minutes during which I asked questions about the impact of breakthrough innovation on the labor market. We followed a semi-structured path in which we focused more on the aspects related to the HR environment.

3.2.5 Interview number five

Paolo Lombardi, HR manager at CDK Global and ex HR regional hub Italy manager at Automobili Lamborghini S.p.a. and Volkswagen Group. He has a great experience in the automotive industry and in general as a HR he took the responsibility to drive the change at his companies. He also is an expert in engineering business processes.

We chose him because of his consolidated experience in the automotive industry. He gave a realistic know-how of how automotive companies approach breakthrough innovation and in particular, because of his experience as an HR, the impact of breakthrough innovation on the labor market.

The interview took place at CDK Global headquarter in Padua, Italy, the 30th of April. We had a face to face meeting which lasted thirty minutes. We posed questions to him in an semi-structure way: we focused on the aspects in which he could provide more details and knowledge, such as how companies in the automotive industry manage the change.

3.3 Data processing

3.3.1 Data coding

To assess the data we collected, we compared the different interviews to analyze the main arguments of each discussant. We underlined in particular the differences between the perspectives of each interviewer in order to provide the thesis with a comprehensive point of view of the specific argument.

Coding the data, we stayed as close as possible to the questions I asked to the experts in order to structure the results in a schematic way. We focused the attention to the statements which directly gave an answer to the questions and secondarily we used data less correlated with the questions in order to give a more exhaustive perspective of the research field. We gave a perspective of the data which is also proper not just of the different ideas of each expert, but also of the different positions they cover, focusing on the academic part for the professor or the managerial one for the HR expert. This allowed us to analyze the issue in a complete way.

4. Results

4.1 Empirical and theoretical results

4.1.1 The timing of adoption

Our first result is about the crucial *role of the timing of adoption* in breakthrough innovation processes regarding the impact on the labor market. As stated by Luca Vignaga, CEO at Marzotto LAB S.R.L.: “The problem is the transition: we need to know how long it will take to put into the market the first driverless car. I do not say: “this innovation will be good for sure”. There have been

many global processes we couldn't manage to steer: globalization has been improperly driven, for instance. Since 2001, when China first entered in the WTO, many people have "lost" in term of jobs and salaries. Unskilled workers in western countries have seen their salaries flat for a long time, many of them have lost their job. Will we be able to steer this phase? I don't think so, but I hope we learnt something. For sure it will create sorrow to a lot of people: you can't teach a technician how to be a data analyst. I think there will be space for technical training, even if not radical. In the past there has been a lot of losers and I think the problem is the timing, because in the short term there is no time to train people. The experts of innovation believe that innovation is exponential. I think it isn't and this is something we should be grateful for: if it was exponential, many workers would have already lost their job. However, we could face a breakthrough innovation which could potentially destroy our business in a very short term". Then Alejandro Allera, Professor at Montpellier Business School, gave a different point of view from the educational perspective, but stated a compelling problem related to the timing of adoption of breakthrough technologies: "The offer of education can be fast enough, my concern is on the acceptance of the change. This is a psychological effect: people don't accept to change so easily, there could be political or sociological issues as barriers between the workers and the job shift. Because of age or generation, people are not willing to change: there is a resistance to change". Antonella Rubicco, CEO at A3Cube, gave a more optimistic view of the timing of adaptation to breakthrough innovation: "Today Smartphone have changed the way we work and we have gradually adapted to it without noticing it. I believe artificial intelligence will change the way we work as Smartphone did, gradually. The level of training among employee grew with the time and we should go a step further because people will have to continue studying. I think it is something positive for the society. During the first industrial revolution people moved from the countryside to the city center and who knew how to read had an advantage on the others. At the same way, who has the proper skills will have an advantage on the other in the next years". Luca Bauckneht gave an historical perspective: " Oftentimes the topic of the speed of breakthrough technologies is mythologized. The disruption of one hundred fifty years ago is maybe greater than the one we are living today. The disruption created by electricity, for example, is greater than a lot of innovation we are facing now, both in terms of adoptions and impact on the society: the business of oil lamps in US has been destroyed in very fewer years. In the automotive industry, the first automobiles have replaced the horse carts within less than five years in Manhattan. We don't have to mythologize the speed of change of today, because we have seen a lot of greater innovations in the past".

4.1.2 Driverless Cars, work in progress

Our second result is about the time of adoption of the *specific case of driverless cars*: all of the interviewees said it will take some time before it will arrive into the market. Antonella Rubicco stated: “I see the arrival of autonomous vehicles far from now because there are a lot of decisions which an autonomous vehicle can’t take right now. For instance, I was involved in an accident, the only one of my life, and in a very short time I had to decide what to do. I was on a straight road and I had to decide whether to clash with a truck or hit somebody. At the end I had luck and I had a soft accident, but this type of situation, which isn’t usual, is impossible for an algorithm to calculate. The man has a third way which is the one of act according to the instinct, but what can a machine do?”. Alejandro Allera also believes it will take time for driverless cars to appear on the market: ” It’s a matter of ten years, but just for the first product, for the total exploitation of the market maybe one hundred years. You must realize the differences between the regions of the world: South America is very different from Europe for example in terms of adaptation to new technologies. There is also an issue about people who love to drive. If you listen to what people said about the paper books, a lot of experts predicted the end of this industry, but what happened is that people actually prefer to read a paper book rather than an e-book. For the autonomous cars people are looking for efficiency in terms of security, costs and time, these will be the three drivers for the industry”. Luca Vignaga, even describing the adoption of driverless cars inescapable, said that the process isn’t exponential and it won’t appear in the very short period. Paolo Lombardi pointed out some barriers to the implementation of autonomous vehicles:“ The phase of testing is the most complex: there are issues about the legislation and the assurance. The future phase of the complete switch will be the easiest one to manage, because of the great decrease of the accidents, and enormous time freed for the commuters. The first phase and the phase of the switch are the most complex because the issue is about integrating the normal cars and the driverless cars and there is a lack of infrastructure to implement driverless cars”.

4.1.3 The jobs which will become obsolete

The third result is about the type of *job positions which will disappear* in the next year. The answers were broad between interviewee and interviewee, however, many interviewees pointed out that the workers who are going to lose their job will be the less skilled workers, the ones who are more related to industries such as taxi drivers or shop assistants. Alejandro Allera, Professor at Montpellier

Business School explained which these categories are: “the drivers. In some industries there will be a mismatch for some delivery job position. However, it is very fatalist to say that shoppers and drivers will disappear, because there are some goods for which you need more interaction. Perhaps also the sales people, because if you want an autonomous car, you won’t need a sales person.” Luca Vignaga, CEO at Marzotto L.A.B. believes that the shift of job positions will be about:” Big Data. In the future there will be a great need for high quality data and people prepared to analyze and store them. There could be unprecedented scenarios of flows of production. The process of making the business model more accessible has a cost: there will be less workers and a better management of the flow at the beginning of the process or at the end of it. In between the two there won’t be a lot of space in the future, especially for workers. China has already started applying this business model, especially machine learning, to the manufacture. There will also be a loss in the shop we are used to, there will be a need for shop animator rather than a seller”. Luca Bauckneht added to the discussion:” A statistics demonstrated that almost the 2,5% of the labor market in the US works in the automotive industry, including positions such as the taxi drivers, the truck drivers and a lot more. The number is very significant. The scenario in the US seems to be dramatic, but I don’t think that it is going to be as dramatic in other continents. The morphology of the US bolsters the autonomous vehicles industry, because there are cities which are designed from scratch, with a logistic organization which is very easy for an algorithm to calculate and implement. In Europe it is not the same: it’s more predictable for Italy to have enormous hubs, but the autonomous vehicles industry is not going to replace comprehensively the market. The morphologic variable is crucial and Europe is going to be an hybrid. For Africa and Asia there is another variable which is central: the labor cost. Because in Africa the medium salary is around two dollars per day, it is not convenient to buy a robot which does the same task. Thus, I believe that this kind of jobs won’t disappear completely and the percentage of these jobs will depend dramatically on the country”. Paolo Lombardi intends the driverless car revolution in a broad sense: “There are a lot of job positions which will become obsolete and in various industry. All kind of companies which transport people will have to adapt, and we won’t buy cars anymore: it will be more like a service. This change will turn upside down dramatically the way we intend the industry. There won’t be need for the car license. The infrastructure will be also challenged: the highway will change and there will be some hubs in which the cars will be able to exchange data. There will be the possibility to eliminate the queues, because there will be a data interchange according to which the speed of the cars will adapt their velocity. The change will be total and ineluctable and we can already see all the types of advantages: like the safety. There is the aim of zero accidents”.

4.1.4 Threat of inequalities

Moreover, we found how one of the biggest concerns of the interviewee related to the process of breakthrough innovation, especially for autonomous vehicles, is *the issue of inequalities*. We found how the fact that there will be a stronger demand in the labor market for skilled workers and a decreased demand for unskilled workers involves a rising gap between the two, the skilled and the unskilled. In particular the problem is that the skilled are already the wealthiest in the society and this trend is going to exacerbate an already existing social fracture. Alejandro Allera commented:” It is a challenge, but it isn’t the first time that this happens, if we think of autonomous factory one hundred years ago the cars were totally handmade, but now the factories have a lot of robots to work within the factory. Kia for example in South Korea have a 100% autonomous factories, but have a lot of employees working to develop this structure. people who don’t have the skills will have a lot of difficulties because the opportunity to find a job for them is reducing and reducing. So I think that probably there will be inequalities, but the interesting thing is what we can learn from other industries, because the technological revolution is right there.” Antonella Rubicco gave a quite different perspective to the issue:” I can see it right now in my daily work: there is an enormous gap between the kind of job the people are looking for and the one which the market requires. People can’t find jobs but at the same time firms can’t find workers. In my experience we had problems finding a programmer because of the skills required, we were looking for someone who could develop a program in a specific way that could be implemented by students with a high school degree while college students who came out of the university as informatician couldn’t make it. There is space also for the ones who have fewer skills, maybe it’s more narrow than before, but it exists”. Luca Bauckneht contributed with a different perspective:” There will be inequalities in relative terms, but not in absolute terms. We have to evaluate it with historical lens: today we live in the best possible world, as Popper said, and nothing goes in a different direction for the future. Tomorrow will be the best possible world: the level of education, quality of life or disease management: all these indicators improved dramatically in the last one hundred and fifty years. There could be a higher gap between the rich and the poor, but the poor of tomorrow will be richer than the poor of today, as the poor of today is richer than the poor of one hundred years ago”.

4.1.5 How to manage the process of innovation

Furthermore, another key point of my results is *how to steer this industrial revolution keeping the labor market safe from economic storms*. The main answer which all of the interviewees pointed out, even if with different shades, is the crucial role of education and the concept of skills. Skills must be enhanced or readapted in order to survive to this revolution. Luca Vignaga declared it very clearly: “The most important element in order to steer this revolution is the skill management which allows a worker to surf from one place to another. The specialized worker can metabolize the skills he acquired along his career in order to create new drivers for the future. If he could manage a small group of employees or develop some skills with his own hands, these competences of project management and handcraft are useful to adapt himself within the labor market. Along this process there will be two types of firms: on the one hand global firms, which do not care about where they stay physically, such as Facebook or Microsoft. They just care about collecting the proper workers. They move where they find lower levels of taxation. On the other hand there are the firms which care about the territory, because there they could find the proper experience in terms of workers and culture. This type of firm needs roots, while the first type is like a starship”. Alejandro Allera offered a new approach in terms of adaptation to the new situation:” I would jump in the new way and I will try to adapt to the job shift. The governments and institutions have to approach these positions and make the shift easy for the workers. The answer is education, we have to accept that times have changed and for certain types of industries there is no space anymore. They will, thus, need to adapt and move to other professions, the union of taxi drivers could make a survey and realize which are the skills the taxi drivers could reuse in other industries. For example, taxi drivers have good communication skills and they could reuse these skills in other industries, like in restaurants or, for the knowledge of the city, in the tourism industry. Many of these people could change to tourism, restaurants or other types of jobs related to their skills”. Luca Bauckneht focus his attention on the power of the individual:” The training for the employees is very important, but it is more important to stress the concept of *unusquisque faber est fortunae suae* (everybody is responsible for his own destiny). The individual must take a stand and ask for training and stimulus in order to learn. There is a co-responsibility between the individual, the company and the State. Moreover, education in western countries, especially in Europe, is free. One hundred years ago the horse cart driver had to spend a lot of money to re-skill himself, but today there is no alibi anymore for the ones who complain, because there is the free access to instruction”. Paolo Lombardi, however, gave an optimistic view of how inequalities could develop in the future:” Inequalities are inevitable for the ones who have barriers, however, thanks to internet, learning is enormously easier than the past. Because of that I believe that, in terms of income gap caused by the

skills, inequalities won't grow: it's true that there is the need for figures which are high-skilled, but there will be need for figures which are less skilled. Workers must train themselves in the short term, for the long term, however, it is a matter of strategy and here the government has the responsibility to anticipate the future drivers. If you see an assembly line now and you compare it with the one of thirty years ago, you will see that now there are more robots, but there are also technicians who are humans. The process is more computerized but there is the need for humans to drive and use this technology. What is changed is safety and the productivity of the assembly line, which is enormously greater than the past. I remember that when I started working in the automotive industry there were gas and ashes all over the assembly line. People died because of the work environment. Luckily, the working conditions have changed a lot and now it is easier and safer to work in the assembly line".

4.1.6 Considerations about future trends

The final result of our inquiry concerns the *future*. We asked to the interviewees whether they are optimist or not about the implementation of breakthrough technology from the side of the impact on the labor market. The experts answered in different ways. Alejandro Allera was the most optimistic about the future. He answered:" I'm a 100% optimist. If old jobs are destroyed, there will be new jobs. There is a need for adaptation. Inequalities worry me, I understand the people who are in the line, but at the same time I think there is an opportunity. There is not black and white, this is not the end of the world. When people are menaced, they are more creative. It is not an optimistic scenario, because it is forced. I invite people to risk and adapt to new industries and to learn about what is happening". Luca Vignaga answered in a less optimistic way, but with a strong conscience on how to escape the barriers of the future:" I see some big issues. However, the world has steered transition which were as problematic as this one. I like the growing sensibility about the environment and I'm convinced that technology can help us. In the short or medium term there could be great social shocks,

one of the most important is inequality. The turbo-capitalist model¹ is not sustainable anymore, we need to find a third way: a compromise between the technological model² and the turbo-capitalist model”. Paolo Lombardi encouraged the youth to be optimistic: “Young people have to be optimistic about the future. There are new generations which are now a lot more skilled technologically in comparison with the other generations. For instance, when I started working in Volkswagen there was just one computer in the whole firm. Now it’s completely different: people who come out of school are already prepared for new technologies which are used in the factory. The problem for the new generation and for the State is to anticipate the trend of the next ten years, making the process of education aligned with the demand of labor. Now young children are born digital, while my generation wasn’t stimulated to learn how to manage the computer”.

¹ Turbo-capitalism : extreme belief in the market forces, particularly combining « privatization, deregulation and globalization », as defined by Luttwack, 1999.

² Technological model: generalisation referred to the belief that technology is the way to achieve progress and wealth.

4.2 Result analysis

4.2.1 Is breakthrough innovation exponential?

The first concept we can extract from our results is about *the speed of breakthrough innovation*: each of the interviewees agreed on the fact that the autonomous vehicles revolution won't hit our society very early.

This is a cornerstone in our research, because the speed of innovation is a crucial variable of the impact on the labor market. The fact that this breakthrough innovation is going to be slower than it was thought is a good finding for the ones who feel jeopardized by breakthrough innovation. It means that even if their job position will disappear in ten years, they will have the time to adapt their skills to new industries. This is also very important for the oldest segment of the labor market which could be potentially damaged by this industry. A later arrival of driverless cars involves a safer retirement process. According to the results of this research indeed, many taxi drivers who are fifty years old have chances to be immune to this revolution. A slower process also involves a better placement and skills adaptation for the students who will approach the labor market in the future. They will have the time to study a certain type of skills which will be more likely to make them find a job when they come out of high school or university.

4.2.2 Short and long term: two different perspectives

From the results we can see a blatant *distinction between the short and the long run*. The short term is almost always described as a land of sufferance in order to achieve a better future in the long term. Even in the answers of the most optimist expert there is a degree of acceptance for a near future of unpredictable issues. The most prominent is the issue of inequalities, which came out in each interview. The experts acknowledge, although with different nuances, that the breakthrough innovation can bolster the income gap already existing between the poorest and the richest segment of the society. They are worried that the stronger demand for skilled job positions, especially for some type of industries such as data analyst or software developer, will raise their salaries while decreasing the ones without any specialized degree. A different demand on the labor market can increase a certain type of salaries while reducing others. Because of breakthrough innovation, the "losers" are going to be the less skilled, while the "winners" are going to be the most skilled, the ones with a college degree. The concern moved in particular on the truck or taxi drivers which will lose their job because of

autonomous vehicles. Will they be able to find a new job? The most optimistic interviewee answered yes, the less optimistic answered no, but everybody agreed that in the short period there will be suffering for the “losers” of breakthrough technology and autonomous vehicles.

We find this difference between the short and the long run very interesting as the short period is the one we all will live in. As Keynes used to say, in the long term we will be all dead.

4.2.3 The role of education

Another key point we found thanks to our findings is *the crucial role of education* in the process of finding solutions to the stream of innovation. The interviewees agreed on the fact that the workers have to adapt themselves to the change, as pointed out very clearly by Allera who, when asked how he would he react to the change, answered: ”Honestly, I would jump in the new way and I will try to adapt and change profession”. The concept behind the answer of education is the need to acquire new skill to be hired in new and safer positions. From this point we found different perspectives between the interviewees: some pointed out how difficult would be for a worker who has always done the same task to adapt himself. The problem for the ones who held this view was about the capacity to learn and to invest money and time to learn skills which would be used for a short period before the retirement. Other experts objected that for these types of worker is difficult even to recognize the change and the difficulties to adopt new technologies and that they would be reluctant to change. The other barrier to the solution of education is the variable of the time. Workers need time to change, to learn and to adapt themselves to other job positions. As declared in the first paragraph of the result analysis, the process of breakthrough innovation and in particular the adoption of autonomous vehicles should be slower than it was thought, but many of the interviewees also objected how a new technology could enter into the market overnight causing a shock to a lot of workers and without leaving them the time to find new solutions for their future.

5. Discussion

5.1 Managerial implications

From the point of view of the companies the issue of the impact of breakthrough innovation to the labor market is prominent.

5.1.2 Continuously evolving training

First of all, because of the fast-changing environment in which the companies operate, the training for the employees must be continuously evolving: there is no space anymore for the type of training “once for all”, according to which once the worker has finished his degree he does not need to learn anything anymore. The new relationship between the employee and the company’s training will be a constant and broad training which will follow the employee throughout all his career. The employee must be aware of the new technologies on the market related to his job position in order to exploit the potential of the possible implementation to his company’s branch. They must also know how to use the already existing technologies related to their positions and for the adjacent positions in order to increase constantly their productivity. This is the only way for companies to keep abreast of the chances the innovation offers: because there is a huge amount of possible solutions for existing problems, the employees of the company must keep their eyes open to exploit unexplored paths. This type of solutions is crucial also for the Corporate Social Responsibility: this is the only way from the worker’s point of view not to be overwhelmed by the stream of innovation. By keeping them abreast of the new technologies the company assures its employees against the possibility of losing their job as a consequence of breakthrough innovation. It’s a win-win for the employees and the company: the employees are safer and have a lower risk of being replaced by breakthrough innovation and for the company it’s an investment on the future.

5.1.2 New types of jobs

Secondly, companies should be prepared for new types of job positions in order to adapt the type of job positions which are more likely to disappear. In the results it was evident how certain kind of skills and job positions will not be necessary anymore in the future. The interviewee listed a great number of jobs which will be obsolete in ten years and the literature analyzed at the beginning of this thesis confirm this global trend. The experts agreed on the fact that, for example, data analyst and software developer will have a starring role leading the firm towards the breakthrough innovation. Although these kind of job positions require a high level of skills, Antonella Rubicco pointed out how even less skilled workers, if specialized in peculiar fields, could find their paths in the companies of the future.

Not to be surprised by this process, companies should look for investment in these trends which will have a leading role in the companies of the future. This involves an open perspective of the future.

Luca Vignaga explains this view: “The company must invest on innovation, the CTO (Chief Technical Officer) has to be the first to believe in the project and he must be an example for the all company going all over the world looking for new solutions. The companies must have the courage to convert themselves. The most important thing is to observe what is happening around the world”. Investing in innovation they prevent a possible arrival which can make an old business obsolete: the capacity to keep the eyes open is pivotal for every kind of industry. On the other hand, this research shows in details which kind of positions will be obsolete in the near future. Companies should be aware of that and start investing in these types of employees to make them ready for a possible shift towards new types of positions within the company. The results explain in particular how taxi or truck drivers won’t be necessary anymore in the future and a proper management of the change can prevent them from a negative shock. The company must then train its employees which are at risk in order to provide them with new skills useful for the company. Possibly, these new types of skills should be concerned with the new job positions that innovation will create.

5.1.3 Need to take the helm of innovation

The impact of breakthrough innovation on the labor market can be fatal for a lot of people if the companies primarily do not stand up and steer the change. From the results is evident how dangerous could be an innovation process which is left without any guidance by the companies or by the policy maker: inequalities, unemployment and social injustice are the direct consequences the interviewees have seen of an anarchic management of the innovation process. Companies must then be aware of this global trend and adapt themselves to the change. Paolo Lombardi contributed to the discussion with an interesting point of view regarding the managerial implications:” The firm should train the older people: it should escort the older people in order to fill the gap with the young generation. Moreover, I believe that a mix of the two generations, the young and the old one, is healthy for both to keep abreast of the change. Thus, I’m not concerned about a blackout of the society caused by the technological unemployment. The most complex thing is to anticipate the needs of the future society”.

5.2 Theoretical implications

From the theoretical point of view the implications of the impact of breakthrough innovation on the labor market are significant.

5.2.1 Is Moore's Law effective?

First of all, the effectiveness of the Moore's Law is menaced by the results of the interviews. According to Chris A. Mack (2011), the Moore Law implies, indeed, that the number of components of a semi-conductor will roughly double every two years. This law has been extensively assumed to describe the process of innovation as a whole and it is directly correlated with the definition of innovation as exponential. It means that innovation follows a non-linear function according to which the speed of innovation increases more and more year after year. The results of this thesis explain something different from what it was thought of the speed of innovation. Every expert objected how the arrival of autonomous vehicles will not appear before ten years, at least. There is a discrepancy between the results and the theory which is crucial for the conclusions of the thesis: as we have seen in the result analysis and the practical implication of the results, time is a critical variable to assess to evaluate the impact of breakthrough innovation on the labor market as it decides whether people have time to prepare and arrange their skills for the technological innovation or not.

If the process of innovation gives the time to the workers to adapt themselves to new job position, the impact of breakthrough innovation on the labor market would be milder than the theory predicts.

5.2.2 Short and long term from the theoretical point of view

The results of this thesis underline a strong difference of impact between the medium and the long run. The interviewees have shown how the medium (and the short) term is riskier than the long term. This difference is due to the fact that in the long term the workers and the educational system have time to adapt themselves to the new demand of jobs, while almost every expert has pointed out how the medium term is more likely to be dangerous in terms of inequalities and unemployment for the ones who have their job on the line because of breakthrough innovation. This new theoretical difference and the correlation with the education hasn't been taken into consideration by the literature, which considers the workers "passively". It means that it just considers them losing their job instead of trying to adapt themselves. The long period, however, is unpredictable as many variables could come across and seriously compromise the optimistic scenario of a peaceful accomplishment of the workers. The most prominent variable is about how the policy makers and the companies can react to this global trend: if they realize that the issue deserves consideration and stand by the workers

helping them to find new opportunities, the job shift would be a lot easier for them to realize. However, if the companies and the state ignore the issue the long term could exacerbate the already existing inequalities causing to these categories a great shock in terms of financial sustainability.

5.2.3 Who is responsible for the drawbacks of innovation?

Another theoretical implication is the relationship between inequalities and breakthrough innovation. The interviews have shown how the fact that there will be a greater demand for skilled labor, the ones who have a college degree, in particular for certain types of degree such as engineering or computer technology, will make the salary of these positions grow while the weaker demand for unskilled labor will make the poorer earn less. According to the results the gap between the salary of the richest and the poorest is, thus, going to grow. The issue is prominent as the inequalities are already a social issue which creates pressure on the society and the future trend leads to an increase of this difference. And the specific weight of how inequalities grow or are going to grow because of breakthrough innovation was not considered a significant variable by the literature.

Theoretically, the concept of how to manage the breakthrough innovation has always been considered from the point of view of the company or the State. The results, however, highlight how the individual is responsible for his own destiny. From the interview with Luca Bauckneht a latin citation stood up: *unusquisque faber est fortunae suae* (everybody is responsible for his own destiny). From the results it was clear how the increased number of data and the low cost of instruction, especially in Europe where the cost of education is almost free, evaluate the possibility for the workers who are jeopardized to re-skill themselves and find new job positions according to the stream of innovation. He has now the tools to protect himself, according to the results, from the risk of being replaced by the computerization. In order to do that, the single worker must then react actively finding new position where he can continue his own carrier.

Somebody can argue that the amount of data which are available thanks to internet can be a help for the individual, but also a distraction: the world is more and more complex and even the best analyst of any kind have proved to be wrong analyzing some global driver: the global crisis of 2008 and the last political election in the U.S. are just two examples. So that the question which could rise from the discussion is: how could a taxi driver predict what to do if even the analysts are often wrong about their predictions? There is not an easy answer for this question, but for sure there is a co-responsibility among the State, the companies and the individual in determining the future of the labor market.

These three forces, the State, the companies and the individual must collaborate in order to prevent social disasters which an unregulated innovation process can cause. The three must take the helm of innovation and make it more acceptable for everybody.

5.3 Comparison with the literature

The literature analyzed at the beginning of this thesis takes as assumption the *exponential speed* of innovation. According to the Moore's Law C Mack (2011) , the speed of innovation should be exponential: the number of semi-conductors should double every two years. It would mean a dramatically high speed of the process of innovation which according to our results would be unsustainable. However, the results of this thesis demonstrate that there is a mythization of the process of innovation and that, according to the experience of the experts, the impact of breakthrough innovation on the labor market and in particular of autonomous vehicles will be slower than it was thought. As seen in the results, the timing of innovation is a crucial variable of the resulting impact on the labor market: if the results are correct and the velocity of innovation is effectively slower than what the literature affirms, there would be more time for the workers to re-adapt themselves to new job position through a process of new skills acquisition. The concept underneath this implication is that education needs time to be taught and to be learnt by the students. Thus, a slower velocity of innovation would result in a milder impact of breakthrough innovation on the labor market.

According to Shumpeter (1942) and as defined in the literature review, innovation is a destructive creative force which destroys the job positions which are obsolete and create continuously new ones. This definition caused ambiguity in the results: many of the experts interviewed confirmed that the balance is positive and the future will be more generous than the present. In the literature review we defined these types of people as the techno-optimists. On the other hand, several interviewees defined themselves skeptical about the future trend of the labor market, assuming that the impact of breakthrough innovation and in particular of autonomous vehicles will be negative in terms of balance of jobs created and destroyed. However, the majority of the interviewees defined themselves optimists: there is the conscience that the process of innovation is not steered properly at a macro-level, the poorest will suffer in terms of unemployment, but if the State demonstrates to be reliable in planning the future trends, in particular on the theme of education, young people have to be optimist about the future. The interviewees focused themselves on the school system and the predisposition to change of the individuals, who have to be aware that the old paradigm of throwing the books away after the degree is not reliable anymore.

6. Conclusion

In the introduction innovation was resembled to a stream which is ineluctable, and the only possibility for the humanity to react to this stream was through the water mills which would have granted a steered and socially responsible process of innovation. During the research we tried to identify how dangerous the stream could be and which are the possible watermills that could be built to exploit its potential.

Breakthrough innovation can be dangerous, especially in terms of inequalities, if the State doesn't hold the helm and build an efficient school system which continuously keeps abreast of the new technologies and the new types of job positions. This is due to two main variables: the first is the time of innovation, which is not as fast as many scholars say, but which still can be faster than the educational system and create certain types of jobs which the labor market can not absorb. The arrival of autonomous cars will hit the market late because of the infrastructures, which need huge investment to be implemented and a lot of correlated type of industries which need to be defined before the entering on the market, such as the insurance or the responsibility in term of legislation in case of accident. The timing of breakthrough innovation has often been defined as mythized by the experts interviewed in this research, however it is also stated that the driverless car revolution is ineluctable and it is just a matter of time before the first autonomous car will appear on the market.

The second variable is the demand for skilled labor: more and more the companies are going to look for workers which are prepared to manage difficult skills, while the ones who have skills which are easy to replace are going to suffer the most the arrival of breakthrough innovations. This dynamic could potentially increase inequalities, because the demand of labor of the most skilled will rise and thus their salaries will follow, while for the low skilled workers could happen the opposite. However, this is just a pessimistic scenario that could happen if the school system doesn't follow the global drivers.

Here come the watermills, that is to say the possible solutions which are outlined by the analysis of the literature and by the discoveries of this research. The only great tool to exploit the potential of breakthrough innovation in order to do not be overwhelmed by it is education.

According to the results, training must be promoted by three actors: the first and the most important is the individual, who has to realize that if he stays still, he is going to be swept up by the innovation

process. Thus, he must exploit the enormous potential which the technology itself offers via a very easy access to auto training session of whatever he thinks it could be useful for him in the short term. The paradigm of studying “once for all” is faded away and the only possibility for the individual to improve to be prepared to breakthrough innovations and eventually improve his standard of life is keeping abreast of the new technologies.

The second actor is the company, which should be focused on the medium term granting continuous stimulus and opportunity to improve the skills of each of its employees. The companies have the responsibility, for the employees’ and for the company’s sake, to offer the possibility of increase the skills and the knowledge of the employees through programs of training and incentives.

The third actor and the one responsible for the long term is the State, which has to plan the strategic drivers of the future and invest on the school system in order to make its students prepared for the future.

We analyzed the techno-optimists in the literature review and we also asked to each of the interviewees whether they feel optimist about the future. We can say that we feel optimist about the future impact of breakthrough innovation on the labor market, but it will depend also on how the young generation will be able to steer the stream and manage to keep innovation a progress for as many people as possible.

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