Professional MBA
Entrepreneurship & Innovation

An analysis on the effects of disruptive mega-trends on work: A Study on Austria

A Master's Thesis submitted for the degree of
"Master of Business Administration"

supervised by
Prof. Marc Gruber

DI Alexandre Barban

h1527627

Vienna, June 2017

Affidavit

I, **ALEXANDRE BARBAN**, hereby declare

1. that I am the sole author of the present Master's Thesis, "AN ANALYSIS ON THE EFFECTS OF DISRUPTIVE MEGA-TRENDS AT WORK: A STUDY OF AUSTRIA", 64 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master's Thesis as an examination paper in any form in Austria or abroad.

Vienna, 30.06.2017

Signature

Preface

I wrote this master Thesis, "An analysis on the effects of disruptive mega-trends on work: A study on Austria" for my Professional MBA Innovation and Entrepreneurship, a program from WU and TU in Vienna. This was the last work before obtaining my Diploma. It has been quite a journey.

I have been thinking for a long time that something was wrong with innovations and technological trends. I had the feeling that there was a delta between what might come and how the society is preparing itself for it. Then arrived the self-driving cars prototypes. I just thought that all the taxi drivers will lose their job and that it will be very hard for them to learn new useful skills.

Wide program! I was fortunate enough to have been oriented by my supervisor, Pr. Marc Gruber. He helped me to stay focused on the question I wanted to answer.

This is how this journey begun. I went through theories, plenty of them, about economic evolution, innovations waves and recession. The findings have been truly amazing. Although long, this was an easy part based on what happened. The forecast section was extremely interesting, but it was also very frustrating because you are biased by your own beliefs. The challenge was to put those feelings in the background. I concluded with an acid test: interviews with some professionals to understand how they are seeing and reacting on coming mega-trends.

Of course, nothing went according to plan. I truly thank my family for their continuous support during this hard time. I also thank two friends who helped me to make it happen. My colleague from work, Manuel Munguia who loves to talk about the possibilities of coming technologies, and my colleague from study Günter Reise who constantly encouraged me even when I seemed to have lost faith: "We eat an elephant one piece at a time!".

This paper is first intended to better understand the potential disruption the future is gathering for us. It is also to help decision makers and organizations, both interested in Innovation and on their effect on work and on lifestyle. It is all about culture after all. In Austria and Abroad.

Thank you for your patience, and I hope you will enjoy the reading.

Alexandre Barban

Vienna, June 30, 2017

Abstract

The world is changing, and it is changing quicker and quicker. Today it is about digitalization, tomorrow it could be about self-driving cars. Those rapid changes might put some pressure on the relation some category of workers have with work.

The aim of this paper is to understand where we are today when referring to innovations. For this reason, the academic question of this study is "What could be the effect of the current mega-trends on work in Austria?"

The research question is divided into three sub-questions. The first one is about the possibility of facing a potential Technological Revolution. A detailed study of the existing theories from Kondratieff, Schumpeter and the Neo-Schumpeterian school from the eighties, associated with a pool of coming technologies as forecasted by Gartner, is the method used to answer this question. The results are showing an increased probability to face a new Technological Revolution. The second sub-question is about the destructive potential on work those new technologies might have in Austria. A detailed overview of fundamental indicators for Austria, combined with studies about the effect of digitalization on work, and with a home-developed scenario about self-driving cars will answer this question. Again, the results are pointing to a turbulent direction. The last sub-question was about the resilience of Austria to sustain this potential transformation phase. A set of interviews with professionals from the Austrian scene showed that the resilience is moderately high, with one main topic that needs to be improve: continuous education.

With this conclusion, it is recommend to focus on the following problem: How to bring the right training to the persons who need it. Further set of studies how to do this would be welcome.

Table of Contents

Table of Figures

List of tables

List of abbreviations

AR: Augmented Reality

FTE: Full Time Employee

GDP: Gross Domestic Product

IoT: Internet of Things

IR#1: First Industrial Revolution[1]

IR#2: Second Industrial Revolution

IR#3: Third Industrial Revolution

IR#4: Fourth Industrial Revolution

IT: Information Technology

K-Wave: Kondratieff Wave

Phase A or upswing: growing phase of a K-Wave

Phase B or downswing: descending Phase of a K-Wave

SMI: small medium industry

USP: Unique Selling Proposition

VR: Virtual Reality

[1] Inspired by (Gordon, 2012)

1 Introduction

It all began with the fact that driving a car is a real problem for me. I never really bought the dream of freedom that having a car is offering. After all, I am living in a big city, and I have been living in big cities for the last 20 years. You have plenty of alternatives there that are cheaper, greener and more convenient. Additionally I never considered the car as a visible representation of my social status or of my wealth. Finally, after owning a car for some years, rarely driving it and letting is rot on a parking slot, I decided not to have a car anymore. This decision drastically reduced my need of driving. I almost unlearned how to drive, and today I do not feel comfortable driving a car.

There is a negative side to this situation of course. When you eventually have a family, the car stays the best way to organize your family social life. As an alternative to drive a car, I see only four options. First, I am organizing myself with the public transportation. The backside of this is the cost on time and the exhaustion of transporting the entire luggage for a full family. Second, I limit my holidays to home, but I quickly learned that after all, this was not an option. Third, I take the time and the money to relearn how to drive properly. This is not my preferred option, as I really do not like driving. Fourth, I am dependent on my wife, who is the one driving. While the fourth option is plain of sweetness for me, it is not carrying the right message to my son: Men are not driving.

Imagine now what kind of effect the announcement of Elon Musk from March 19, 2015 did to me: “Self-Driving Tesla Cars Will Be in the U.S. by Summer” (Kessler, 2015). While there are still philosophical and legal barriers that the concept of autonomous cars has to overcome, this is creating a fifth option to me: I might not need to drive my car in the future anymore. The four first options could eventually become obsolete, and I finally do not have any car problem left.

While daydreaming about the possibilities this is offering me, I though a little bit more about this. Europe is facing a real car accident epidemic. In 2015, in European Union, because of car accidents: 26,100 persons died, more than 100,000 are permanently disabled, 200,000 are experiencing serious injuries and more than 1,300,000 are injured (European Commission, 2017). I assumes that in almost all the cases a driver did an error that triggered the accident. Improving the behavior of the drivers is part of the road safety program initiated by the European Union (i.e. banning drinking, using drugs, talking to the phone, eating while driving). As the digital word is

not prone to “human error”, experts estimate that 90% of the car accidents might be avoided by having a fleet of self-driving cars (Michele Bertoncello & Dominik Wee, 2015). When this will be there, it will free billions of hours that could be used for producing (working, doing hobbies), consuming (playing, watching video), or improving the life style (sleeping, meditating). It will also drastically reduce the working value of the professional drivers such as taxi drivers, truck drivers, ambulances drivers… The effects are even deeper than just this. It will have a big impact on the car insurance companies, the driving schools, the car workshops, the emergency services…

Putting all this together, this simply means that many low educated people might lose their working place!

When I reached this point of reasoning, as the self-driving car is only one of the coming new products, I wondered how the mega-trends would affect the value of work and I decided to focus on my country, Austria.

1.1 Problem formulation

To be able to answer the aim question "*What could be the effect of the current mega-trends on work in Austria?"* I formulated three problems that I will solve in this paper.

Problem 1: Is it probable that we are facing a new Technological Revolution?[2]

Problem 2: How could this Technological Revolution affect the distribution of work in Austria?[3]

Problem 3: How prepared is the economic environment in Austria to sustain the choc of a Technological Revolution?

I have formulated the first problem with the intention to show that we are most probably at the beginning of a new era in term of technology. I will use the previous work from academics to be able to answer this question. Once I have shown the high probability of such an event, I will solve the second problem by first analyzing how the work is distributed within Austria. Then I will show how the coming Technological Revolution might have an effect on this distribution. To achieve

[2] I am using the term Technological Revolution that is broader than Industrial Revolution. I am inspired by the work from Daniel Shmihula who follows the wording from the Neo-Schumpeterian (Shmihula, 2009).

[3] Please note that I consider unemployment as part of the work distribution. I consider this part of the population as the one with skills that are not fitting the economic needs of the society.

this, I will use the large numbers of current studies focusing on the effect of digitalization on work in the most advanced countries, including Austria. The profusion of such studies about this subject is an indicator to me that there is an increasing awareness about some coming technological change[4]. This profusion also shows that governments, at least in Europe, have a high interest to be prepared for this potential wave of transformation. Focusing on the governmental interest to this topic will help me to solve the third problem. What I want first to understand is what the different economic actors from the government are preparing to deal with this Technological Revolution. Second, I will scrutinize the other major actors of the economic life: the enterprises. If they are working on becoming more agile, they will be better prepared to use this Technological Revolution at their advantage. If not, they might suffer the consequences of such a transformation.

I believe that the results of my study might help the Austrian economic environment to get a holistic understanding of what is most probably coming. It will help enterprises to become more agile by training their employees that are at risk of declassification. It will help the governmental and non-governmental actors to accept the fact that a new world is coming. Therefore, it will help Austria to be proactive about this change, and to accompany the technological wave like a surfer instead of trying to stop it with their bare hands.

1.2 Objectives of the Master Thesis

Based on the previously enunciated three problems, I have two objectives that I aim to fulfill along this thesis.

Objective 1: Demonstrate that the world is changing and that probably the next big change has already begun.

Objective 2: Understand how the different actors of the economic life of Austria are aware about this change and how they are preparing themselves to accompany this technological wave.

To reach my objectives and to answer the problems I already have formulated, I will use a mix of techniques from literature and statistical analysis to interviews of the economical actors. The next chapter describes more into detail how I aim to achieve this.

[4] Please note that when I chose the subject of my Thesis, even if already many academic and think tanks begun to work on this topic, it did not reach at that time the mass public media. It seems to be a big topic in May 2017.

1.3 Course of investigation

My investigation follows a straight path. First, I go through the existing literature to understand what are the triggers of a Technological Revolution. For this, I gather information about the three Technological revolution, better known as Industrial Revolutions, and list what they have in common. Then, I go through the theories developed since the beginning of the last century about cycles, waves and innovation clusters. On top of this, many contemporary searchers are already talking about the coming technological waves. I then check if I can apply my findings about the three Technological Revolutions, and if this concurs with the conclusions from the academics working on this subject. This process is to answer the question raised by the first problem: *Is it probable that we are facing a new Technological Revolution?* With this step is behind me, I adventure myself in the currently abundant literature and articles about the impact of the Digitalization on work in Austria[5]. I compile the results of this literature research with work statistics in Austria. I use then a case study and a scenario method to foresee a potential impact of some technologies on our current world. The case study is about Pokémon Go that created a new bridge between Internet and real life. I then develop the scenario about the impact of a full adoption of self-driving cars. With this done, I conclude with a rough estimation of the impact that the next Technological Revolution will have on work in Austria. This answers the question raised by the second problem: *How could this Technological Revolution affect the distribution of work in Austria?* The last step of my investigation occurred on the field. I went and met with people having a decision power about work in Austria. In parallel, I performed interviews with the Human Resources of a small panel of enterprises and I got in contact with governmental organisms whose focus is on business (WKO), and on employee rights in Austria (AK Wien). The analysis of the interview part, with a literature analysis complement, allows me to answer the question raised by the third problem: *How prepared is the economic environment in Austria to sustain the choc of a Technological Revolution?*

The Figure 1 gives a visual representation of the flow of thoughts that I just described. The Thesis will follow this flow of thoughts. I need to solve the problem in the right order, as each problem needs to have the previous problem resolved as prerequisite for solving it.

[5] Digitalization of work is a current topic. However, it is only a part of the current cluster of innovation. It is nevertheless interesting to mention those existing studies: this shows that people are aware that something is ongoing.

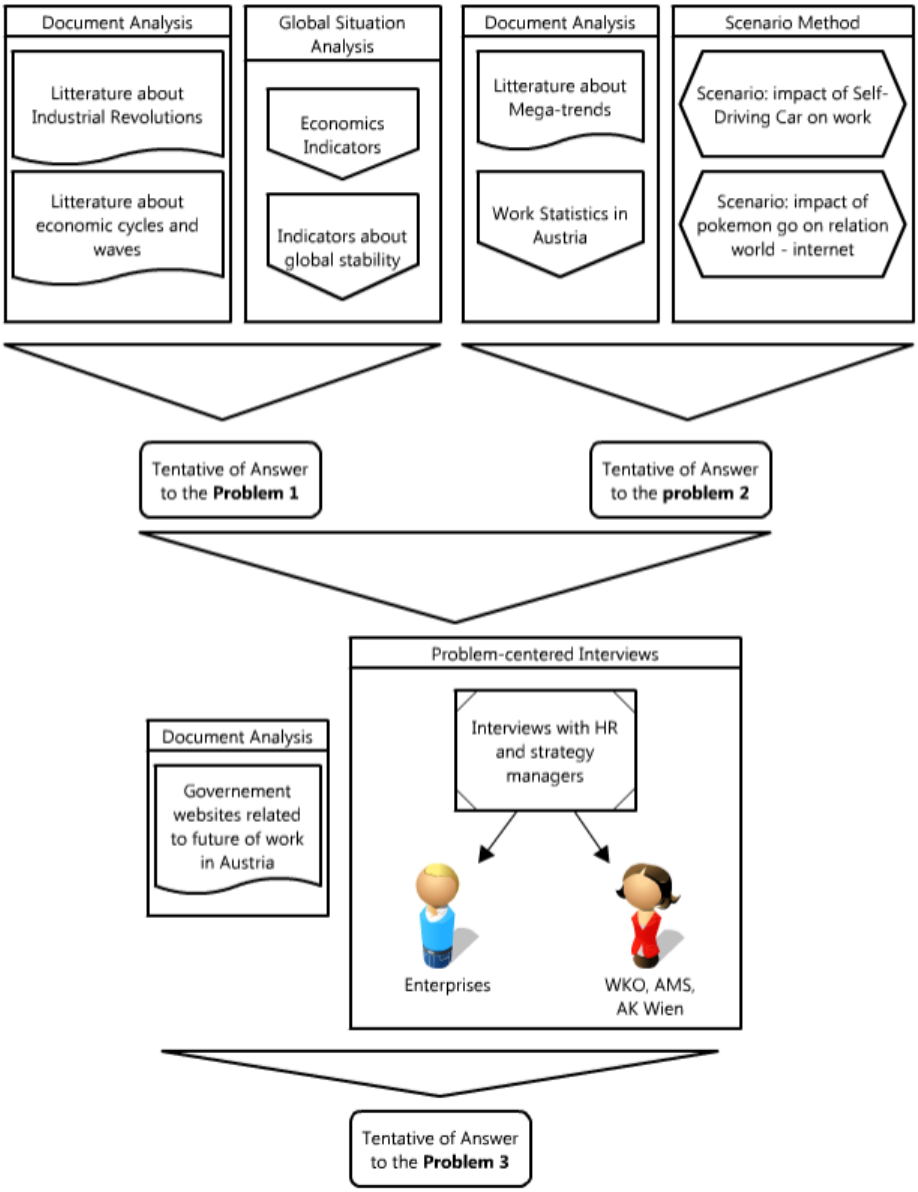


Figure 1: Flow of thoughts and associated techniques to solve the three Problems

1.4 Structure of the Thesis

I divided this paper in five chapters. The first one is the introduction. I posed there the problem and the objectives. I explained the strategy that I developed to solve the problems and reach the objectives. The second chapter is about a study of the past. First, I shortly described the Industrial Revolutions, then I talked about the theories on economic waves and innovation clusters, and finally I gave a short overview of the three economic sectors of activities. I focused then in the third chapter on the current situation. I studied the mega trends and shortly the worldwide situation.

The fourth chapter focuses on Austria. Finally, the fifth chapter summarizes the solutions to each of the three problems and raise an open question.

2 Past: Industrial Revolutions and associated theories[6]

The world as we know today is the result of a fantastic technological and economical acceleration that happened during the three industrial revolutions. It all began mid of the eighteen century with the first Industrial Revolution (IR#1) that took humanity out of an artisan world and placed it into an industrial world. The key topics are here coal, steam machine and cotton. The second Industrial Revolution (IR#2) began at the end of the nineteen century and saw the beginning of the mass production. The key topics are in that case electricity, internal combustion engine, communication and entertainment, chemicals and running water. The third Industrial Revolution (IR#3) happened around 1970 and brought us to the globalization of the economy. The key topics are in that case the computer and Internet. This overall transformation happened very quickly, in only 250 years.

Today we hear very often the term "Industry 4.0". This is nothing else that the recognition that something is ongoing and that it might be a new Industrial Revolution, the fourth one.[7]

Many academic members studied those Industrial Revolutions and came out with tangible observations. They developed theories about the mechanisms of those transformational periods, about economic cycles (Kondratieff-waves, or K-Waves) and about innovation clusters. Those theories are pointing out to some extent common structures such as growth, recession, innovation trigger and social instability.

Let us begin with a short historical review of the three first Industrial Revolutions. We will then study the different theories related to those revolutions, especially the theories from Kondratieff and Schumpeter. Finally, we will point out the impact of those Industrial Revolutions on the repartition of the work between the three sectors of activities.

---

[6] The industrial revolutions are common knowledge and are taught in every European secondary schools. However, I decided to follow the ideas and dates from (Ayres, 1989) and (Gordon, 2012) to gain some consistency in the paper. When I am using other source for specific reasons, I will specify this in the text.

[7] "Industry 4.0" in the UK, "Industrie 4.0" in Germany, "Industrie du futur" in France… Many Medias and governments in Europe are using and repeating those terms those days. Most probably the country having the most integrated and consistent approach is Germany with its green book "Arbeiten 4.0" (Soziales, 2015).

2.1 The three Industrial Revolutions

The three Industrial Revolutions have at first view the following traits in common:

- A cluster of innovations happened during the IR time.
- The cluster of innovations had a global impact.
- It took some time to attain the full range of effects.

I describe in the following sections each Industrial Revolution with the same template. I wanted to show that the overall mechanism occurring in each Industrial revolution is the same. The differences are only with the length of the revolution, with the kind of innovation, and with the range of effect that the Industrial revolutions triggered.

Please note that the dates I am giving are estimations of the beginning and of the end of the Industrial Revolutions. I did not want to try to force one truth about mere dates because firstly, there is no precise beginning or ending of those complex mechanisms, and secondly there is no perfect truth related to the past (Phillips & Linstone, 2016, p. 162). Furthermore, the uncertainty about the dates will not affect in any matter the general reasoning that will gently bring us to the conclusion of this Master Thesis.

2.1.1 The first Industrial Revolution

The cradle of the first industrial revolution is in the United Kingdom. It occurred from approximately 1750 to approximately 1830. It diffused first to north of France, Belgium, Netherland, Denmark and the United States of America before going to Prussia, Austria-Hungary (in the Czech states essentially) and then further on to Japan.

Cluster of innovation: cotton textiles, iron and coal, steam power and railroads.

Full range of effect: It lasted 150 years from the beginning of the IR#1 to attain the full benefits of the railroads[8] (Gordon, 2012, p. 3).

New source of energy: IR#1 saw the substitution of the human and animal labor by mechanical labor fueled by waterpower at the beginning and later by steam power. The latter could happen only thanks to the use of coal as primary source of energy. Both of the new source of energy

[8] The example describes the impact of IR#1 in the US. The scheme is of the same order for all the leading countries of the time.

allowed an increase of productivity and the latter even allowed the diffusion of the fabric phenomenon outside of well-irrigated areas.

New transportation networks: The first part of IR#1 saw massive investment in projects to link the rivers with canals, therefore creating a real water network. This allowed the goods to be transported from where they were produced (Iron and Coal) to where they were used (furnace and distribution of the new source of energy). The second part of the first industrial revolution saw a massive investment into railroads projects. The newly created network first complemented the canal network and then substituted it. Both networks allowed a radical change in the size and range of logistic.

New communication channel: The steam-power associated to the Gutenberg printing process allowed a quicker and more efficient process to print. This drastically decreased the cost of the books, allowing a better knowledge diffusion within countries. Furthermore, this quicker and cheaper way to print combined with the new transportation system (the railroad) allowed a new way to diffuse information within a country. The gazette was born.

2.1.2 The second industrial revolution

The second Industrial Revolution occurred from approximately 1870 to approximately 1900 at the same time in Europe and in the United States. Many are seeing IR#2 as the most important event that created the modern society. Five of the greatest inventions occurred during this time:

- The Electricity (bringing light and electrical power everywhere)
- The internal combustion engine (changing the relation to space and distance)
- The running water (greatly increasing life expectancy)
- How to rearrange molecules (chemistry, plastic, pharmaceutical…)
- Communication and Entertainment

Many other “smaller” inventions also occurred at that time, such as the mass production of steel. Furthermore, the recombination of different technologies such as new material with internal combustion engine finally allowed the human race to fly. It is not the subject of this work to go deeper in listing all of the smaller invention from IR#2.

Cluster of innovation: Electricity, internal combustion engine, running water, How to rearrange molecules, Communication and Entertainment.

Full range of effect: IR#2 had a diffusion effect that lasted almost 100 years. The benefit of it stopped in 1972 (Gordon, 2012, p. 12).

New source of energy: Natural gas and petrol quickly found their place as a better source of energy compared to coal and natural water (rivers). Coal and waterpower are still used, but in a new way. It left the direct application to put machines and engines into motion, and went to the backstage to produce electricity.

New transportation networks: With the internal combustion engine and its applications, the car and the plane, the whole relationship to space changed immensely and saw the creation of economical and touristic center of cities and the peripherals, also known as suburban area.

New communication channel: IR#2 saw the reign of the instantaneous communication begin. The description from Robert Gordon allows us to understand the importance of this innovation. He states, "It [the successful telegraph test between cities] led to the greatest celebration in the history of the United States up to that date [2012]" (Gordon, 2012, p. 7).

2.1.3 The third industrial revolution

The third Industrial Revolution happened approximately between 1960 and 2000. Almost all the technological products created today are derivatives from the main innovations from IR #3.

We are talking here about the transistors that allowed the computers, about the connectivity between computers that created the Internet. In addition, one of the most important innovation is the mobile device with data access. This allows humanity to reach the last frontier of freedom, which is simply having the world at the tip of your finger.

Cluster of innovation: The transistor, the telecommunications extended to optical fiber (laser), and to satellites. From this, the Internet and later on the connection anywhere anytime thanks to smartphones.

Full range of effect: The range of effect is not finished in 2017. The recombination of those technologies allows the digitalization wave that is currently happening worldwide.[9]

[9] Please refer to the chapter 3.2.

New source of energy: The new source of energy that had an incredible potential is based on nuclear: fission and fusion. The use of natural gas is also growing since the distribution network is extending, and the resources immense.[10]

New transportation networks: This IR did not see tremendous new transportation networks, except for the densification of the highways networks and the aerial network. The only new transportation network is for work and leisure, and is the creation of high-speed train networks.[11]

New communication channel: The new communication channel is the new paradigm of reaching everything everywhere. Internet is born and is here to last. And, it is said that you can find everything and anything on the Internet. This signs the instantaneous sharing of information on a worldwide level. The last barrier to overcome for a full knowledge access is the number of languages that an Internet surfer is able to understand.

2.2 Cycles, waves and innovations' clusters theories

The industrial revolutions, especially IR#1 and IR#2 happened almost 250 years ago. The influence of the two first Industrial Revolutions has been so extreme on the western societies that many scholars and economists studied in detail this period, with a beginning point around 1750.

The first breakthrough happened with Nikolai D. Kondratieff in 1925 who found out that since the beginning of the IR#1, the technological countries were experiencing waves of growth, peak and stagnation that were lasting between 47 and 60 years (Kondratieff & Stolper, 1935, p. 107).[12] He called them the long waves of economy. Approximately ten years later, around 1940, Joseph A. Schumpeter associated the growth to the entrepreneurs and to cluster of innovations. Just after World War II, the economy of the western countries and of some new peripheral countries flourished during what is called the glorious thirties. It was not the right time to be pessimist and to talk about the end of this growing era. This is what happened in 1973 with the oil crisis. A number of academics dug into old theory and resumed in the eighties the work from Professor Schumpeter. Those are called the Neo-Schumpeterian. They took the theory from Professor

[10] In 2017, the nuclear fission process seems to be in a dead-end because of the environmental and the danger of this technology. The nuclear fusion process is still not mastered in 2017.

[11] The first one was the Shinkansen in Japan in 1964, then the TGV in France in 1981 and the ICE in Germany in 1991. This information is to be found on Wikipedia.

[12] N.D.Kondratieff was not the first scholar who mentioned the existence of long waves in economics (Grinin, et al., 2016, p. 53). However, he was the one who made it one of the most known theory in the last century.

Schumpeter and developed it by adding a socio-institutional aspect to it. The cluster of technologies cannot alone trigger a new growth wave. The society shall in addition be ready for this cluster of technologies to allow a large diffusion of it, and therefore trigger a new growth wave. Finally, after 2008, in a new time of crisis, new school of thoughts are developed based on the previous enunciated ideas.

The next chapters will describe more into detail those theories. From those theories, we will gather for the conclusion all the needed information that will help us solve the problem 1.

2.2.1 Kondratieff and the Long Waves in Economic Life ~1925

Nikolai D. Kondratieff published in German in 1926 his article about the Long Waves in Economic Life. In his article, Professor Kondratieff studied from 1760 to 1926 several economic indicators for three countries: United Kingdom, France and United States of America. He removed secular trends by using statistical tools and smoothed the short economic cycles (between 7 and 11 years) by applying a 9 years moving average (Kondratieff & Stolper, 1935, p. 105). The indicators he used were multiple: the wholesale price level, the rate of interest, the wages and foreign trade, the production and consumption of coal and pig iron. The results were showing for all of the mentioned indicators the same two and a half cycles from 47 to 60 years (Kondratieff & Stolper, 1935, p. 107). Each of the wave has two phases. Each wave begins with a rise phase (phase A or upswing), followed by a decline phase (Phase B or downswing). Professor Kondratieff also notes, "During the recession of the long wave an especially large number of important discoveries and inventions … are made" (Kondratieff & Stolper, 1935, p. 111). Another remark concerns the rise phase and the peaks that occurs at the same time as "disastrous and extensive wars and revolution" (Kondratieff & Stolper, 1935, p. 111).

We can observe the K-Waves from 1926 until today. Different studies confirmed the existence of the long wave of economy for other indicators. Korotayev and Tsirel are showing the K-Waves for the World GDP from 1870 until today (Korotayev & Tsirel, 2010). Korotayev is using spectral analysis to understand if the K-Waves are indeed present on a worldwide indicator: the GDP. He leveraged the impact of the two world wars, and this is showing that between the different economic cycles (Kitchin Cycles, Juglar Cycles, Kuznets Swings, and K-Waves)[13], the most powerful cycle

[13] The Kitchin cycles have a period of 3-4 years, the Juglar cycles have a period of 7-9 years, the Kuznets Swings have a period of 15-25 years (Korotayev & Tsirel, 2010, pp. 10-11)

is the one from Kondratieff. Korotayev explains that the fact that the K-Waves visible in the western economy before 1870 is not seen in the world economy because the world economy was at that time not enough integrated to reverberate the western economies (Korotayev & Tsirel, 2010, p. 29). Some other independent studies about the real GNP from the US using mathematical model shows that the GNP is composed of 56 years cycles that are themselves divided into four quarters cycle of 14 years (Albers & Albers, 2015). In summary, today, many studies are confirming the existence of long waves in economic life.

Please see the Table 1 to have an overview of the past K-Waves and a projection of the coming K-Waves.

K-Wave	Begin of the Upward Phase[14]	End of the Downward Phase	Length
K-Wave #1	1780	1840	~60 years
K-Wave #2	1840	1890	~50 years
K-Wave #3	1890	1940	~50 years
K-Wave #4	1940	1980	~40 years
K-Wave #5	1980	~2020	~40 years
K-Wave #6	~2020	~2050/2060	~35 years

Table 1: K-Waves from 1780 to mid of this century (projection), adapted from (Grinin, et al., 2016), (Coccia, 2017) (Korotayev & Tsirel, 2010) and (Kondratieff & Stolper, 1935)

The graphical view, as presented in Figure 2 is also showing the accepted dates of begin and end of Phase A and phase B, giving the facto a length to the peaks and the hollows. Some remarks concerning this view:

- There is no information about any K-wave before 1780. The first reason is that there is no recorded economic data to prove this, or not (Volland, 1987, p. 131). The second reason is that most probably the K-wave appeared when humanity begun to exploit more efficient source of energy allowing the exponential growth of humanity. In short, it seems that the trigger of the first K-Wave was the first Industrial Revolution.

[14] Please note that the showed dates are only one date within a period of some years (up to 11 years). This is because those are long waves, and that the peak is lasting some years and is not concentrated on one year. I decided to give a year to make the reading easier. The same is true for the hollow of the K-Waves. I used the dates from (Grinin, et al., 2016) but those are aligned with other sources.

- The third K-Wave has a specific shape. This is because of World War I and World War II that occurred at the peak and at the hollow of the wave.
- There seems to be a decrease of the lifespan of the K-Waves[15]. It is possible that this shortening of lifespan is related to the nature of the K-Wave itself and its potential end. As Grinin et al. mention, "K-waves appeared at a certain phase of global evolution and they are likely to disappear at its certain phase" (Grinin, et al., 2016, p. 66).

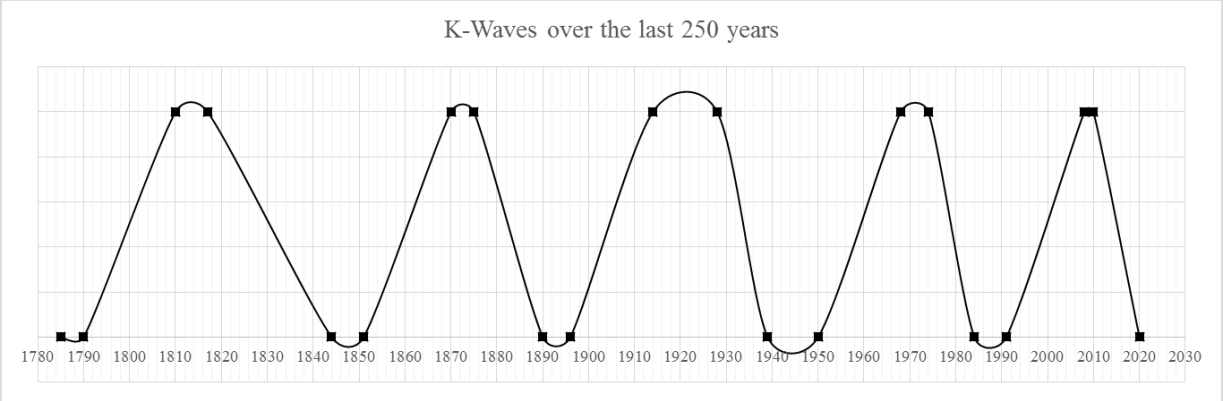


Figure 2: 5 K-Waves between 1780 and today --- source (Grinin, et al., 2016) and (Korotayev & Tsirel, 2010)

Many scholars came with theories trying to explain what could be the main trigger for those cycles, and why it seems that they are accelerating with the time. It is Joseph Schumpeter who the first associated upward growth with innovation. The next chapter will develop this potential relationship.

2.2.2 Schumpeter and the innovation clusters ~1940

For Joseph A. Schumpeter, the main trigger for any economic wave or cycle is innovation, carried by the entrepreneur. The term innovation relates to new ideas that went through the long journey from invention to commercialization (Śledzik, 2013, p. 91). Professor Schumpeter presented two hypothesis that relate to the phase A and the phase B of the K-Waves, as presented by Ayres (Ayres, 1989, p. 9).

The first hypothesis is that the main trigger for the phase A comes from a set of complementary radical innovations that is mature enough to enter the market. This cluster of innovations is creating

[15] Different views were in competitions about the lifespan from the K-Waves. The first school is trying to focus on keeping the lifespan of the K-Wave between 50 years and 60 years (ideally 54 years); while the second school is arguing that there is no reason to fix the length of the K-waves. It seems that after 2010, in the light of the 2008 crisis the second school is making some points. Please refer to chapter 2.2.3 and 2.2.4.4 to learn a little bit more about it.

a new set of industries that are complementing each other. This virtuous complementary circle enables the industries to rapidly grow and therefore foster a global growing phase: the upswing of the K-Waves.

The second hypothesis is that radical innovations are parked in a waiting slot during the phase A of the K-Waves. In this rapid growth phase, it makes more sense to invest in incremental (non-radical) innovation because we are in a growing market. The risk is low for incremental innovations and the return is high because the market is expending. But once we passed the peak and we are in the downswing phase, the risk is still low, but the return is decreasing because the market is saturated. Therefore, when the economy is in the phase B, then the radical innovations are awakening from their long hibernation and a cluster of winner innovations is taking the lead to trigger the next growing phase. The decision makers from the economic market are ready to take more risk to get some profit.

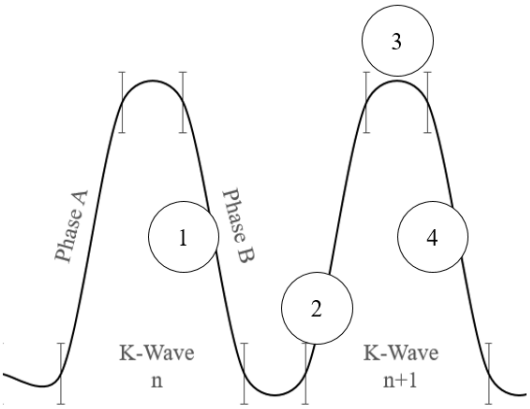
Since 1940, not many economists considered seriously the theory from Professor Schumpeter. It is mainly because his theory was not aligned with the mainstream theory, which was that everything could be explained by mathematics (Śledzik, 2013, p. 94). It was furthermore not elegant to doubt that the economy entered an eternal golden age of high growth. Then in the late seventies and the eighties, most probably because of the end of the glorious thirties, many economists revived the theory from Schumpeter.

While there was contradictors that saw this Schumpeterian way as misled and that the two hypothesis could not be proven (Mansfield, 1983, p. 144), many studies were made to reinforce the two hypothesis from Schumpeter, especially the second hypothesis which is the clustering of innovation during unstable economic growth (phase B). (Kleinknecht, 1981, p. 303).

In the Figure 3, you can see one K-waves with the Schumpeterian point of view attached to it. One of the missing point is the explanation of the existence of the peak. Some theories developed

by the Neo-Schumpeterian are offering a reasonable theory about this. Please refer to chapter 2.2.3. for more information.

In the Table 2, I matched the Industrial Revolutions from the chapter 2.1 with the K-Waves and their respective cluster of innovations. Please note that the size of the inventions during the Industrial Revolutions might have a full effect on the economy only longer later. The creation of the internal combustion engine did not make the car manufacturing a leading industry at the beginning of the twentieth century. This happened only when combined with the new producing process invented by Ford, many years later (Ayres, 1989, pp. 39-40). This is related to the time of diffusion of the technology to the economy as mentioned in the chapter 2.1.



Step 1: Phase B fostering new cluster of innovations (depression trigger)

Step 2: The cluster of innovations is mature and pull the growth

Step 3: An event is stopping the growth

Step 4: Repetition: Phase B fostering new cluster of innovations

Figure 3: Innovation triggering growth and growth hindering innovations

Industrial Revolution	K-Wave	Schumpeter's Cluster of Innovations
IR#1: 1750 to 1830	K-Wave 1: 1780 to 1840	Cotton textiles, iron and static steam power
IR#2: 1870 to 1900	K-Wave 2: 1840 to 1890 K-wave 3: 1890 to 1940 K-wave 4: 1940 to 1980	Steel and moving steam power, railroad Electricity, chemical, heavy industry Automobile, manmade material, electronics, entertainment
IR#3: 1960 to 2000	K-wave 5: 1980 to 2020	Microelectronics, ICT, Internet

Table 2: Industrial revolutions, K-Waves and clusters of innovations

2.2.3 Freeman and the Neo-Schumpeterian ~1980

After the trauma from World War II, the western world experienced a rare golden age that lasted 30 years. From 1945 to 1973, growth was constant; the technologies developed before and during the war reached almost everybody and all theories about cycles, recessions, waves lost their primary interest for the decision makers. This golden age was about to last forever. Well, while influencers were developing mathematical model to predict this infinite growth, it seems that the wheel of time was continuing its journey: "The Wheel of Time turns, and Ages come and pass, leaving memories that become legend. Legend fades to myth, and even myth is long forgotten when

the Age that gave it birth comes again." (Jordan, 1990)[16]. The first very visible shock of the end of growth happened with the oil crisis in 1973. While it was considered as the trigger of the crisis, it was actually only a follow up of the cycle going forward (Ayres, 1989, p. 60). It is during time of crisis that old theories are rediscovered, and the Schumpeterian theory is no exception. It begun in 1975 with Gerard Mensch who did a study about the clusters of innovation and their relationship with the K-waves (Volland, 1987, p. 124), and based on this work, a number of economists and scholars joined the long-wave's theory discussion. Christopher Freeman is seen as one major influencer about the Neo-Schumpeterian theory from the eighties (Castellacci, 2006, p. 843).

Christopher Freeman and the Neo-Schumpeterian consider that the K-Waves are a reality (Dator, 1999, p. 366), at least for the moment. Like Professor Schumpeter, they put the cluster of innovation as the "bandwagon" of technologies that will trigger and accompany the upswing phase of the K-Wave. However, he is introducing the concept of "technological revolution" which is an attempt to see the system as holistic as possible (Freeman, 1984, p. 498). Professor Freeman states that this technological revolution must have five characteristics to be genuine:

> "(1) A drastic reduction in cost of many products and services…
>
> (2) A dramatic improvement in technical characteristics of many products and processes…
>
> (3) Social and political acceptability…
>
> (4) Environment acceptability…
>
> (5) Pervasive effects throughout the economic system…" (Freeman, 1984, p. 498)

While the two first points refer to the strength of the cluster of innovations, and the fifth one to the bandwagon effect that will affect the whole economy system, the points three and four are about the system itself where the cluster of technologies might flourish. This means that the Neo-Schumpeterian are actually introducing a social perspective that did not exist with Schumpeter. The third characteristic is very important because it means that the society has to be ready for the cluster of innovation to be able to diffuse it on a large scale. It helps to understand the delay between the moment new technologies are created (definition of the Industrial Revolutions, please refer to Chapter 2.1), and when those technologies are massively diffused within the society (definition of the K-Waves, from a Schumpeterian point of view). This is a good theory to explain

[16] This short paragraph is repeated in each of the thirteen books of this saga. I think this is a good summary of the tendency for people to forget during good time that there is no eternal growth and prosperity.

the differences between the IR and the K-Waves as seen in the Table 2. The fourth point was very innovative and visionary in 1984. The world did not yet had the massive media coverage about worldwide pollution problems[17]. This argument is very contemporary as this characteristic was totally absent for the first set of K-Waves (the local pollution due to coal burning for example). From my perspective, this is a reaction to the impact of the previous clusters of technologies on the global environment.

The Neo-Schumpeterian introduced two dimensions to the Technological Revolution that are the Techno-Economic system (the technological trigger, within the economic system), and the socio-institutional system (the social environment within which the economy and the technologies are located). For a Technological Revolution to be successful, both sides of it shall be involved. One side cannot be successful if not aligned with the second side. As Sarah Kaplan and Mary Tripsas explain it clearly, for a new technology to reach full acceptance from the mass market, it has to follow an experience journey with many interactions between the producer and the user (Kaplan & Tripsas, 2003, p. 14). In short, the more disruptive the technology, the higher the failure rate and if successful the longer the acceptance time.

The Neo-Schumpeterian had the merit to put a global theory including the economic K-Waves, the Innovation clusters and the interaction of the technologies with the society. This is explaining why some innovation clusters are taking more time to mature and to trigger a new upswing phase in the K-Wave. Still missing is the understanding of the peak-trigger. The next chapter focuses on the scarcity of resources, on the management of surplus and on the new Russian school.

2.2.4 Beyond Neo-Schumpeterian?

I did not want to sound arrogant with the title of this chapter. However, I did not find a focus within the Neo-Schumpeterian theories about the end to the growth from the upswing from the K-Wave. I did find some thoughts from other scholars and economics that might shed some light on why there is this growth-stop.

[17] I am referring here to two main topics: the acid rain with the allocution of F. Mitterand, French President in 1986 (http://discours.vie-publique.fr/notices/867003400.html) and the ozone hole with the signature of the Montreal Protocol in 1987 (http://ozone.unep.org/en/treaties-and-decisions/montreal-protocol-substances-deplete-ozone-layer)

2.2.4.1 R. J. Gordon and the innovations that happen only once

One of the idea that can explain the end of the upswing is the unicity of each of the innovation. R. J. Gordon is saying it in very simple and very clear way: "A common feature of this innovative revolution was that many of the improvements could only happen once" (Gordon, 2012, p. 10). This means that the benefit that the society is getting from an innovation is reached once the market penetration is approaching 100%. After this penetration is attained, there is only some residual benefit from this innovation left.

For example, the railways were pulling the economy during the second K-Wave. Once the network got mature enough, there was no need to go into massive investment plan because the received benefit would have been too low for it. Who cares to gain an additional 10 minutes on an 80 minutes' drive, if that was to cost a massive investment. This is also known in economy as the marginal benefit. If you are ready to pay x amount of money for your first dishwasher, you will not be willing to pay as much for the second one. In addition, this is only if you are willing to get a second one. This is because the first dishwasher is already filling your need.

This theory is by itself explaining the end of the exceptional growth (a.k.a. the peak) once the innovation cluster fulfills the expected needs from the society.

2.2.4.2 C. S. Volland and the scarcity of resources

Craig S. Volland is a contemporary of Gerard Mensch and Christopher Freeman. He is part of the thinkers that revisited Schumpeter and the K-Waves. Like the others, he admitted the existence of the K-Waves. He additionally was heavily influenced by the work of a geologist, M. King. Hubbert (Volland, 1987, p. 124), and developed his own theory about the K-Waves. His proposal is that one natural resource (so far it was energy, but it is not only limited to it) propels each K-Wave. Moreover, he explains that as long as this new natural resource is finite, there is no possibility to avoid the peak in the K-wave. It is not easy to correlate this theory with the K-Waves as there is no one-to-one match between the use of some finite source of fuel and the cycles themselves. However, you can see per cycle the fuel that is the dominant one and the fuel that is the new type of resource.

I matched in Table 3 the natural resources (until now the fuel is still the most important) that were the base of each of the six K-waves.

K-Wave #1	Primary fuel: Water and wood
K-Wave #2	Growing fuel: coal Dying fuel: Water and wood
K-Wave #3	Primary fuel: coal Growing fuel: Oil
K-Wave #4	Primary fuel: Oil Growing fuel: Nuclear
K-Wave #5	Primary fuel: Oil Dying fuel: Nuclear Growing fuel: Renewable, Natural Gas
K-Wave #6	? Primary fuel: Renewable, Natural Gas? ?: Dying fuel: Nuclear, Oil?

Table 3: Matching the fuel sources with the K-Waves --- Inspired from (Volland, 1987, p. 126)

Three remarks comes to mind about this. First, we do not see a one to one correspondence between the K-waves and the main natural resource. Second, we do see that in 2017 the nuclear energy does not seem to be a new main source of energy replacing oil. This is supported by the fourth point of a technological revolution, as mentioned by Freeman (see Chapter 152.2.3) which is about the environmental acceptability. The populations are less inclined to accept nuclear power because of the hidden costs (dismantling costs) and because of the radioactivity danger for the people and for the environment[18]. Third, if the next source of primary fuel is a renewable one, then there is one argument for seeing the end of the K-Waves as we know them because of scarcity of ressources.

Another interesting fact is that during the upswing of a K-wave, the access to the primary natural resource might exacerbate war and international tension. Think about the French-Prussian war of 1870 were the winner took the region of Alsace-Lorraine, very rich in coal (growing resource of the K-wave 2). The same region came back into the hands of France in 1918 after Germany lost World War I. Coal was still the main source of fuel. The same can be said with the

[18] Many accidents happened in nuclear power plants, but three of them clearly showed to the public the potential regional danger of this technology: Three Mile Island Accident in the USA in 1979, Chernobyl in Ukraine in 1986 and lately Fukushima in Japan in 2011 http://www.processindustryforum.com/hottopics/nucleardisasters

turmoil and influence fight between world powers about the middle-east region, rich in Oil that are the primary source of fuel from the K-Wave 4 and 5.[19]

In conclusion, while in the theory from R. J. Gordon the trigger of the peak is market-oriented, in the theory from Craig S. Volland the trigger of the peak is resource-oriented.

2.2.4.3 Management of the excess of capacity

We saw in the two previous chapters (2.2.4.1 and 2.2.4.2) that two phenomenon are happening making the economic life cyclical (or wave-shaped). The first one is the full market penetration and the second one is the scarcity of the natural resource. While the latter is creating a challenge that will foster new ideas, and hopefully innovations, nothing from the former explains why we are experiencing recessions. If well done, there should not be a recession, but something like a small growth (created by the replacement of the broken and obsolete products from the market). As history shows, this is not the case. Michael C. Jensens is explaining this with his theory of the failure of exit (Jensen, 1993, p. 831). His theory is that during the expansion phase (Upswing or Phase A from the K-Wave), the companies are heavily investing in increasing their production's capacity. Because each product is following an S-curve, there will be a moment where the market is almost fully penetrated. And, because the companies do not have an efficient control system, the market is seeing a massive surplus in production. This is pulling the prices down, exacerbating the competition and destroying working places. Some extracts from Jensen, compared to the Figure 2 shows an interesting development of this theory:

"the English Luddites who destroyed industrial machinery … in the period 1811 to 1816" (Jensen, 1993, p. 845). This corresponds to the beginning of the Downswing of the K-wave 1.

"recession and panic of 1893" (Jensen, 1993, p. 835): This is the hollow between K-Wave 2 and K-Wave 3. The management of this excess was done by massive M&A: "Between 1895 and 1904, over 1,800 firms were bought or combined by merger into 157 firms" (Jensen, 1993, p. 835)

"from 1979 to 1989 the Fortune 100 firms lost 1,5 million employees, or 14 percent of their workforce" (Jensen, 1993, p. 841). This correspond to the downswing phase from the K-Wave 4. The management of excess happened again with M&A: "M&A transactions, 35,000 of which

[19]

occurred from 1976 to 1990, with a total value of $2.6 trillion (1992 dollars)" (Jensen, 1993, p. 837).

Those are examples point out that the downswing and especially the hollow part are not stable and peaceful periods.

Added to this, during the first two industrial revolution, the insecurity of the future was so heavy that "the demand for protection from competition and for redistribution of income became intense" (Jensen, 1993, p. 845). While some government or ideology might be tempted to protect their firms from international or national competition, history proves that the results are more than deceiving (Jensen, 1993, p. 845)[20].

From my understanding, this is the pendant of the socio-institutional system that is needed to successfully trigger the upswing from the K-Wave. This management of excess capacity during the Phase B is how the society (competing firms, but also government with their policies and protection programs) is dealing with the exit from the previous upswing.

2.2.4.4 The Russian school and the three Production Revolutions

Leonid E. Grinin and Andrey V. Korotayev are two Russian academics that are very active for the last ten years on theory related to the K-waves. The future will tell us if we could call them the Russian school of the long wave economics. Their theory is encompassing the previously described theories from Kondratieff, Schumpeter and the Neo-Schumpeterian (Freeman and Marchetti) and is proposing a higher level of explanation. They are saying that humanity is following extremely long Production revolutions. Those revolutions are going through three phases. The first phase is the Initial innovative phase, followed by an Intermediate modernization Phase and is ending with the Final Innovative Phase (Grinin, et al., 2016, p. 55). Humanity is going through four Production Revolutions. The Figure 4 gives us an overview of the four production revolutions. Grinin and Korotayev also take into account the socio-institutional aspect and argue that the readiness of the society will either accelerate the different phases of the revolution or slow it down. By readiness of the society, they mean inside the core countries (countries that are the top of technologies) and the difference between the core countries and the peripheral countries. One of their strong

[20] The main reference here is the deceiving result of the communism for all the countries associated to Russia during this period (1917-1989).

prerequisite is that the peripheral countries shall catch up the core countries to some extend (Grinin, et al., 2016, pp. 58-59).

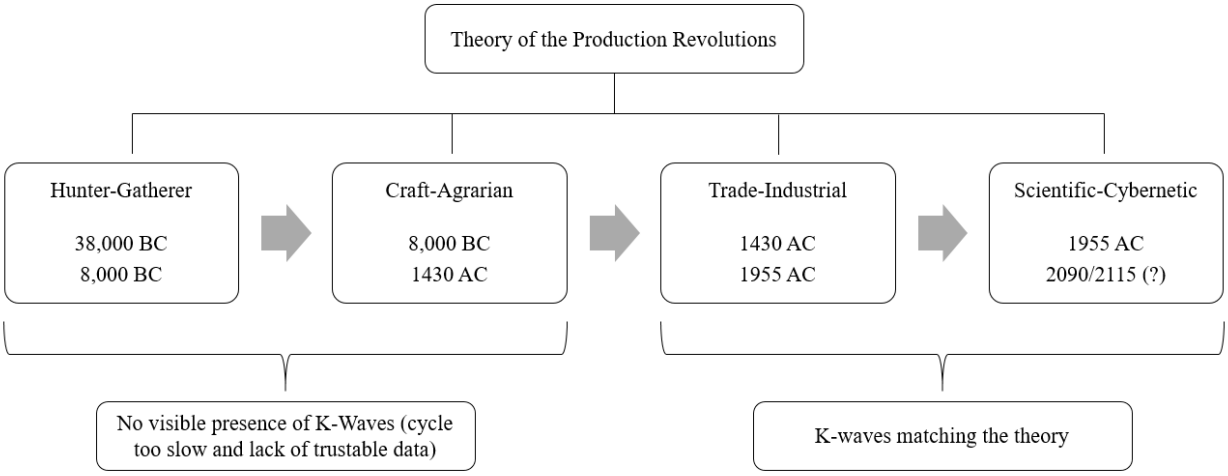


Figure 4: Theory of the Production Revolution --- Inspired by (Grinin, et al., 2016, p. 55)

From their research, they state that the current production revolution begun in 1950 and will be a mix from next level of IT (IoT, smart machines…) serving the main technology that will enhance human: Medicine. In short, they believe that the people born in 2000 and later will probably see the golden age of longevity.

They also are pointing out that the sixth K-Wave might be the last one. Their argument is that they expect to have the new cluster of technologies based on the revolution of the regulation of system. This cluster will efficiently manage the excess capacity as expressed in 2.2.4.3, avoiding the recession phase. This is supported by the medicine of global ageing that will push the human lifespan to new unexpected limit extending the facto the memory of humanity. This will theoretically help humanity to avoid doing the same mistake by a different generation.

2.2.5 Conclusion on the theories

In summary, we learned from the last chapters five main points:

1. We can see in economic indicators a long wave that last around 50 years. There might be a time when this long wave will cease to exist. However, there will most probably be at least one more K-Wave to come.

2. Innovation is the trigger for the upswing of the waves[21]. Each K-Wave has a set of innovations that is pulling the growth during the upswing phase.
3. There is a socio-institutional aspect determining the speed of massive introduction of the new technology cluster.
4. It seems that time of instability and fear is happening during the downswing phase.
5. It seems that international tensions are happening during peak and hollow time of the K-Wave[22].

This summary will help us in Chapter 3 to solve the first problem: *Is it probable that we are facing a new Technological Revolution?* What we are still missing is the impact that all those K-waves and technological revolutions have on work in general. The introduction of the three activity sectors and their repartition along the IR will help to answer this question.

2.3 The three activity sectors

We have seen in the previous chapters that many theories has been elaborated to explain the long waves in economic life and to explain the cluster of innovations that is triggering the growing phase. But what does this mean in term of work of the population? We are back to a socio-institutional aspect.

2.3.1 Definition of the three main sectors of the economy

In economy, the production of value is divided between three main sectors of the economy:[23]

- The first sector is usually called the Primary sector and it is the economic activity that is creating added value from what Mother-Earth is giving. This includes harvesting, mining, and resource extracting. The resources can be renewable (such as wind, solar, food) or non-renewable (such as oil, or any element like metals for example).

[21] Please note that some theories are stating that innovation is the result of wars, and that therefore the wars are the trigger of innovations that are the trigger of the K-Waves (Coccia, 2017, pp. 21-22). For this paper, it does not change much to link or not the innovation cluster to war from the previous cycle.

[22] As the trigger of war during the peak in a K-wave is the competition about a scare resource during a growing time, the trigger for instability that can be war during the hollow in a K-wave is based on fear and lack of future perspective. (Coccia, 2017, p. 5)

[23] This information can be found anywhere on the internet. Except when specifically expressed, I used the following source for this chapter: http://www.economicshelp.org/blog/12436/concepts/sectors-economy/comment-page-1/#comments

- The second sector is usually called Secondary sector and is based on manufacturing goods. This is a transformation economy taking resources from the primary sector and transforming it in goods. Those goods are then put on the market. Typical secondary activities are furnaces, and manufacturing factories (cars, electronic, white goods…).
- The third sector is usually called the Tertiary Sector and is based on services that are sold to the customers. Retail of the manufactured goods, banking and insurance or access to the internet are considered as part of the tertiary sector.

2.3.2 Impact of the industrial revolutions on the working force in the three sectors

The three Industrial Revolutions have had a huge impact of the distribution of the workforce within the three sectors of activity. While the primary sector was the predominant one before IR#1, it switched to a dual mode Primary and Secondary sectors with IR#1. With IR#2, there was the beginning of the tertiary sector who filled itself from the primary and the secondary sector. IR#3 depleted even more the secondary and the primary sectors.[24]

Since 1973, more than half of the working force are in the Tertiary sector. Therefore, two new sub-sectors from the tertiary has been created.

- The Quaternary sector represents the knowledge base business (R&D, computing, telecommunication, education).
- The Quinary sector is not yet well defined. Sometimes it represents the workforce that is employed by the government (therefore serving the country instead of creating goods and services to be sold), and other times it represents domestic services[25]

The Figure 5 represents the weight of each of the economic sectors for a country going through the different stage of development. From an agrarian economy to a service economy, passing through the industry phase. This evolution is seen in each of the countries that went through the different phase of industrial development.

[24] From Britannica online. Sector of economy study by Colin Clark. https://www.britannica.com/topic/economic-growth

[25] Inspired by http://study.com/academy/lesson/quinary-sector-of-industry-definition-examples.html and http://www.economicshelp.org/blog/12436/concepts/sectors-economy/comment-page-1/#comments

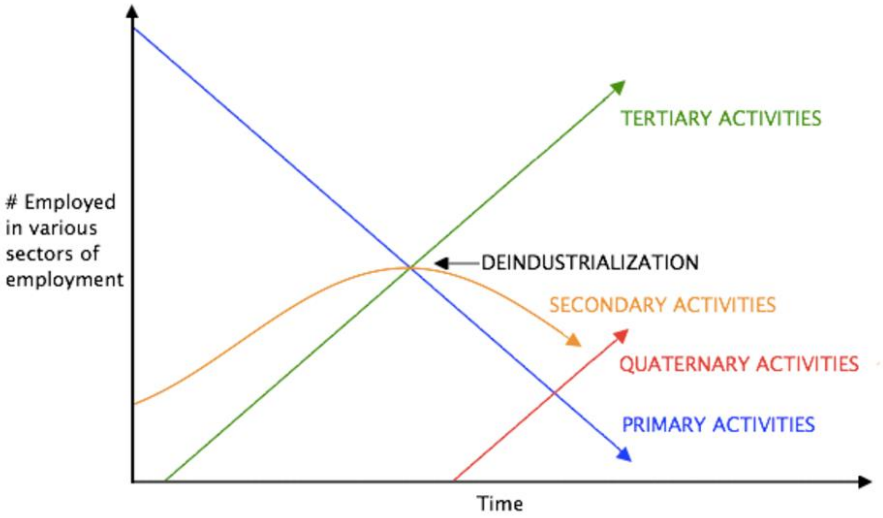


Figure 5: Colin Clark's sector model of an economy --- source Wikipedia

What we can conclude from this historical approach is that since we can observe the K-Waves, there has been a massive redistribution of the workplaces between the different sectors. And, as we did develop in Chapter 2.2.4.2, each of the downswing phase saw fears and internal instability. This means that this continuous change of work repartition within the three sectors did not occur naturally but has been force by fundamental forces that were on the K-Waves path.

As a side note, it is important to understand that this picture is only representing the value creation part of the working force. We are missing the following categories:

- Civil servants and elected people
- Unemployed people
- Non-profit associations, also called Non-governmental Organization (NGO)
- All the platform workers in the collaborative economy[26]

Having said this is that it seems that we are today missing complete studies to understand the impact of Technological Revolution on the work repartition. But even without this it is easy to understand that those technological waves did have all the time an important impact on work.

[26] Those are all the persons that are "selling" some services through platforms on the internet such as Uber, AirBnB and many other outsourcing platforms. There is a lot of turmoil about how to consider this, on Austrian and European level (Policy Department A: Economic and Scientific Policy, 2016)

3 The present

The previous chapter focused on the past and on the long waves' theories. The present chapter focuses on what is existing in term of technological mega-trends. I show furthermore some international facts about the worldwide economic and the politic situation. I will conclude this chapter with giving a solution to the first problem.

3.1 Technological Mega-trends in 2017

The aim of this chapter is first to understand which megatrends are already having an impact on the economy, and second, which might probably come in the near future. For this, I am using two main sources: Gartner with specifically their well-known Hype Cycles and the projections from academics such as Grinin, Grinin and Korotayev (Grinin, et al., 2016).

3.1.1 Gartner and the Hype Cycles

My first source is the Hype Cycle produced since 1995 by Gartner (Forni & Meulen, 2016). The Hype Cycle is a graph showing the path from an idea to its commercial launch. Gartner is explaining in one of its webinars (Burton & Walker, 2016) that each idea or technology in this case is going through five phases before being a mature diffused technology. Those phases are also depicting the life of any high-tech start-up before transforming into a mature company. It begins with an innovation trigger. It is follows with the peak of inflated expectation. This is the moment where the expectations are at the highest. Then the bad news begin (technology not adapted to the needs, unseen limitations…) and the technology is falling into a Trough of Disillusionment. Only work to transform the technology into a product that is adapted to the market will help the start-up to climb on the Slope of Enlightenment. Finally, the star-up is reaching in a mature condition the Plateau of Productivity. To get a visual view of the Hype Cycle, please consider Figure 6, which is the Hype Cycle forecast from Gartner for 2017. This graph is remarkable in the sense that a vast amount of innovations still did not reach the highest expectation point. Those technologies can be defined as infant innovation still to come. Gartner expects many of them to become mature within 10 years, with some of them (machine learning, Natural-Language Question Answering) quickly passing through all the phases of the cycle as Gartner expects them to reach maturity (and Plateau of productivity) within five years.

Figure 6: Gartner's hype cycle forecast for 2017 – Authorised Source Gartner

Before going into the groups of technologies that constitute the mega-trends from 2017, I wanted to share with you an observation about the distribution of technologies in the Hype Cycle during time. As I already mentioned, many technologies are before the highest level of expectations. This mean that we do have more new technologies than mature technologies on the hype cycle. To be more precise, we have 26 technologies before the peak and 8 after it. This is a ratio of 76% of young technologies yet to be developed and exploited. When looking at the Gartner Hype Cycles for the last 20 years we can see the evolution of percentage of "young" technologies. I show the tendency in Figure 7. While the young technologies slowly increased their ratio from 30% in 1995 to approximately 50% in 2014, it abruptly accelerated in the last 3 years to reach an astonishing 76% in 2016. This soft indicator is showing the brutal acceleration of innovations that is coming into the development pipe, and based on the theory from Professor Schumpeter developed in the chapter 2.2.2. it shows that we might have a new innovation cluster being created. This is supporting the hypothesis that the probability that we will face in the near future a Technological Revolution is high.

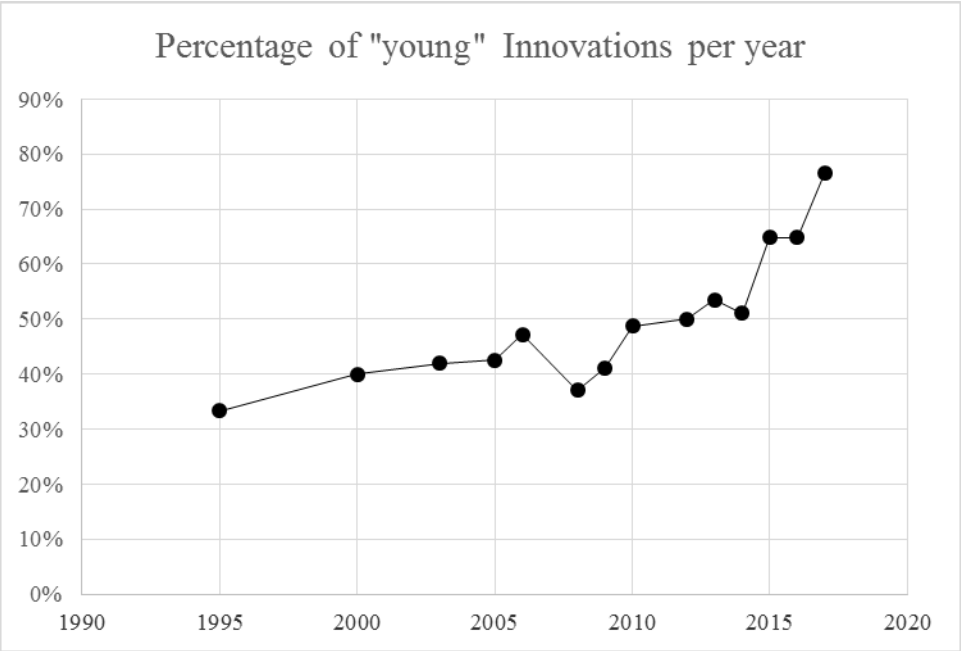


Figure 7: Evolution of the young Technologies over the last 20 years. Inspired from various sources from Gartner[27]

Concerning the 2017 tendency, Gartner is placing all the technologies from the Hype cycles into three clusters (Burton & Walker, 2015, p. 18): Transparently Immersive Experience, Platform revolution and Perceptual Smart Machine Age. For more details, please see Figure 8.

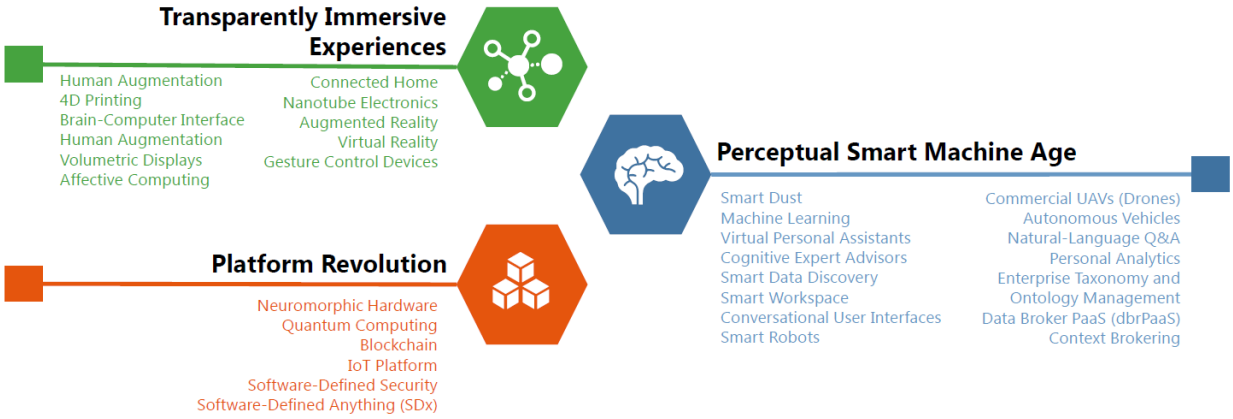


Figure 8: The Gartner three technologies clusters -- Source Gartner (Burton & Walker, 2016)

However, the analysis from Gartner, while very complete, is restricted to the IT world and lacks a global approach. This is why I decided to look at other source of technologies forecasting. This is developed in the next chapter.

[27] The sources are the hype cycles that we can find on the website from Gartner and on the Internet.

3.1.2 Academic technological forecast

My second source is from Russian academics that are very active on challenging and exploiting the K-Waves theory: L. Grining, A. Grinin and A. Korotayev. One of their last articles called "Forthcoming Kondratieff wave, Cybernetic Revolution, and Global ageing" (Grinin, et al., 2016) is providing a wider approach of technologies, not restricted only to physical and IT technologies. They came with the term MANBRIC Technologies. This stands for **M**edicine, **A**dditive Technology, **N**anotechnology, **B**iotechnology, **R**obotics, **I**nformation Technology and **C**ognitive Technology (Grinin, et al., 2016, p. 62). It is a more detailed approach than the NBIC (Nano-Bio-Info-Cogno). Their theory is that Medicine will be the leading technology of the next Cybernetic Revolution (please remember their theory as explained in Chapter 2.2.4.4) and that all the innovations from the six other domains are reinforcing the Medicine cluster. The Figure 9 shows how the seven innovation clusters are related. Their view or forecast, as explained in the previous chapter is the medium term future (around 2030, 2040) as they are not considering the K-Wave but the production revolution.

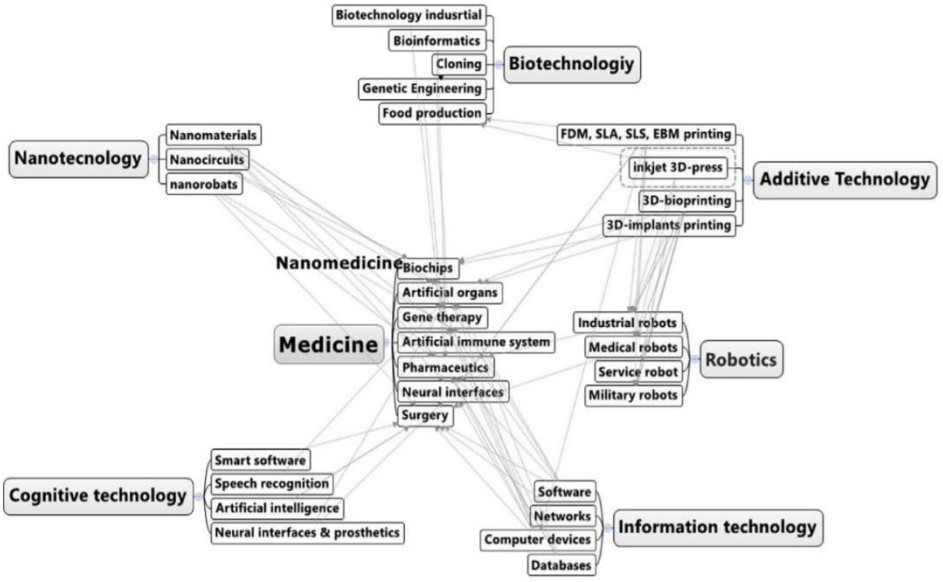


Figure 9: MANBRIC overview --- Source (Grinin, et al., 2016, p. 62)

While the medium term is about medicine, we are interested on the short term and on what will happen soon. The Figure 9 is nonetheless telling us a lot of information, as it is a mix of technologies that either arrived either to maturity, or that are forecasted to arrive to maturity in a short horizon.

3.1.3 Summary of the mega trends that will have an impact on work

The two sources of information I am using to identify the possible coming next technologies, are very complementary. The first one, from Gartner, is focusing on IT and IT related technologies in a near to medium future. It is showing us that some technologies are about to happen in the next

2 to 5 years, while many might happen within 10 years. The second source of information, from Grinin, et al, is more general, and is embedding IT techno and Bio techno. Therefore, it is less precise in term of probable chronology. One has to remember that it is based on production revolutions, and that the cybernetic one began in 1950 (please refer to Chapter 2.2.4.4). This is why the Figure 9 is showing technologies that are today already in their mature phase.

Once we put aside the mature technologies from Grinin, et al, and the futuristic technologies (horizon 2050) which are medical based, the rest of the technologies are also covered by Gartner and his Hype Cycle 2017. Please see Figure 10 to have a visual view of it, and go to the annexes to see the corresponding table.

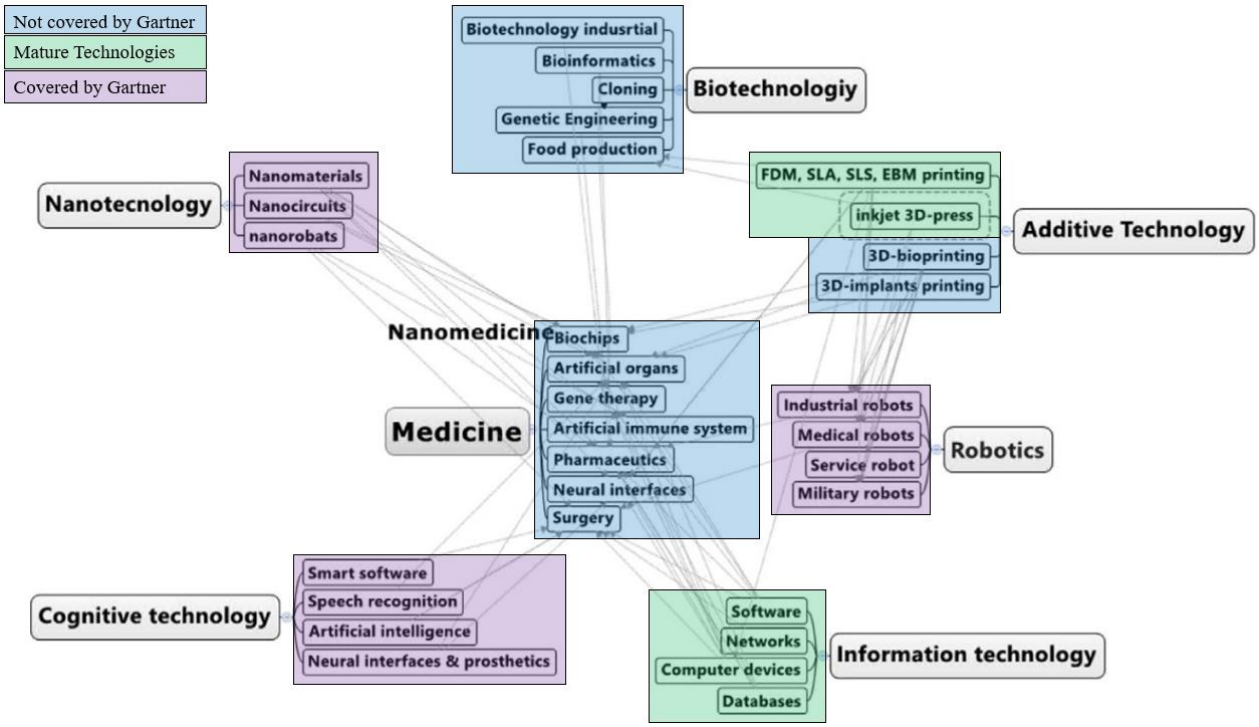


Figure 10: Mapping Gartner with Grinin, et al. – Inspired by (Forni & Meulen, 2016, p. 18) and (Grinin, et al., 2016, p. 62)

What Grinin, et al. did not cover, most probably because it is not directly supporting the leading technology Medicine, are either technologies related to finance, or technologies not having trivial impact on the work repartition. I am only seeing four technologies such as Augmented Reality, Virtual Reality, Commercial UAV (unmanned aerial vehicle) and self-driving cars that are not covered by Grinin, et al. The last two will have an impact on the work of persons who are usually delivering goods to users, while the two first will increase the efficiency of augmented shopping that will probably reduce the number of needed vendors.

In summary[28], we do have four main clusters of technologies to come that might have a strong impact on the repartition of work: Cognitive Technologies, Robotics, Augmented and Virtual Reality and Delivery vehicles. The Table 4 shows when the cluster might be mature for commercial launch and what could be the impact on work.

Cluster of Technologies	Horizon of Maturity[29]	Work Related Impact	Examples
Cognitive Technologies	2 – 5 Years	• First level Support	First level support for Internet Access Providers
Robotics	5 – 10 Years	• Warehouse workers • Maintenance workers • Help at home	Decrease of number of workers in Warehouses Decrease of number of gardeners and cleaning personal Decrease of number of specialized workers in factories
Augmented and Virtual Reality	5 – 10 Years	• Shop vendors • Real-estates visits	Decrease of number of vendors Decrease of number of employees in real estates
Delivery vehicles	5 – 10+ Years	• Delivery person • Death of the vehicle working pool	Decrease of number of drivers because of UAV End of the need for drivers because of self-driving cars

Table 4: Four Clusters of future megatrends potentially having an impact on work

While it is good to have some coming technologies to consider, we also might want to look a little bit more into one particular existing technology that is very popular those days: Digitalization.

3.2 The special case of Digitalization[30]

Since 2016, we can see in many countries a number of articles talking about the danger of the Digitalization on work. Just to give you a taste of a few of them, I picked up some sentences:

"Almost half of the working places in Germany are in danger" Translated from German (Dörner, 2016)

[28] Please note that I only took into account only the main clusters of innovation as defined by Gartner and digitalization. There are many other innovations that are already burgeoning and that might as well have a big impact in our life in the near future, but I do believe that those technologies will have less impact on the work in Austria. 3D printing is a good example of very interesting technology that might change even deeper the conception and production process as it is done today. This argument is developed by Jeremy Rifkin and he thinks that the end of the big corporations as it is today is nearing (Rifkin, 2012)

[29] Based on Gartner Hype Cycle 2017 (Forni & Meulen, 2016, p. 16)

[30] Please note that digitalization is not part of the coming technologies as described by Gartner, because this technology already exists. However, the coming new technology, especially cognitive technology will enhance the capabilities of the current digitalization.

In France, "Estimates range from 10% to 42% of jobs that would be affected by a high likelihood of automation and thus potentially threatened" Translated from French (AFP, 2017)

"About 35% of current jobs in the UK are at high risk of computerisation over the following 20 years…" From (Stylianou, et al., 2015)

Whilst all the cited titles in the three main European countries are alarmist, it seems this is to raise the awareness of what might come. Other studies and analyses are milder about this.

The first argument against the very high number of job at risk is based on the definition on the tasks that are potentially threatened by automation. A study done by the OECD (Arntz & Zierahn, 2016) explain that a job is not only an addition of tasks that a worker performs, with some that are susceptible to be automated, but is a complex network of interactions between those tasks. The authors argue with this that de facto the results provided by (Frey & Osborne, 2013) is overestimated. Their own calculation based on data from the PIAAC (Program for the International Assessment of Adult Competencies) is showing that "the share of automatable jobs … is 12% in Austria" (Arntz & Zierahn, 2016, p. 8).

Arntz and Zierahn also explain that this number is a maximum that will probably not be reached for three reasons (Arntz & Zierahn, 2016, p. 25):

1. The calculation is based on the capabilities of the technologies rather than the use it will be done from them. The diffusion and the acceptance will take probably longer.
2. The workers that will be touched by automation will certainly get an internal training to perform new tasks.
3. Technological Innovation, while destroying some jobs is also creating new kind of jobs.

While I do understand those arguments, I think that they are false reinsurance that everything will be good. I think that the first argument is dangerous. It could mean that by being slow at learning how to use effectively a new digitalized service, it will help saving some working place. This argument is forgetting that other actors will quicker implement those innovations and will gain a USP against the companies, or countries that are too slow to adapt. Whilst the proposition of the second argument might very well be true, it is hiding the fact that one Job nevertheless disappeared in the equation. Instead of hiring somebody from outside for a new position, the company will train one worker with obsolete skills to fill the position. From a global perspective for this case there is one job less, and this because of automation. From my perspective, the third

argument is the strongest. However, as stated in the OECD paper, this time it seems that the low educated workers will be hit the strongest, and that the challenge that society is facing is about their training to acquire new suited skills (Arntz & Zierahn, 2016, p. 25). In addition, even the worse numbers from the Frey and Osborne's study — 47% jobs at risk in the US — (Frey & Osborne, 2013, p. 38) are only related to the automation of work as done today. It is not taking into account the second wave of automation that might actually disrupt whole sections of the production chain. I am providing an example in Chapter 4.2.2.2 in the form of a scenario about the self-driving car and its probable effect on work in Austria.

The second argument was about what to do with automation. Richard Freeman explains that the problem is not if robot are substituting human in their current tasks, but whether if the substituted humans will find a new job with equivalent or decreasing wages (Freeman, 2016, p. 39). The main problem will be a societal one about how to avoid increasing inequalities and how to redistribute the wealth generated by robots.

There is an additional very interesting conclusion in the study from Frey and Osborne concerning the protection that education is providing against computerization of job: "Finally, we provide evidence that wages and educational attainment exhibit a strong negative relationship with the probability of computerization" (Frey & Osborne, 2013, p. 45). While the wage level is valid only when comparing to the other, the educational level is something that countries can work on to prepare their population to the coming digitalization wave.

In conclusion, even without going too far in the future with the coming innovation clusters, we see that there is the awareness that something is about to happen.

3.3 The worldwide situation

3.3.1 The economic situation

The year is 2008, and this year saw a worldwide crisis. All the economy suffered and the impact on the world GDP growth is impressive. The Figure 11 shows clearly the shock from 2008 that was even higher than the shock from 1973, which announced the end of the post-war golden age. However, it seems that the situation is less spiky than what happened after 1973. This is mainly due to the fact that the financial institutions, especially in the western countries are more elaborated and more resilient today than what they were in 1973. The main reason why the GDP world growth seemed that steady is because all the major economies, USA, Eurozone, Japan, UK massively

injected liquidity in the financial system by using Quantitative Easing. The amount injected from 2008 until today is more than 10,000 Billions $. Added to this the republic of China soft pegged their money to the US $. This has the same effect as the QE: injection of a large amount of liquidity into the financial system. This allowed the whole system to artificially survive this crisis.[31]

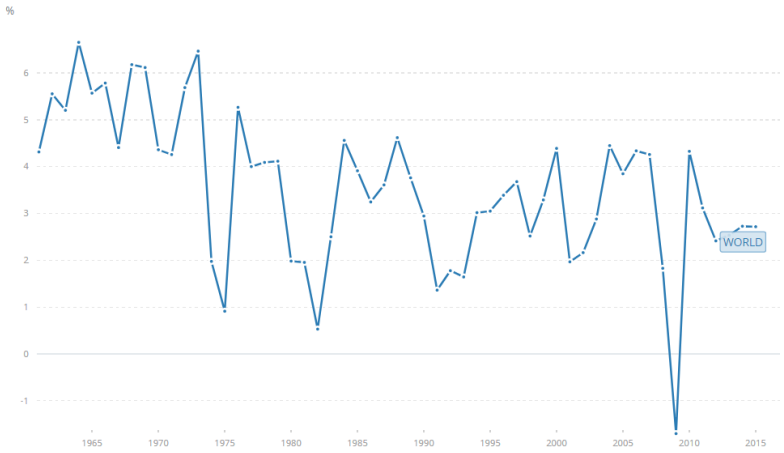


Figure 11: Growth of the world GDP from 1960 to 2015 --- source World Bank

After reading the studies from diverse sources (please refer to Chapter 2.2.3), added to our own observation about the worldwide GDP growth and common literature about the subprime crisis from 2008, it is safe to conclude that we are not in a growth phase since 2008. It seems that we are in the downswing phase of the fifth K-Wave.

3.3.2 A society in turbulent waters

Based on the conclusions about instability from chapter 2.2.4.3 it would be interesting to watch the global society today and see if we are in a calm period, or if there are international tensions.

Let us have a look at the national elections and other referendum that happened during the last twelve months:

- June 13, 2016: UK vote for the Brexit, breaking down the European integration process.[32] It is considered a populism triumph, and is a protectionism move to get more control back to the UK.

[31] For more information about this information, please refer in the Annex to a short paper I wrote during my MBA.
[32] http://www.bbc.com/news/uk-politics-32810887

- November 8, 2016: Donald Trump is elected president from the United States of America.[33] Donald Trump is considered as a populist and extol that America shall be what count for America. His baseline is for more protectionism.
- December 4, 2016: after voting a second time (because of extremely close scores and because of doubts about cheating) Austria gave a winner between a green candidate and a populist candidate for the presidency of Austria. The populist eventually lost with 48.32%.[34]
- May 7, 2017: Marine le Pen, a French populist, after ranking second from 11 candidates finally lost in the second round against Emmanuel Macron. One of the promises from Marine le Pen was to quit the Euro Zone, and to protect the French citizens against globalization.[35]

We can see that there is a fear emerging very strongly out of the populations from some major western countries.

Added to this, we are also facing a new kind of worldwide threat that some call a war against Islamic Terrorism. This terrorism is mainly represented by groups such as:

- The Islamic State of Iraq and the Levant (also called SIL, ISIS or simply the Islamic State)
- Boko Haram
- Islamic Revolutionary Guard Corps-Quds Force (the terrorist special unit from ISIS)
- Haqqani Network
- Kataib Hezbollah[36]

All this together is threatening old alliances and increasing the risk to dislocate patiently build international organizations. What would become of the NATO and of the EU in the coming years? No one is crazy enough to make any forecasting about this, but all are sincere when saying thatwe are facing a period with increased challenges.

---

[33] https://www.nytimes.com/2016/11/09/us/politics/hillary-clinton-donald-trump-president.html

[34] https://kurier.at/politik/inland/hofburg-wahl-zwischen-norbert-hofer-und-alexander-van-der-bellen-der-wahrscheinlich-letzte-akt/233.912.100

[35] http://www.lemonde.fr/les-decodeurs/article/2017/05/07/les-resultats-du-second-tour-de-l-election-presidentielle-2017_5123789_4355770.html

[36] http://nationalinterest.org/feature/washington-watching-the-5-deadliest-terrorist-groups-the-11687

The best summary we can have is the doomsday clock that reached two and a half minutes before doom this year. It is the lowest level since the international crisis in 1953 where the two superpowers respectively tested their hydrogen bombs.

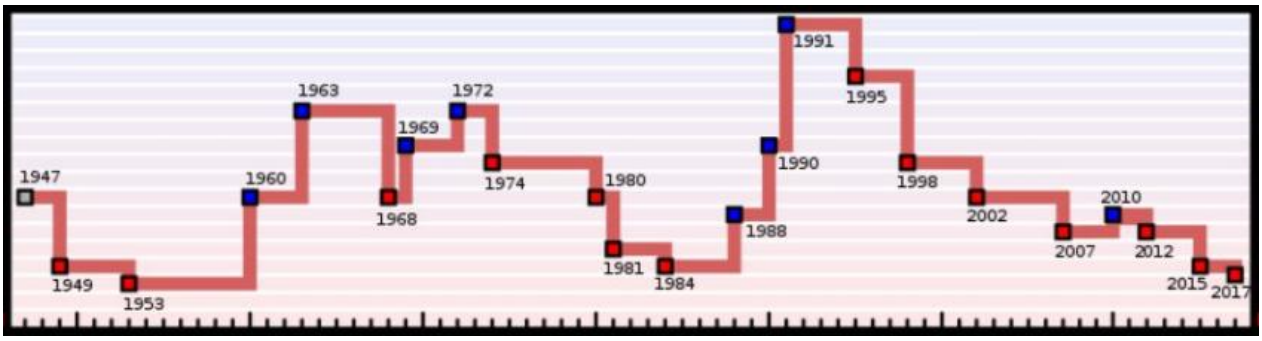


Figure 12: Doomsday clock from 1947 till today --- source A.V. Club[37]

In conclusion, the fears from citizens in western countries increased immensely in the last 10 years, and the worldwide stability is under pressure from many regional situations. This matches the hypothesis that we could be in a downswing phase, approaching the hollow period between two K-Waves (Please refer to the conclusions from the Chapter 2.2.5).

3.4 Quality and sustainability of the mega-trends and readiness of the society

In this chapter, we will match the four mega-trends presented in chapter 3.1.3 with the five Neo-Schumpeterian conditions to understand if they could form a cluster of innovation that can become the bandwagon from the chapter 2.2.3.

3.4.1 Cognitive Technologies

This set of technologies, expected by Gartner to be ready within two to five years includes all the smart computers technologies. It includes Machine learning, and Natural-language question answering (Burton & Walker, 2016, p. 19). It means that with a proper training, a bot[38] would be able to learn to answer to a very high percentage of common questions. It also means that the same bot will be able to answer to the question in a language that will be natural for the customer interacting with it. The main impact will be first the replacement of any first level support who are generally answering trivial requests and questions and when needed routing the request to the

[37] http://www.avclub.com/article/people-behind-doomsday-clock-explain-why-were-so-c-250484 and http://thebulletin.org/timeline

[38] a device or piece of software that can execute commands, reply to messages, or perform routine tasks, as online searches, either automatically or with minimal human intervention. Source http://www.dictionary.com/browse/bot

proper second level department. It will also allow to scale such service without drastically increase the cost that is currently base on employees.

3.4.1.1 A drastic reduction in cost of many products and services

The new set of technologies is having a drastic reduction in cost of all products that requires a first level support. This is simply because we change the cost of FTE against the costs of a program to be deployed.

3.4.1.2 A dramatic improvement in technical characteristics of many products and processes

The new set of technologies will improve the level of the first level support by most probably answering directly a bigger percentage of requests than the employee does. This is because the bot will have an almost instant connection in all related Database while the employee is limited by the time he needs to go through the database. The new set of technologies will also most probably perform less error than the current employee will. The bot will not, like the current employee might do, be incline to tiredness and negative emotions.

Think about Apple's Siri, Google's Assistant, Amazon's Alexa and Microsoft's Cortana. All those bots are already here to free time for the users, and Gartner expect that "By 2020, 30 percent of web browsing sessions will be done without a screen"[39].

3.4.1.3 Social and political acceptability

The new set of technologies will probably score medium for the third point. The society is not yet one hundred percent ready to interact with machine that mimics humans. There is after all the Frankenstein syndrome[40]. However, as long as there will an easy and quick way to avoid the bot and connect to a human interface and as long as this is not touching sensible topics such as ethical decision, the diffusion of this set of technologies will be slow at first, and probably exponentially increasing on medium term.

3.4.1.4 Environment acceptability

There will be no issue concerning environment acceptability. This will follow the same environment acceptability fate as the whole IT world.

---

[39] http://www.gartner.com/newsroom/id/3482117

[40] This is the belief that the rebellion from the created against the creator is inevitable: http://arcana.wikidot.com/frankenstein-syndrome

3.4.1.5 Pervasive effects throughout the economic system

All the basic services that we currently think as granted such as, running water in the home, electricity, warmth (or air conditioning), access to TV, to the internet have a very low level of failure acceptance. It needs to work all the time. All those services have a support number. And all the companies try to reduce the associated support costs by near or off shoring the first level support, or by creating other ways to solve the issue through connected user guides, FAQ (Frequently Asked Questions) etc… All those services will benefit from this set of technologies making the access to those services maybe cheaper and surely better by reducing the downtime, and most importantly by giving as much transparent information as possible to the customer. The same logic apply for any other kind of products or services you are using, when you face something unexpected making you unable to retrieve the perceived value of this product or service.

By making it also cheaper and allowing this kind of support services to be highly scalable, it might open the door for new kind of services based on support.

3.4.1.6 Conclusion

I checked the five points from the Neo-Schumpeterian through the most obvious use of the combination of cognitive technologies. Apart from the social and political acceptability that scored medium, all the four points are scoring high. This makes this set of technologies potentially in the cluster for the next technological wave.

3.4.2 Robotics

Currently robots are seen either as preprogramed machines in assembly chain (such as in the car industry), as chirurgic doctor extension for the precision it allows, as small home appliances (vacuum cleaner), or as science fiction treat or hope. What we shall not forget is the current continuous work to improve the robot capabilities, especially in coordination with cognitive technologies. This dependency to the previous set of technologies shift also the commercial horizon up to five to ten years according to Gartner. When you are looking at what is currently developed in countries such as Japan, or United States of America, you will be astonished by the wide variety of robots existing. It goes from animal-shaped robots, to humanoid robots without forgetting mini-origami robots to clean the inside of a body. The Figure 13 is a compilation of some robots that already exist.

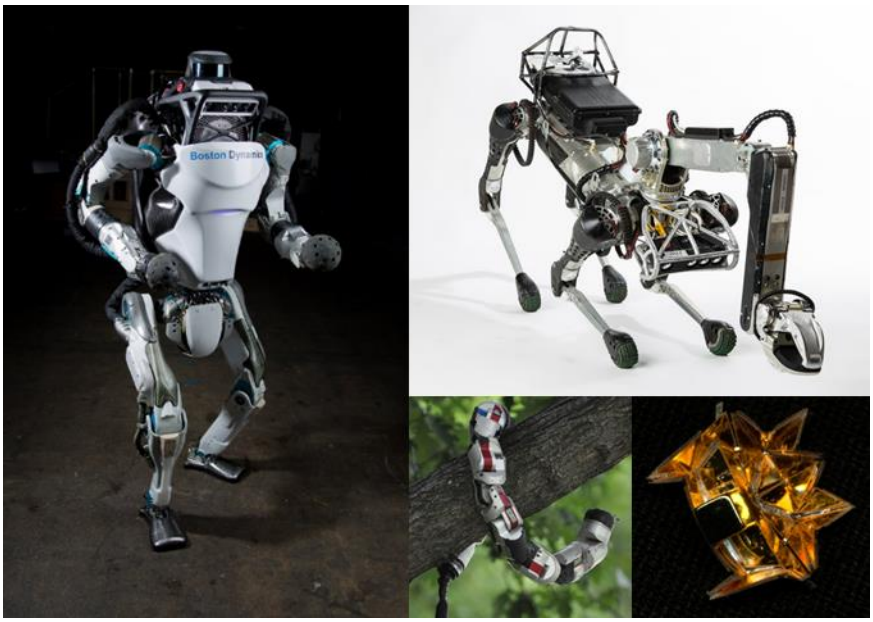


Figure 13: Some robots in 2017[41]

As there is a very wide pool of robots that can be developed, I am picking examples to match the five points from the Neo-Schumpeterian theory.

3.4.2.1 A drastic reduction in cost of many products and services

Let us study an example: the origami robot. Currently when somebody is swallowing a button battery (3500 cases in the US ending in a hospital)[42], when the battery is not naturally expelled, a chirurgical intervention is needed. This is costing a lot of money in term of hospital capacity use, surgeon's time, percentage of complication, recovery time etc… Instead of having this long and costly process, the patient could simply swallow the pill, let the origami robot fold itself into its final form and let the operator drive the robot with electromagnetic field to catch and expel the ingested object. In that simple case, we can see that the cost reduction is indeed drastic.

3.4.2.2 A dramatic improvement in technical characteristics of many products and processes

Let us study an example: the snake robot. After a catastrophe (earthquake, tsunami, bombing…) the search of survivors needs to be done quickly and efficiently. Today it is done almost manually

[41] On the left side: Atlas, on the right top side: Spotmini. Both of them from from Boston Dynamics. More pictures and very cool movies to be find on their website: https://www.bostondynamics.com/ Left robot from the bottom: a modular snake robot to reach difficult and restricted environment: http://biorobotics.ri.cmu.edu/projects/modsnake/ Finally the right robot from the bottom is a centimeter long origami robot developed by MIT to be ingested in a digestible pill: http://news.mit.edu/2015/centimeter-long-origami-robot-0612

[42] https://www.forbes.com/sites/janetwburns/2016/05/19/tiny-origami-robot-captures-intruders-patches-holes-in-stomach/#5b6a8a7d1f39

and definitively not in an optimum sense. With a high number of snake robots, the search could be done simultaneously and systematically without risking any additional landslide. Those robots could sneak into almost all the small holes and entries such a devastated landscape can have. The quality and the fastness of search will be immensely extended, and the people who before needed to scan for survivors would then focus on saving life.

The technical characteristics did not exist before, therefore it is a very efficient improvement of the currently used technics.

3.4.2.3 Social and political acceptability

The robots themselves are actually the physical extension of the cognitive technologies previously described. The fear and resistance this will generate will be based on this physical representation. However, the Frankenstein complex[43] will probably begin to slowly fade as computer representation for movies or computer games already exists and are omnipresent in many cinematographic blockbusters. There is after all already a hotel in Japan that is almost totally managed by robots[44]. The diffusion of this set of technologies will take some years. This means that the acceptance will have this time to increase. Usually when the supposed danger of a new technology is not proven and when the benefits are quickly perceived, the acceptance increases.

However there will probably be a watching comity that will be developed to monitor for a long time this new set of technologies.

3.4.2.4 Environment acceptability

If the robot industry, as all the manufacturing industry, is able to show that they can produce those robots in a sustainable way (sustainable energy, sustainable materials…), then there will be no issue here.

3.4.2.5 Pervasive effects throughout the economic system

The first robot generations had huge pervasive effects in the producing process. However, we are not mentioning here production robots, but robots that are active in operational fields. It is not possible to make projection about the pervasive effect those will have in the economic system. What might happen is to have dangerous tasks that were done by humans and that will be performed

[43] This is the fact that humans tend to reject what has been created and that is too human (or life) like: http://arcana.wikidot.com/frankenstein-complex

[44] http://www.skynews.com.au/culture/offbeat/2017/03/15/tokyo-gets-first-robot-managed-hotel.html

by robots. Some new tasks that were not previously possible will be possible (for example robots to build and prepare settlements in hostile environment — Mars?).

3.4.2.6 Conclusion

This set of innovation is not showing a convincing answer to the five points from the Neo-Schumpeterian. While many points are strong, the social acceptance is at best medium and the most important economic factor – the pervasive effect – does not seem to be there. What is possible is that this set of technologies, associated with another set of technologies might trigger a more robust cluster of innovation to pull the economy. In this case, this could be the robots with the self-driving cars.[45]

3.4.3 Augmented and Virtual Reality

The Augmented reality (AR) is the process to add digital information to the information that a user is getting in real life. The well-known fail of the google glasses was based on this AR notion. In 2016, one game showed that business can be done with AR: This is Pokémon Go from Niantic, using the license from Nintendo. The Chapter 4.2.2.1 describes this case more in detail.

The Virtual Reality (VR) is a little bit different because the aim is to create the illusion to be in another reality by immerging the user with the help of headset and 360° screen. The alternative reality could be a simulated one, or could be the representation of somewhere else. Gartner forecasts the mass introduction of AR and VR into the market between five and ten years from now.

3.4.3.1 A drastic reduction in cost of many products and services

The two technologies have a potential for drastic reduction of costs. When talking about VR, any inspection of site could be done, when associated to robots or other capture tool (glasses worn by person on site), without having the inspectors being in the site. This will remove the need for any travel to perform this kind of activity, and therefore reduce drastically the cost.

Concerning AR, the impact will probably not be that drastic. It could happen in all shops vending fashion goods. With an AR and a cognitive interface, many of the basic questions could be answered automatically without the need of a person (do you have the same in red and extra

[45] This can be compared to the bicycle innovation that alone was not pervasive. However, associated to the internal combustion engine, it created the car and the plane. And those constituted the bandwagon of some K-Waves (Ayres, 1989, p. 29).

small in stock?). By having less employees, this will reduce the cost as the employee could work on other tasks during this time.

3.4.3.2 A dramatic improvement in technical characteristics of many products and processes

VR will introduce a new level of perception. The entertainment world might want to use this new technology to create a new generation of game. It seems that in term of movies technologies are hard to adapt. Except for the wow effect this is bringing at the beginning, the cinema industries are not exploiting properly new technologies. Just think about 3D in cinema. While it was astonishing at the beginning, it did not bring a huge USP per se. A good scenario with good actors without 3D is still more enjoyable than a bad movie in 3D. Probably the same will happen with VR.

AR will on its side, when it will be in its mature mode will bring a huge new technical improvement. If well done it will allow users to understand what they see (ex: the shape and color of a cloud will give the probability of rain or how uncomfortable it would be to take a plane now).

3.4.3.3 Social and political acceptability

The two technologies are here to improve and enhance the experience of the users. Therefore, as long as this is not used for non-ethical purposes, it seems that there will be no issue with the acceptance of those technologies.

3.4.3.4 Environment acceptability

The same remark as the previous set of technologies. If the technology industry is proving themselves to become sustainable for production and operation, there will be no issue at all for environmental acceptability.

3.4.3.5 Pervasive effects throughout the economic system

Once a large portion of the population will own an interface for AR or for VR, the cost to produce new applications will be negligible. This means that to create a full new range of applications will have almost no production costs. The effect will be as huge as the application platforms for iPhone and smartphone. Based on the success of the applications, there will be a pervasive effect throughout the economic system.

3.4.3.6 Conclusion

In conclusion this set of technologies does not seems to have the attributes by themselves to support an economic growth, especially by lacking the first point which is the drastic cost

reductions in many product and services. However, this will create a brand new set of applications for almost free, supporting any other disruptive innovation.

3.4.4 Delivery vehicles

The term delivery vehicles includes UAV (Unmanned Aerial vehicle), also known as drone, and self-driving vehicles. From my perspective, this set of technologies is the one that might trigger a huge change of context for humanity. The UAV will help created new connections to rural and suburban areas, while the self-driving vehicle will revolutionize the way people and goods are transported. Gartner foresee the UAV being market ready from five to ten years and the self-driving cars in more than ten years.[46]

3.4.4.1 A drastic reduction in cost of many products and services

It is all about transport and delivery. Today, delivery and transport is all what is important in modern connected life. We shop online and expect to get the good delivered at home when we are here. We use transport to get an access to culture (usually downtown), to nature (usually peripheral from the cities) and to remote location for holidays. Except for healthy activities and for connected life, transport and delivery is touching every aspect of our life. The reach is therefore immense. This little revolution will remove the cost for the human work for all this delivery and transport activities. This set of technologies is fully matching the requirements of this point.

3.4.4.2 A dramatic improvement in technical characteristics of many products and processes

There is no real need here to develop as it means that something that was almost unthinkable fifteen years ago is about to be achieved. The products that are touched by this new set of technologies are all the vehicles transporting and delivering goods and persons. The processes that are impacted by this are all the logistic and delivery processes. The second point is also fully fulfilled by those technologies

3.4.4.3 Social and political acceptability

In term of acceptability, while the UAV will probably not face a huge resistance, the self-driving cars and truck might have difficulties. The resistance will probably source itself to the responsibility part. Driving is still presenting a higher chance to have an accident as when you are

[46] Announcement on June 27, Ocado is forecasting to have its first self-delivery truck to be launched in the UK in 2019 (it is in two years!!). https://www.theguardian.com/business/2017/jun/27/ocados-self-drive-vehicle-makes-deliveries-in-first-uk-trials

not driving. This means that this activity has a potential for damage. The credo for this would probably be: "I do not want to put my life and the life of my kids into the hand of a machine". However, with big data capabilities it is today possible to gather tons of information about human driving behavior vs. experimental self-driving cars behavior. And the analysis of those data will probably show that the risk to have an accident is substantially higher when it is a human driving the car. With such studies, probably the resistance will slowly fade.

3.4.4.4 Environment acceptability

The technology for the self-driving car is a first only an add-on to an existing technology. Second, this technology is having immediately a positive impact on the consumption of oil per kilometer by having an optimized path and an optimized driving behavior. Concerning the UAV, most of the civil application are electricity powered. Therefore, there is no environmental issue as perceived by the population for this technology.

3.4.4.5 Pervasive effects throughout the economic system

This set of technologies will have a pervasive effect as it is really touching all the branches of the economy. This will also allow new way of transporting and delivery goods and persons. In term of delivery, old network, with a minimal adaptation could be used. Why not using the sewers network for small (packet size) self-driving machines. Some nodes could be used for stocking in a half an hour reach to the final customer. The final user will then tell the delivery company when he wants to receive his packet, and this small self-driving machine will deliver it within thirty minutes. The self-driving cars will also allow reaching medium range destination (up to 1000 km) during night, while the customer is sleeping in a bed-car.

3.4.4.6 Conclusion

This set of technologies, while having a medium hurdle of resistance might be the one that really trigger a transformation of our society. It fulfill after all the other four points from the Neo-Schumpeterian. The impact will be beyond anything that we experienced in the past since the invention and the mass-market introduction of the internal combustion engine. Remember, the car and the truck changed the approach to holidays, changed the way big cities are organized (city center vs. suburban periphery), and changed the way goods were produced (off shoring of productions site). This set of technologies might as well redefine the way we are living.

3.5 Answer to the problem 1

I concluded the chapter 3.3 explaining that economic KPIs show that we are in a downswing phase. The global worldwide situation shows a level of instability that is usually linked with a peak of a K-Wave or with a hollow between K-waves. The remaining question was about a cluster of innovations that might fill the role of the bandwagon as described by Professor Schumpeter.

This was the aim of the Chapter 3.4. I applied the five points developed by the Neo-Schumpeterian school to the fours set of innovations that Gartner and Grinin, et al. analyzed to be the next coming technologies. While the cognitive technologies filled most of the points, the robots and the AR and VR did not convince me that they could be by themselves some bandwagon technologies. However, they could be good support to some other technologies. The last set of technologies that were UAV and self-driving car seems to be a disruptive set of technologies.

By considering all this information, it seems that we are in a coming upswing phase from the 6th K-Wave. The new set of technologies that are currently already ongoing is driven by digitalization[47] and cognitive technologies and will be supported by the two other set of technologies (robots, AR and VR), waiting for the big wave driven by UAVs and self-driving cars.

Problem 1: Is it probable that we are facing a new Technological Revolution?

Answer 1: It is highly probable that we are facing a new technology revolution in the coming years.

4 Application to Austria

Now that we know that there is a high chance that a technological revolution will take place in the coming years, let us understand what this could mean for Austria. We want to find a solution to our *Problem 2: How could this Technological Revolution affect the distribution of work in Austria?* For this, we will begin with a short description of the working environment of Austria. We will then summarize what we found in the current literature concerning the risk of digitalization on work in Austria. I will talk about one AR case and I will develop a futurist scenario to show the

[47] This technology is already on the implementation phase. It is a recombination of technologies and it fulfills all the five points mentioned by the Neo-Schumpeterian: reduction of cost: yes; drastic improvement in technical capabilities: yes; Social and Political acceptability: Yes, environmental acceptability: yes and pervasive effect: yes.

different effect waves a disruptive technology could have on work in Austria. Finally, based on all the cited chapters, I will conclude with an answer to the problem 2.

4.1 Overview of the Austrian economic and educational structure

This chapter describes the general economic environment of Austria and focus on the innovative section of the economy.

4.1.1 Standard Economic overview

Austria has an overall population of 8,606 thousands in the first quarter 2017. 4,448 thousands are considered as the active population. 4,184 thousands are effectively working and 264 thousands are unemployed.[48]

The workload within the three sectors of economy is the one of a technological advanced country. In 2016, Austria has the following repartition:

- Primary Sector: 4,4%
- Secondary Sector: 25,6%
- Tertiary Sector: 70,1% (please note that this includes the Quaternary sector)[49]

The unemployment rate in 2016 is about 6% (EU definition). However, this relatively low unemployment rate is hiding the fact that Austria is showing a tendency to produce more unemployment than the rest of Europe. Please see the tendency in Figure 14. This tendency is showing that currently Austria is relatively fragile concerning the management of the unemployed persons.

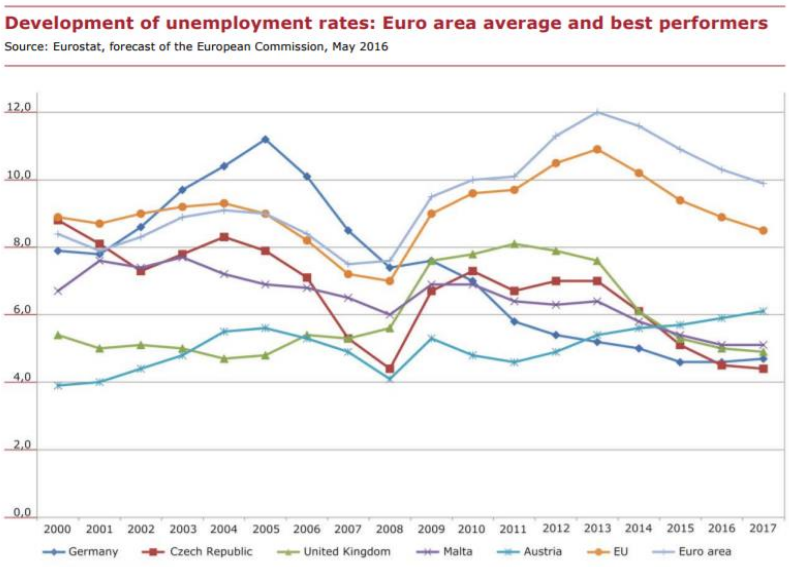


Figure 14: Comparison of unemployment rate between Austria and European countries --- source (Federal Ministry of Science, research and economy, 2016, p. 7)

Austria is also among the richest country per capita in the world. With more than

[48] Statistik Austria: http://www.statistik.at/web_de/statistiken/menschen_und_gesellschaft/arbeitsmarkt/erwerbsstatus/index.html

[49] From WKO: http://wko.at/statistik/eu/europa-beschaeftigungsstruktur.pdf

$44,5K in 2016[50], Austria is ranking 15th richest country per capita in the world. This means that probably the country will not be limited by lack of financial resources to put in place any development program.

4.1.2 General indicators for innovation economy in Austria

Three indicators show how innovative an economic structure in a country is. The first one is the investment in R&D, the second one is the education system, including the continuous training for adults, and the third one is the general environment for start-ups. There are also some international innovation indicators that allow a ranking for innovation between different countries. For 2016, Austria was ranking seventh compared to thirty-four European countries[51].

4.1.2.1 Investment in R&D

The Figure 15 shows the effort that Austria put into this topic for the last twenty years. The R&D effort doubled from 1.5% in 1995 to more than 3.0% in 2016. The Figure 16 shows that in 2017 Austria is well placed in effort dedicated to R&D. It is the fifth one in term of financial effort, while only eight countries have a human effort that is denser that in Austria. The will to become more innovative as well as the dedicated resources are there.

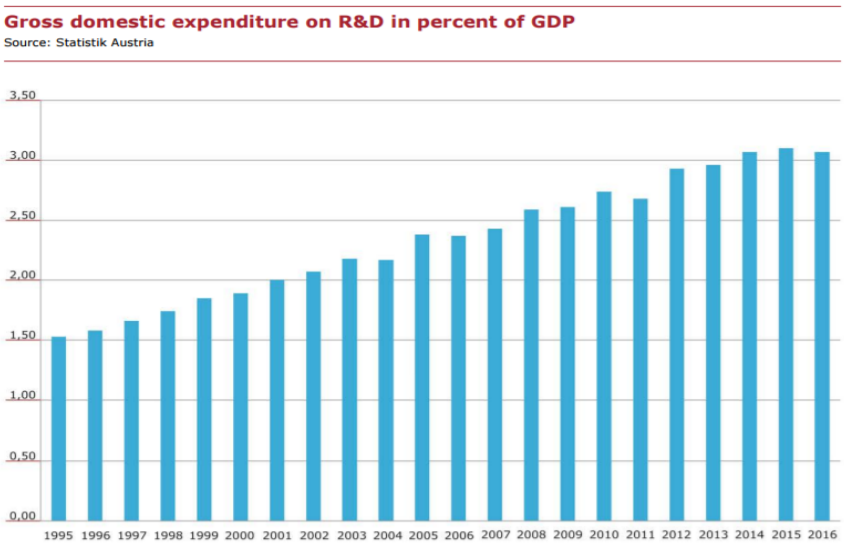


Figure 15: R&D expenditure as % of GDP in Austria --- Source (Federal Ministry of Science, research and economy, 2016, p. 6)

[50] http://knoema.fr/sijweyg/world-gdp-per-capita-ranking-2016-data-and-charts-forecast
[51] Source Interview with WKO (Pöcherstrofer, 30.09.2017)

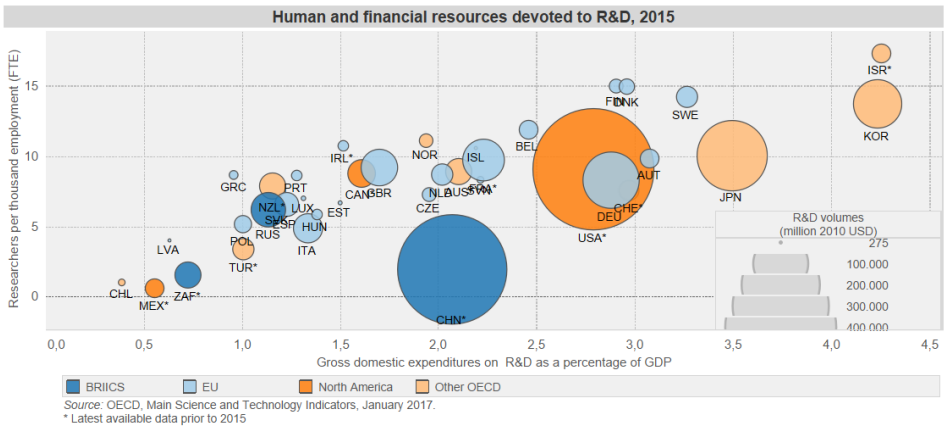


Figure 16: OECD and BRICS countries in term of R&D financial and human efforts --- source OECD[52]

4.1.2.2 Education system

As mentioned in Chapter 3.2, education attainment is a protection against disruptive time. It is important to see how the overall population in Austria is doing about this. The Figure 17 compares the percentage of adults with a tertiary diploma between all OECD countries from 1981 to 2015. The red line is Austria, ending with 30%, and the black line is the OECD average with 34%, both in 2015. We take as granted that the education system is equivalent between the OECD countries in term of value of the diploma. Austria is slightly underperforming in term of higher education and therefore more exposed than other countries to job disruption from digitalization.

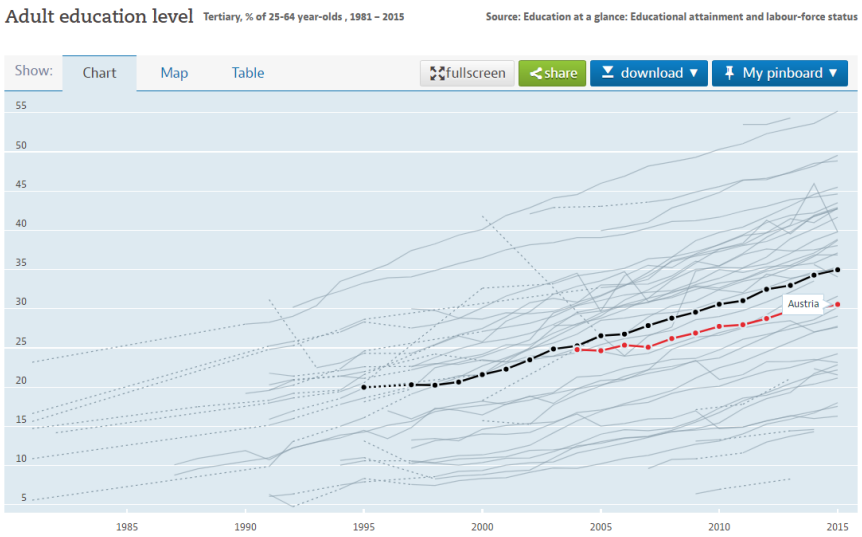


Figure 17: Percentage tertiary education 1981 - 2015 Highlight Austria vs. average OECD --- source (OECD, 2017)

[52] www.oecd.org/sti/rds

Other indicators, such as the PISA test is showing that Austria is scoring averagely for basic knowledge in reading, writing and science. It seems that western countries do have nowadays an issue bringing basic knowledge to their young population, when compared to Asian countries. The Figure 18 shows that in the last years the average scoring from Austria is decreasing in the three main categories: Science, Mathematics and Reading. The overall result is still good in the first half.

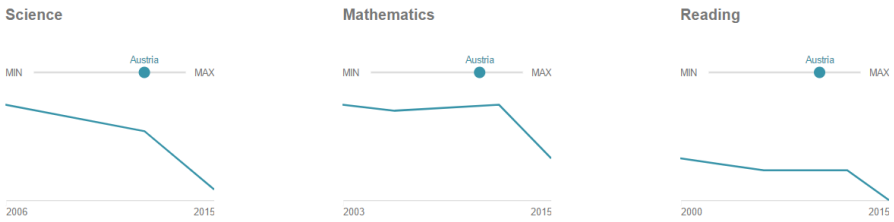


Figure 18: Evolution of Austria results for the PISA test from 2006 to 2015[53]

4.1.2.3 The startup scene in Austria

The startup scene is very important for understanding how a global structure is working to create ex nihilo new innovative products and companies. Austria as a startup scene that got out of the wood in 2015 when the founders of Runtastic made their exit with Adidas for $240M in 2015[54]. This is hiding the fact that the full ecosystem for innovation exists since the Startup week in 2011. Since then, this ecosystem is growing and strengthening. Many events are occurring now round of the year. This innovation and start-up scene fosters a new generation of young people eager to jump into this uncertainty pool.[55] While it is a growing startup hub, it is still behind the direct competition from the leading hubs in Europe, such as Berlin, London or Paris. The government is also playing his role as it is very active in pre-seed money.

Global Entrepreneurship Monitor (GEM) is collecting worldwide data about entrepreneurship ecosystems in all countries. The Entrepreneurial Ecosystem can be seen in Figure 19. We can see that the two weak points are on the education level. This is no real surprise as we saw in Chapter 4.1.2.2 that education is a weak point. The second one relates to the overall cultural and social norm, probably the low level of failure acceptance in Austria. An active startup scene might help changing this overall culture. However, changing a culture is something hard and takes time.

---

[53] Source http://www.compareyourcountry.org/pisa/country/AUT?lg=en
[54] https://techcrunch.com/2015/08/05/runtastic-acquired-by-adidas-for-240m/
[55] https://techcrunch.com/2016/07/08/austria-the-upcoming-early-stage-investment-capital-of-europe/

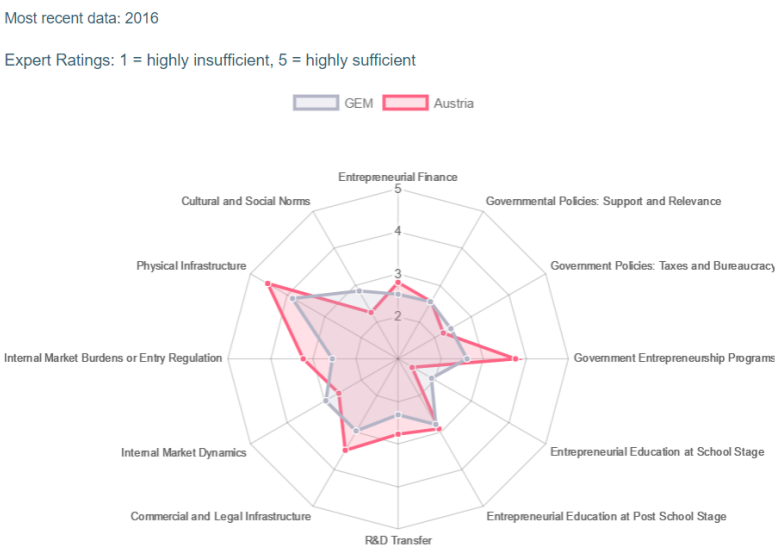


Figure 19: The entrepreneurial ecosystem from Austria compared to the average GEM --- source GEM[56]

4.1.3 Conclusion

In general, it seems that Austria is not weak in economy nor in innovation. However, it seems that there are two time bombs that are running. The first one is related to the overall Austrian approach to unemployment. While still having a relatively low level of unemployment, it seems that Austria did not succeed in duplicating the success of some countries for that topic. The second one is about education; it seems that somehow the overall education system in Austria might not be adapted to the challenges of today. The average level of the students are decreasing while there is a need for an improvement of this level. The very good point is the change of direction in term of R&D investment and in creating a startup ecosystem.

4.2 Potential impact of new technologies

This chapter focus first on the impact of the digitalization on the Austrian workplace. It shows then that Augmented Reality is easy and not costly to put in place. Finally, there is a scenario description: What if tomorrow the self-driving car is a reality.

4.2.1 Impact of digitalization on work in Austria

As already developed in Chapter 3.2, digitalization is a reality that is already changing the way work is done. Digitalization received in 2017 in Austria a certain attention. The Krone Zeitung

[56] http://www.gemconsortium.org/country-profile/38

titled April 12, 2017: "360,000 jobs are in danger because of digitalization"[57] And this has been repeated by many other media and institutions. The WKO is the Austrian Chamber of commerce of Austria and has developed a brochure called Economy Digital, to help enterprises to use the opportunities offered by the digitalization (Abteilung für Rechstpolitik - WKO, 2016). AK Wien is the Austrian workers council and has a department focusing on digitalization with a Moto: "Digital Change – Fair and Just" (AK Wien, 2016). Already in 2015, the Austrian government launched the Digital Roadmap to be the guideline for Austria to become a digital leader[58].

The current base of this wave of information is a report written by the Institut für höhere Studien (IHS) in Austria (Nagl, et al., 2017). This report is mainly based on (Frey & Osborne, 2013) and (Arntz & Zierahn, 2016). The conclusion of this report is that 8,5% of the jobs in Austria, which represents a little less than 320,000 jobs present a high danger of digitalization (Nagl, et al., 2017, p. 16). My remarks from chapter 3.2 are still valid. I do think this is underestimated. The scenario developed in 4.2.2.2 shows additionally that the study is only considering first wave work replacement, without talking about the change that a disruptive technology will bring to the structure of work. The first wave is about automatic program replacing human work, and this is what is usually studied in the reports from HIS or the OECD. The second wave is the use of the technology to create new ways to perform work, or the second effect of a disruptive technology.

4.2.2 Scenario and case study

4.2.2.1 Case Study: Pokémon Go – What does this really mean?

Pokémon go is a game that was launched during summer 2016. It immediately caught the attention of the media as it was based on the success brand Pokémon from Nintendo. As it incorporated a low level of Augmented Reality, people were curious to understand what was behind this hype. In summary, this game is a collecting game with arenas to fight and with some social interactions. Everything is there to get the usual game addictive effect. Now the huge difference with the other games is twofold.

[57] Translated from http://www.krone.at/digital/360000-jobs-durch-digitalisierung-bedroht-keine-entwarnung-story-564362

[58] https://www.digitalroadmap.gv.at/

First, you cannot gather Pokémons where you want. You need to be at specific places to collect them. The places are mostly in the cities with a higher concentration in parks. This means that this game is brings the gamers outside their home and makes them walk to parks.

Second, you need to catch the Pokémons on your phone, while the camera is on. This means that you are in a camera mode, with an additional layer showing you the Pokémons, jumping and attacking you.

As any application on smartphone, there has been a succession of updates introducing new options and testing the stability of the game with such a high number of players. The gained knowledge here is huge.

What is important for our topic is the following:

- A stable community of 65 million of players are regularly playing. This is placing Pokémon go in the category of very successful games.
- It proves that there is no need for any special hardware to benefit from AR. This means that this AR category of applications could be developed and rapidly diffused through an app to the final users.
- It brings a physical dimension to games that are going in the same direction as all the health applications. This application brought sedentary people outside and in average made them add 2,000 steps a day[59]. When you know that a sedentary person is only going 3,000 steps per day and that a general recommendation is to walk minimum 10,000 steps[60], you see what this game can do for you.

In conclusion, Pokémon go shows that Augmented Reality is already here, that there is no high additional costs for users (a smartphone is enough). The experience Niantic[61] is gathering is huge for other games using AR, but also for any kind of application based on AR.

[59] https://consumer.healthday.com/fitness-information-14/walking-health-news-288/pokemon-go-players-add-2-000-steps-a-day-720486.html

[60] https://www.ncbi.nlm.nih.gov/pubmed/14715035

[61] Niantic is the company that bought the license from Nintendo to produce and that operates Pokémon Go

4.2.2.2 Scenario: Self-driving car, the effect on Austria

When looking at the technological forecast from Gartner (see Chapter 3.1.1), we can see that the self-driving car is expected to be on the market in more than 10 years. Almost each big players[62] in the car industry and IT industry is testing prototypes[63]. However, there is no immediate threat to work because of this[64]. However, let us imagine for a moment what difference that kind of technology will make on work in Austria.

In that case, let us consider the whole fleet of transportation that Austria is having replaced by self-driving machines. Let us not put planes and helicopters for the moment in this category. Only what is on wheels and on see. In that case, the cars, the trucks, the trains, the subways, the tramway, the bus, the boats, etc… will be self-driving. All the driving skills are becoming obsolete.

This means that we will have a first wave touching all the persons that are driving. This represents in Austria 126 930[65] employed persons in 2014 (Statistik Austria, 2016). This is 4.5% of the whole workforce in Austria in 2014. Some work will simply disappear. The group of taxi drivers is the best example. Some other will not need this driving skill anymore and will not be considered as hard work anymore. A good example would be a bus driver, or a truck driver. In this case, the driver will not drive anymore, but will be responsible for the wellbeing and safety of his cargo (people or goods). The work will be very different. I do not consider it as a hard work anymore, because as long as nothing is happening, the employee will be able to do what he wants. Consequently, the level of the job will diminish, as well as the satisfaction of the employee. Furthermore, the reward for this new job will be less than when this person was a driver. This 4.5% of impacted persons is from the first impact from this technology. Please note that this number is focused on the positions that need as first skill driving. Many other working positions have a small part of travelling (customer support, sales …). For those professions the freed time will increase

[62] In a publication from CB insight the 18th of May, 44 companies are developing their self-driving prototype. https://www.cbinsights.com/blog/autonomous-driverless-vehicles-corporations-list/

[63] I will not give all the sources; a simple search on internet gives you plenty of information about those prototypes. For example, Google published his decision to adapt the self-driving modules from dedicated cars to mass-produced cars. http://fortune.com/2017/06/13/google-alphabet-self-driving-cars/

[64] Please note that for the sake of this Master Thesis, I am focusing in this scenario on the threat the new technology might bring, to be able to estimate the impact on work in Austria.

[65] I did not count the number of drivers from the Austrian post, as I did not find the number of drivers. Probably the number of drivers will be declassified from driver to packet carrier (as their skills to drive will not be needed anymore).

the efficiency and in big structures it will de facto decrease, even if only slightly the number of employees.

There is a second impact from this new technology. As the need of learning the driving skills will disappear, the need for driving schools will also disappear. One of the main reason why probably the governments will support this new technology is for the massive decrease of car accidents on the roads. With a number of accidents divided by at least one hundred, many other services will be impacted. The car repair shop will be massively touched. The services helping people on the road such as ÖAMTC will only exist for defect vehicles, not for car accident anymore. The need for a huge organizational safety network (ambulances etc…) will decrease in importance. The presence of police force to monitor the respect of the traffic laws will become superfluous. IT specialists to check the conformity of the self-driving programs might replace it. The market for car insurance will cease to exist, replaced maybe by a smaller market, which will be the self-driving program insurance. All added together, there are 131 133 jobs in Austria that will be partially impacted by the second impact of the self-driving cars.

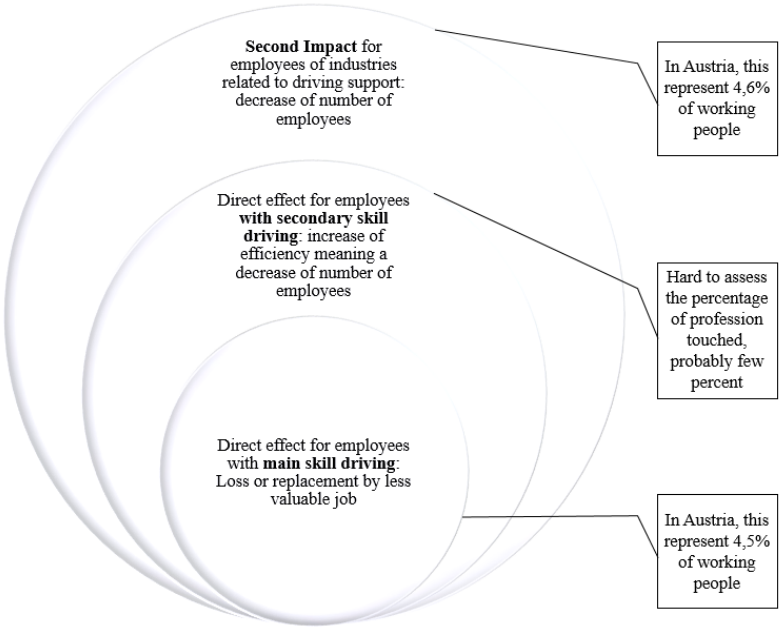


Figure 20 : Different effects of self-driving cars on twork in Austria

In total, more than 10% of the working places in Austria will be negatively touched (in term of number of places) by the self-driving cars' technology. Figure 20 shows the adding effects of the different impacts of this technology. The detail of the calculations is in the Annexes.

There will be new business opportunities that will appear thanks to the self-driving cars. Most probably, this will occur not only in the software development companies or within the car manufacturers. I doubt however that this alone will compensate for the impact this technology will have on the working environment (more than 10% directly touched or heavily impacted). Furthermore, we need to remember that the skill driving a car (or a vehicle) is one easy skill to learn. Almost everybody has a driving license. This could mean that training or educating the

population of workers whose principal skills are driving might be a challenge for everyone in the future. Especially if the training will have to happen during a very short period.

In conclusion, we learned that the self-driving car, one major technology to come, will affect directly or indirectly around 10% of the working population of Austria. The next step is now to understand how prepared is the country to "deal" with this probable coming situation?

4.3 Answer to Problem 2

The Pokémon go case showed us that AR is not anymore a technology that will happen in the future. It is already technically operational and for no additional cost for the end-user. The IHS study showed us that at least 9% of the population is facing an almost immediate risk to see his working tasks taken away by digitalization. And the scenario about the self-driving car is showing a double disruption effect that will affect more than 10% of the Austrian Workforce. While it is not expected to be instantaneous nor in the coming years, this shows the range of the disruption.

In conclusion, the potential impact is very high. However, be aware that I did not take into account the creation of new tasks and new job from the new technologies. I do de facto consider that it will be the economic and business structure of Austria that will succeed of not in this task. It will be the aim of the Chapter 4.4 to answer this question.

Problem 2: How could this Technological Revolution affect the distribution of work in Austria?

Answer 2: This Technological Revolution will heavily affect the distribution of work in Austria. Many jobs as they exist today will profoundly be transformed. The persons in this situation either will find another job or will increase the number of unemployed.

4.4 How prepared is the working environment

By working environment, I am referring to the governmental actors supporting the business and social environment and to the enterprises in Austria. This is a qualitative study mainly based on interviews with a limited number of actors. A documentation research supports this field study.

4.4.1 Description of the methodology

Let me first explain why I am conducting interviews, and how I am planning to get the best results out of a few interviews[66].

4.4.1.1 Aim of the Interviews

The aim of the interviews is to solve the problem 3: *"How prepared is the economic environment in Austria to sustain the choc of a Technological Revolution?"*.

The first set of interviews with the Human resource leaders from three societies in Austria will help me to answer the following questions:

a) How aware are the enterprises about the coming technologies (Digital, Robots, smart computer…)
b) Are they seeing those megatrends as a treat or as an opportunity?
c) How are they preparing themselves either to use the opportunity or to resist to the treats?

With the sample of interviews, I will be able to answer how threatening for the workforce from the enterprises those mega-trends could be.

The second set of interviews with governmental actors will help me to answer the following questions:

a) How aware are the government's actors about the coming technologies? (Digital, Robots, smart computer…)
b) Are the government's actors seeing those megatrends as a treat or as an opportunity?
c) How are the government's actors preparing the future (what project, action plan) either to use the opportunity or to resist to the treats?

With the interviews with leaders from the main governmental actors, I will be able to assess how agile against a brutal change of concept the overall structure of the business environment is.

[66] Concerning interviews I am strongly inspired by the methods described in latest edition of "Einführung in die qualitative Sozialforschung" (Mayring, 2016)

4.4.1.2 Iterative interview improvement method

The idea was to collect as much information as possible about how prepared the actors are concerning a potential disruptive technological wave. This means that one good way to get this was to have Problem's centered Interviews. During this interview, I set the context at the beginning of the interview and defined the problem I would like to solve. Then, the interviewee was free to speak freely on the subject. My part consisted on bringing back the interviewee to the problem by providing some guidelines if she/he was deviating too much. An important point was to be sure that the interviewee understood correctly the problem I wanted to solve. I recorded all the interviews and they are all available on demand.

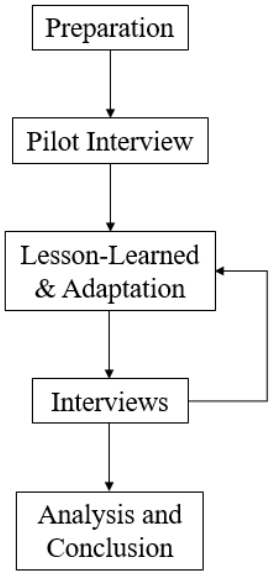


Figure 21: Iterative learning process

During the preparation of the interviews, I isolated the problem and broke it into three sub-problems to-be-solved. The final preparation sheet for the interviews, with the guidelines are in the annexes. Then, I ran a pilot Interview with the CEO of a small facility management company and I learned some lessons there. I adapted the preparation sheet with the newly learned information. I ran my set of interviews and iteratively adapted the preparation sheet.

From each interviews I got many information and I isolated the information that helped me solve the third problem. The Figure 21 gives you an overview of the iterative method I used.

4.4.2 Findings from the interview with the enterprises

Although the number of interviewed enterprises was not exceptionally high, the diversity of the enterprises shows that the perception of the mega-trends and the position of the company in relation to new technologies differs from one company to the other. I interviewed the CEO of a small facility management enterprise (Riemer, 08.06.2017), the Head of HR of a freight company (Weltler, 22.06.2017), and the Head of HR of a telecommunication enterprise (Hauer, 23.06.2017). I clustered the information I collected into Awareness (of the mega-trends), Opportunity or threat (of the mega-trends) and preparation (of the companies).

Awareness: While all of the interviewees were aware that something is coming, the level of awareness was different from one company to the other. With no surprise, the telecommunication enterprise was well aware of the coming technologies and of the speed of this coming. This was

because they are already selling this digitalization services to their customers. They were also very realistic about the risk on the working place. They were currently implementing an automated tool to fix the incidents for the IT services they were selling. They knew that in the short future they a would have to reallocate the resources currently working on such tasks. The awareness of the two other companies was not as developed. The approach to the new technologies relates probably to the size of the company. In small companies, the time and the resources are usually missing to develop program based on the new technologies. In bigger companies, there are different innovations that are already taking place. Those bigger companies are most of the time focused on development of new products. In both case, the interviews showed me that the mindset of the employees is slowly preparing themselves to the new technologies.

Opportunity or threats: All of the interviewed persons saw first those trends as an opportunity. The main part of the opportunity was surprisingly the expected benefit from new created services, especially for the technology and the small companies. The three companies also mentioned that their employees were keen to embrace new tools and new technologies. For the Technology Company, this was because the employees were technicians, for the freight company it was because many people were young and having a special bond with technologies, and for the facility management it was because of the diversity of tasks and the open mindset the employees had. The increase of efficiency was mentioned, but the interviewees did not perceive it as beneficial as the potential USP expected from the new technologies. The facility management company made one terribly accurate remark about new technologies. This was bigger than just his company was. He explained that to implement successfully some new technology, it has to be embedded in the lifecycle of a building (planning, building and operating). That meant to organize this with two other kind of enterprises. Concerning the threats on the workplace, except for the technology company where it was clear that some jobs would be cut[67], the two other companies did not feel that some of their working place were at risk. For the freight company, as it was a "people business" (Weltner, 22.06.2017) even though the efficiency could increase there was no direct threat against their employees. For the facility management company it was the diversity of the tasks the employees had to carry, with always-new situations that made the resilience of the jobs very high.

[67] Please note that I am here mentioning the job tasks, not necessarily the person associated to the job.

Preparation: For the two companies with perceived low level of threats, the preparation to face the mega-trends was currently limited to education as usual. When an increase of efficiency would come, the freed time of the employees would be well used for new tasks. The skills for those new tasks would be gained through training. The challenge would be to measure the cost of the training versus the benefit of the new tasks to be done. For the technology company, the answer was a little bit different. As explained in the previous paragraph, there would be a cut in some jobs because of digitalization. However, there would most probably be no cut in the workforce. This was because the majority of the employees possessed tertiary diploma and therefore were very receptive for new training. The success rate and the quickness to apply new learned skills would probably be very high. This company was also working to change the culture of the company. The aim would be to achieve a culture that was matching the speed of technology change. The emphasis of this company was about sensitizing their employees about becoming agile, about lean approach, and other scrum training. The medium term aim was to create a culture where the benefit an employee will retrieve would not be only focused on financial gain, but also on enrichment experience.

Conclusion: While the technology company was well aware about the transformational impact the coming mega-trends would bring, the two other companies were aware about new technologies and were monitoring the trends. All the three companies were mentioning training and education as the ideal weapon about any destructive side effect of new technologies. Only the most advance in technology was having an active approach to the mega-trends, based on culture. It would maybe make sense for this company to sensitize their customers about the impact of the new technologies and about how to prepare themselves to use them as opportunity.

4.4.3 Findings from the interview AK Wien and WKO

I had the chance to have personal interviews with the right persons within AK Wien and WKO. It was the number two of the whole Digitalization program initiated in 2015 from AK Wien (Herkommer, 29.06.2017) and the head of Rechstpolitik who organized the brochure called Wirtschaft Digital within WKO accompanied by two experts from WKO (Pöcherstrofer, 30.06.2017). I pursued the same clustering approach as with the enterprises.

Awareness: As expected after reading different brochure from both organizations, the awareness that something was happening, especially with digitalization, was very high. Both organizations developed different programs around digitalization and increased their knowledge of

it. WKO for example had an innovation screening structure based in different countries and lately increased the funds of this program and refocused their marketing on it. This was Advantage Austria and they were employing eighty persons in contact with innovation leaders, such as MIT, to gather information about mega-trends and to share it[68]. On AK Wien side, a new program was born in 2015 with the objective to gather and accumulate knowledge on digitalization, and then build on it. This project was tapping into around one hundred collaborators from different departments from AK Wien. It was pursuing around twenty projects per year. While the term Technological Revolution has not been fully acknowledged by the team from WKO[69] (Pöcherstrofer, 30.06.2017), there is an understanding that being active with all the new technologies became more important in the past couple of years.

Opportunity or threats: The two organizations saw the new technologies as an opportunity. However, for different reasons both organizations already saw the challenges that those new technologies were bringing with them. For WKO the challenges was focused on the country not being ready to fully benefit from those technologies. They mentioned a suboptimal broadband network and a digital mentality yet to come for the entrepreneurs, especially the ones from SMI. For AK Wien, the focus was on the segregation Digitalization might bring and they already had a term for it: "Digital Divide[70]" (Herkommer, 29.06.2017).

Preparation: Both organizations were very active with digitalization. They were both actively organizing programs *to increase the awareness* about digitalization, and about how to be prepared for it. WKO was for example rolling out a project called SMI Digital to raise awareness about digitalization to the SMI (webinar, presentations, seminars…) and they had a Digital Service packet for enterprises willing to be prepared for Digitalization[71]. AK Wien also had an information packet existing with many policy papers and associated topics[72]. On its side, WKO was working hard to

[68] There are different level of sharing, full public, member only and some detailed reports against financial participation to be find on their website: http://www.advantageaustria.org/international/index.en.html

[69] I have one personal comment on this: I do agree with the argument that saying that "the Technological Revolution will arrive" could be compared to witches looking through their crystal ball, and that only the future will tell us if there was one coming or not. However, many indicators, especially the growing interest to prepare the economic actors to digitalization, is pointing to the direction of a future different from today. Even during the internet bubble from the end of the nineties, we could not feel such urgency to be prepared.

[70] Digital Divide means that there is a correlation between sociocultural environments with knowledge of how to use the digital world to its advantage.

[71] https://www.wko.at/service/innovation-technologie-digitalisierung/Digitalisierung-Servicepaket.html

[72] https://wien.arbeiterkammer.at/interessenvertretung/arbeitdigital/arbeitdigital.html

push for a preparation of the *digital environment* with different actors, including the government. They were pushing for a Keynesian approach to develop massively the high-speed network in all Austria, and were working with the government to make it even more Digital friendly as it was today[73]. Both organizations also were working with partners about this topic. This was because this topic was actually bigger than each one. The last topic where both organizations were aligned was about the *absolute need of an adapted education*. Firstly, the *classical secondary education* had to integrate more digital content to bring the next generation of working persons ready for digitalization. This would benefit both the enterprises and the workers. AK Wien on its side was also working with partner to decrease the Digital Divide effect. Secondly, *the continuous education* is where the challenges were the strongest, and this had been confirmed by both organizations. The challenge sounds like this: How can we bring the needed knowledge to the persons that need it the most. For WKO, those will be the leaders of SMI to adapt their strategy to the digital world, and for AK Wien those will be the workers with no job or no future perspective. For both organizations, there was no easy answer to this.

Conclusion: Apart from the government that stayed the final decision taker, I did consider these two organization as the most important organizations when it comes to shape the working environment. I had been very pleased first to see that their awareness about this topic was very high. I was also glad to hear that both organizations already had many projects and initiatives to accompany their stakeholders with this coming challenge. What very clearly came out from those two interviews was that the biggest challenge was related to education: how to bring the needed proper education to the people that needs it the most. In a sense, it looked like a will for a new shaping of culture, trying to make everybody a little bit more aware and a little bit more agile. This to get the overall system more protected against disruptive changes. The key words here were increasing awareness, preparing the digital environment and educating properly the people.

4.5 Answer to the Problem 3

The chapter 4.1 showed us that in general Austria has good fundamentals to face any change. Only two fundamentals are not that shiny: the first one was about the employment rate that was

[73] Austria was leader few years ago with its e-government approach, and while Austria was still top ranking at the time of the interview, it was not leading anymore.

decreasing while increasing in other countries and the second one was about the educational system that was internationally only averagely scoring.

The first focus of the interviews was on the awareness of the actors. This is because when there is no awareness, then there is no chance to be prepared. The answer from all the actors have been positive on this topic, especially from the two Austrian organizations and from the technology company. This is a good sign because it means that some main actors are already closely watching what is happening and are ready to react. The second focus was about how those actors are seeing the new technologies. All of them are first seeing it as an opportunity, and then are mentioning some of the challenges that the technologies might bring. This optimism is from my perspective a driving force. This will help Austria to grow with those new technologies. The actors need to overcome one main challenge: education. Firstly, the secondary education. Both organizations and the freight company (Weltler, 22.06.2017) mentioned this clearly. It is reinforcing the results from Chapter 4.1. about the weakness in the education system. Secondly, the continuous education. This is probably the key to success and it seems it is missing here. With this information, please allow me to answer to the third question.

Problem 3: How prepared is the economic environment in Austria to sustain the choc of a Technological Revolution?

Answer 3: Austria is relatively well prepared for sustaining the probable choc of a Technological Revolution. However, there is Damocles Sword over this conclusion. There is a last remaining challenge, and this would be for each and all different actors to figure out how to bring the needed knowledge to persons who needs it the most.

5 Conclusion

The research question was "What could be the effect of the current mega-trends on work in Austria?" In this question, there is actually a strong hypothesis. This hypothesis is that we do have mega-trends that are coming. However, making prediction is almost like drawing cards for divination, and accuracy is an enemy. This is why I turned the first problem into a soft confirmation of this trend.

Problem 1: Is it probable that we are facing a new Technological Revolution?

I answered this question by learning as much as possible about Industrial Revolutions and about associated theories. With the findings of those theories, I dug out indicators that could increase or decrease the probability of such a Technological Revolution. I also screened for the mega-trends and checked if they were material for a Technological Revolution. The answer is as follow:

Answer 1: It is highly probable that we are facing a new technology revolution in the coming years.

Now that the first implied hypothesis as not been rejected, I could spend some time to answer the research question. The first step to answer it would be to understand the potential destructive impact of the coming mega-trends. This is why I posed the second problem.

Problem 2: How could this Technological Revolution affect the distribution of work in Austria?

I based my research on the work of experts and academics for this, and I challenged some of their conclusions. I then developed a scenario to see what could be the impact of self-driving cars on the work repartition in Austria. With those elements, I answered the raised question.

Answer 2: This Technological Revolution will heavily affect the distribution of work in Austria. Many jobs as they exist today will be profoundly transformed. The persons in this situation either will find another job or will increase the number of unemployed.

All is dynamic, it is not only that a Technological Revolution is destroying jobs, it is also about creating new jobs. And so far, in the history of Industrial Revolutions, this worked pretty well. This last part of my work sent me on the field and had me make interviews with economic actors from Austria. My aim was to solve the third problem.

Problem 3: How prepared is the economic environment in Austria to sustain the choc of a Technological Revolution?

Combined with my research of indicators for resilience, the interviews gave me a relatively optimist answer to the problem 3.

Answer 3: Austria is relatively well prepared for sustaining the probable choc of a Technological Revolution. However there is Damocles Sword over this conclusion. There is a last

remaining challenge, and this would be for each and all different actors to figure out how to bring the needed knowledge to persons who needs it the most.

To answer the research question, the effects of the mega-trends on work in Austria is potentially high. However, the whole structure is aware about those coming new technologies. The economic actors are already working for some years now to prepare the structure to be more agile, more dynamic to sustain this choc. The only weak point is within education, especially for people already in their working life. Probably, if this problem is not quickly solved, the number of unemployed people will substantially increase when the coming trends will be fully diffused in Austria.

6 Discussion

The study clearly pointed out one very interesting points that could be summarized as follow: The pace of transformation is accelerating; therefore, there is an urgent need today for a society to be able not only to educate properly their children, but also to continuously educate properly their adults.

As discussed in the fourth chapter, the main difficulty is to bring the right education to the persons who need it. One interesting idea could be to extend the Welfare State. Today the welfare state is "a system that allows the government of a country to provide social services such as healthcare, unemployment benefit, etc. to people who need them, paid for by taxes"[74]. Usually it does include the education of the children and the possibility for education for unemployed persons. In that case, the continuous education stays a personal choice, sometime supported by the company employing a person. However, even in the case the Technological Revolution is not occurring, all actors agree that the technological pace is today very quick and that education is the best way to deal with it. In such a situation, would it make sense to extend to Welfare state to continuous education? This to avoid getting an increasing number of persons that are not adapted anymore to the working market.

Already in 1996, a report of the OECD pointed out that we entered the Knowledge base economy[75]. I suggest an open discussion about a transformation of continuous education, as it is my belief that this is the next challenge for all societies.

[74] From http://dictionary.cambridge.org/dictionary/english/welfare-state
[75] https://www.oecd.org/sti/sci-tech/1913021.pdf

7 Bibliography

Abteilung für Rechstpolitik - WKO, 2016. *Wirtschaft DIGITAL - Maßnahmen für einen zukunftsfähigen Wirtschaftstandort*

AFP, F. A., 2017. L'impact du numérique sur l'emploi difficile à mesurer. *Le Figaro.fr - Economie,* 23 March.

AK Wien, 2016. *Digital Change - Fair and Just*

Albers, S. A. & Albers, A. L., 2015. *On the mathematic prediction of economic and social crises: toward a harmonic interpretation of the Kondratiev Wave, revised an corrected, with a new appendix*

Arntz, G. M. T. & Zierahn, U., 2016. *The Risk of Automation for Jobs in OECD Countries: A comparative Analysis,* Paris: OECD Publishing.

Ayres, R. U., 1989. *Technological Transformations and Long Waves.* Laxenburg, Austria: International Institue for Applied Systems Analysis.

Burton, B. & Walker, M., 2015. *Webinars from Gartner.* [Online] Available at: www.gartner.com/webinars [Accessed 3 June 2017].

Burton, B. & Walker, M. J., 2016. *Gartner Hype Cycles 2016: Major Trends and Emerging Technologies.* [Online] Available at: https://www.gartner.com/webinar/3377422/player?commId=215757&channelId=5502&srcId=1-3478922244# [Accessed 05 June 2017].

Castellacci, F., 2006. Innovation, diffusion and catching up in the fifth long wave. *Futures,* February, Band 38, pp. 841-863.

Coccia, M., 2017. The relation between war, general purpose technologies and dynamics of K-Waves for technological Economic and Social Change. *CocciaLab,* Issue No. 1, p. 31.

Dator, J., 1999. Return to long waves. *futures,* Band 31, pp. 361-372.

Dörner, S., 2016. Droht mit Digitalisierung jedem zweiten Job das Aus?. *Die Welt,* 11 January.

European Commission, 2017. *European Comission: Mobility and Transport.* [Online] Available at: https://ec.europa.eu/transport/road_safety/specialist/statistics_en [Accessed 20 05 2017].

Federal Ministry of Science, research and economy, 2016. *Economic Report Austria 2016 Executive Summary,* Vienna

Forni, A. A. & Meulen, R. v. d., 2016. *Gartner's 2016 Hype Cycle for Emerging Technologies Identifies Three Key Trends That Organizations Must Track to Gain Competitive Advantage.* [Online] Available at: http://www.gartner.com/newsroom/id/3412017 [Accessed 05 06 2017].

Freeman, C., 1984. Prometheus Unbound. *Futures,* October.pp. 494-507.

Freeman, R. B., 2016. Who owns the Robots Rules the World - The deeper threat of robotization. *Harvard Magazine,* pp. 37-39.

Frey, C. B. & Osborne, M. A., 2013. The future of employment: How susceptible are jobs to Computerization?. *University of Oxford.*

Gordon, R. J., 2012. Is U.S. economic growth over? Faltering innovation confronts the six headwinds, 1050 Massachusetts Avenue - Cambridge - MA 02138: National Bureau of economic research.

Grinin, L. E., Grinin, A. L. & Korotayev, A., 2016. Forthcoming Kondratieff wave, Cybernetic Revolution and global ageing. Technological Forecasting & Social Change, 8 october, Issue 115, pp. 52-68.

Jensen, M. C., 1993. The Moderm Industrial Revolution, Exit, and the Failure of Internal Control Systems. The journal of finance, July, Vol. XLVIII(No. 6), pp. 831-880.

Jordan, R., 1990. The eye of the World - (The wheel of time book 1)

Kaplan, S. & Tripsas, M., 2003. Thinking about technology: understanding the role of cognition and technical change. IPC Working Paper Series, December, Band MIT-IPC-03-007, p. 46.

Kessler, A. M., 2015. Elon Musk Says Self-Driving Tesla Cars Will Be in the U.S. by Summer. The New York Times [Online], 20 March. B1.

Kleinknecht, A., 1981. Observation on the Schumpeterian swarming of innovations. Futures, August.pp. 293-307.

Kondratieff, N. D. & Stolper, W., 1935. The Long Waves in Economic Life. The Review of Economics and Statistics, November, 17(6), pp. 105-115.

Kondratieff, N. D. & Stolper, W., 1935. The Long Waves in Economic Life. *The Review of Economics and Statistics*, November, Vol. 17(No. 6), pp. 105-115.

Korotayev, A. V. & Tsirel, S. V., 2010. A spectral Analysis of World GDP Dynamics: Kondratieff Waves, Kuznets Swings, Juglar and Kitchin Cycles in Global Economic Development , and the 2008-2009 Economic Crisis Structure and Dynamcis. *Structure and Dynamics,* Issue 4(1).

Mansfield, E., 1983. Long Waves abd Technological Innovation. *American Economic Review,* May, No. 2(vol. 73), pp. 141-145.

Mayring, P., 2016. *Einführung in die qualitative Sozialforschung. 6. Auflage.* s.l.:Edition Beltz.

Mensch, G., 1981. Review: Stalemate in Technology: Innovations Overcome the Depression by. *Journal of Economic Issues,* September, Vol. 15(No. 3), pp. 806-808.

Michele Bertoncello & Dominik Wee, 2015. *http://www.mckinsey.com.* [Online] Available at: http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world [Accessed 20 May 2017].

Nagl, W., Titelbach, G. & Valkova, K., 2017. *Digitalisierung der Arbeit: Substituierbarkeit von Berufen im Zuge der Automatisierung durch Industrie 4.0*

OECD, 2017. *Adult education level (indicator).* [Online] Available at: https://data.oecd.org/eduatt/adult-education-level.htm [Zugriff am 25 June 2017].

Phillips, F. & Linstone, H., 2016. Key ideas from 25-year collaboration at technological forecasting & social. *Technological Forecasting & Social Change,* Issue 105, pp. 158-166.

Policy Department A: Economic and Scientific Policy, 2016. *The situation of workers in the collaborative economy*

Rifkin, J., 2012. The third Industrial Revolution: How the Internet, Green Electricity, and 3-D Printing are Ushering in a Sustainable Ery of Distributed capitalism. *The World Financial Review,* 3 march.

Shmihula, D., 2009. The waves of technological innovations. *Studia Politica Slovaca,* Volume 1/2009, pp. 32-47.

Śledzik, K., 2013. Schumpeter's view on innovation and entrepreneurship. *Management Trends in Theory and Practice,* pp. 89-95.

Soziales, B. f. A. u., 2015. *Grünbuch Arbeit 4.0 – Arbeit weiter,* Berlin: Bundesministerium für Arbeit und Soziales,.

Statistik Austria, 2016. *Hauptergebnisse der Leistungs- und Strukturstatistik 2014 nach Klassen (4-Stellern) der ÖNACE 2008*

Stylianou, N. et al., 2015. Will a robot take your job?. *BBC,* 11 September.

Volland, C. S., 1987. A Comprehensive Theory of Long Wave Cycles. *Technological Forecasting and Social Change,* Issue 32, pp. 123-145.

WKO, 2016. *Wirtschaft Digital: Maßnahmen für einen zukunftsfähigen Wirtschaftsstandort*

Interviews

Hauer, Christian (Head of HR @ T-Systems Austria GesmbH). Personal Interview in German, June 23, 2017

Herkommer, Fridolin (Digitalisation Department @ AK Wien). Personal Interview in English, June 29, 2017

Pöcherstrofer, Winfried; Feßl, Thomas; Nindl, Elisabeth (Abteilung für Rechstpolitik @ WKO). Personal Interview in English, June 30, 2017

Riemer, Raphael (CEO @ ICS Facility Solutions GmbH). Personal Interview in English, June 8, 2017

Weltler, Ingrid (Head of Human Ressource @ DHL Global Forwarding). Personal Interview in German, June 22, 2017

8 Annexes

Annex 1: Interview guideline

Name and function of the interviewed:

Company or organization:

Date:

Timeline:

1) Thanking the interviewed that she/he is taking time for me
2) Asking her/him if I can
    a. Record the interview
    b. Name her/him and the company in my MT, or if preferred not
3) Give him the context of the interview: problem centered interview.
4) Give him the context of my MT
    a. Title of the thesis: Impact on the mega-trends on work: a case study of Austria
    b. Review of the three IR and mechanisms
    c. Review of the waves theories (Kondratieff, Schumpeter and other more contemporary academics)
    d. Conclusion, we might face a big technological wave
5) Context Austria
    a. HIS review, AK Wien and WKO: Digitalization and danger on work (the most optimistic is showing 9% impact in Austria)
6) Problem I am trying to solve: *How prepared is the economic environment in Austria to sustain the choc of a Technological Revolution?*

Helping questions:

d) How aware are you about the coming technologies (Digitalization, Robots, smart computer…)

e) Are they seeing those megatrends as a treat or as an opportunity?

f) How are they preparing themselves either to use the opportunity or to resist to the treats?

Guidelines:

- What if the competition does it and you do not? (Example of agile small enterprises, even in financial institutions: FinTech, such as N26: 300 000 customers in Europe).

- Does the training of your employees consider this coming wave, and is it adapted?
- What will be your response to your employees whose skills are becoming obsolete?
- How will you adapt the flexibility of your employees in the future? (Ex: self-driving car: driving time could be counted as real working time for example)
- Do you have an innovation manager or innovation department? If yes, are you, HR working with her/him to integrate innovation with the impact it might have on work?

Examples of jobs that could be impacted:

- First line support: chatbot
- Drivers: self-driving fleet
- Assistant vs Virtual Assistant
- Data analysis that increase efficiency: less Customer Service Manager per customer
- Accounting, controlling
- Legal

Closing question:

After this interview, will you take the time to think about this possibility in your working context?

Annex 2: List of the interviewees

Interview performed the 08.06.2017

Interview with Mr. Raphael Riemer, CEO from ICS Facility Solutions GmbH

ICS Facility Solutions GmbH is a small company with 5 persons. It is a facility management company.

Interview performed the 22.06.2017

Interview with Miss Ingrid Weltler, Head of HR @ DHL Global Forwarding

DHL Global Forwarding is the freight daughter from DHL.

Interview performed the 23.06.2017

Interview with Mister Christian Hauer, Head of HR @ T-Systems Austria GesmbH

TSA is a daughter company from Deutsche Telekom

Interview performed the 29.06.2017

Interview with Mister Fridolin Herkommer, Digitalisation department @ AK Wien

AK Wien is the worker council which mission is to protect the right of the workers

Interview performed the 30.06.2017

Interview with Dr. Winfried Pöcherstrofer, Abteilung für Rechtspolitik @ WKO

Two experts were present during this interview Dipl. Ing. Thomas Feßl, and Dr. Elisabeth Nindl

WKO is chamber of commerce in Austria. They are here to facilitate the companies to perform in Austria.

Annex 3: Detail to the self-driving car calculation

ÖNACE 2008	First Wave	Number of persons	Impact on group	loss or decrease of standing
H491	Eisenbahnfernverkehr (Personen)	3.179	Total	decrease
H492	Eisenbahnverkehr (Güter)	7.491	Total	decrease
H493	Sonst. Landverkehr (Personen)	56.477	Total	loss
H494	Güterbeförderung im Straßenverkehr	59.251	Total	decrease
H50	Schifffahrt	532	Total	decrease
H53	Post- und Kurierdienste	24.324	Partial	decrease
	Total	151.254		

ÖNACE 2008	Second Wave	Number of persons	Impact on group	loss or decrease of standing
C29	H.v. Kraftwagen und -teilen	30.883	Partial	loss
C3317	Reparatur v. Fahrzeugen a.n.g.	3.415	Partial	loss
E3811	Sammlung nicht gefährlicher Abfälle	9.630	Partial	decrease
G452	Reparatur v. Kraftwagen	27.269	Partial	loss
K6512	Nichtlebensversicherungen	19.196	Partial	loss
K6622	Versicherungsvermittlung	12.436	Partial	loss
H5221	Sonst. Dienstleistungen - Landverkehr	3.980	Partial	decrease
	Total	106.809		

Total of employees in Austria 2.841.426

Total	126930	4,5%
partial	131133	4,6%

Source (Statistik Austria, 2016)

Annex 4: Adapted version of the post-module assignment from Managerial Economic: The currency Wars

PostModule Assignment Class 1 – Alexandre Barban

Question 1: Provide your assessment (based of at least two articles from 2015) of one of the following three "hot" international financial topics: (i) divergence in monetary policy of key central banks, (ii) renminbi in the IMF currency basket, and (iii) currency wars. The assessment should be based on at least two articles on the respective subject published in 2014 and / or 2015 (response – up to 2 pages)

The currency wars

The financial word… Is this an ever ongoing battlefield? The nations, by dictating their fiscal and monetary rules, are they providing to their companies high tech weaponry to compete with other companies, from other countries. Can those companies be seen as soldiers, or as their loyalty to the countries are yet to be confirmed, as mercenaries? Can their turnover be seen as their pay? And can a competitive devaluation from a country be seen as a declaration of war to the rest of the world, of a currency war?

Even if the metaphor of war is frequently used and can explain some of the facets of the financial world, it is too simplistic to focus only on it. And a currency war is after all only a way to borrow competitiveness from other countries. Isn't it? Or is it?

Competitiveness… Each country has a limited number of tools to help its resident companies to increase their competitiveness against the non-resident companies. One of them is to let the central bank to decrease the risk free interest base, making the money less expensive for the companies to implement new projects, and therefore to improve their turnover. However, when this rate is near, or even under, zero, this tool is not effective anymore. Another tool, that can be seen as a last resort tool is to depreciate or to devaluate, depending on which exchange regime the country is, the currency of this country. This will immediately make the goods and services produced in the country cheaper in comparison with the goods and services produced outside this country. And because it has the exact inverse effect on the outside, it can be seen as an aggression from this country toward the others. If a certain number of big countries are playing with this last resort tool, then this has a strong negative effect to third countries and it is called a currency war.

Inflation… When the inflation is near zero, it is always bearing the risk of deflation which is catastrophic for each and every economical zone. It is for example the focus of the ECB to maintain a reasonable level of inflation, around 2%. It has been already explained that the devaluation or depreciation can be done to increase the export and diminish the import of goods and services, bringing the Balance of Payment to some more positive (or less negative) values. It is also supposed to help increasing inflation. By bringing more money into the circuit, for an amount of goods and services that stays approximately stable, it should increase the price of those goods and services. And this is the definition of inflation.

To play on the value of a currency, there are different ways to do. The most traditional one is to have a continuous intervention of the central bank to fix the limits of fluctuation from its currency to one or more other currencies. This is the case of China for example, which with its enormous surplus is continually buying a big amount of foreign currencies to maintain a low level of the Yuan. And even if it left his hard peg to the dollar in 2005, the PBoC did not let the market totally take the lead. China is using a managed exchange rate and it is active as the last devaluation took place even in 2016. It is also what Switzerland did to maintain a so called sustainable exchange rate between the Franc Suisse and the Euro. It did so until the 15th of January 2015, when it became clear that the ECB will use another kind of devaluation tool: The Quantitative Easing (QE). And the Central Bank of Switzerland knew it could not withstand such huge pressure, and it let the market deciding the exchange rate. The word has been said, QE! This is a new, maybe more elegant, way to introduce a large amount of money into the economy. It is replacing the old "printing money" last resort tool. Basically, this means that the central bank is "injecting" big amount of money into the economy by buying large amount of debt. This mechanism has been used since the beginning of the Subprime crisis in 2008 by all the big economies, except for China: 2009 for England, 2012 for Japan, 2015 for the Euro Zone, and 3 times for the USA between 2008 and 2014.

The amount of money used since 2008 is astonishing as we are quickly approaching the 10 trillions of dollars when adding the QEs from the US, from the Eurozone, from England and from Japan. And despite this, the effects are only modest for those economies. However, this QE are creating an equivalent of a liquidity tsunami with a huge pressure in direction of third party countries. Switzerland is only the example of Europe. It is bringing instability to countries that are not strong enough, and mature enough from a financial point of view, to withstand such kind of pressure.

From my perspective, this uncoordinated policy is an approach that is focusing on problems, reactively and without a global vision. It gave temporarily a boost to the advances economies, the one able to use that kind of tool, and gave the impression that the high – around 5% - worldwide growth is sustainable on the long term. This currency war, because it seems really to be one, and because of its importance, is able to change the rules of the game. It gives this impress that we are going into a direction where the forces of the market are heavily influenced by the central banks as long as it touches the values of the main currencies. Maybe this is slowly signing the end of the freefloating era, and maybe we will go into a new exchange regime.

In conclusion, it seems that this currency war is not something that can be sustainable for a long term, and that this will, with some other movements in the financial world, bring some radical changes in the rules of the game.

References

- "Un marché des devises sous influence: comprendre la guerre des monnaies" published in July 2013 by Cheickna Traoré in Agefi (Internet)
- "Central Bank Policies Retreat Further Into the Past, UniCredit Economist Says" published the 30th of November 2015 by Paul Vignia in The Wall Street Journal (Internet)
- "Le vrai problème de l'économie mondiale" published the 2nd of September 2015 by Patrick Artus in Les Échos. (Internet)
- "La Suisse paye encore le prix de sa sortie de la « guerre des changes »" published the 30th of October 2015 by Nessim Ait-Kacimi in Les Échos. (Internet)
- "Quantitative Easing In Focus: The U.S. Experience" published the 16th of November 2015 by the Trefis team (http://www.trefis.com) in Forbes (Internet)

Annex 5: The comparison of technologies table – Gartner vs. Grinin, et al.

Grinin, et al	Gartner
Nanotechnlogy	**Transparently Immersive Experiences**
Nanomaterials	Human Augmentation
Nanocircuits	4D Printing
Nanorobots	Brain-computer Interface
Biotechnology	Volumetric Displays
Biotechnology industrial	Affective Computing
Bioinformatic	Connected Home
Cloning	Nanotube Electronics
Genetic Engineering	Augmented Reality
Food production	Virtual Reality
Additive Technology	Gesture Control Devices
FDM, SLA, SLS, EBM printing	**Platform Revolution**
inkjet 3D-press	Neuromorphic Hardware
3D-bioprinting	Quantum Computing
3D-implants printing	Blockchain
Robotics	IoT Platform
Industrial robots	Software-Defined Security
Medical robots	Software Defined Anythings (SDx)
Service robots	**Perceptual Smart Machine Age**
Military robots	Smart Dust
Information Technology	Machine Learning
Software	Virtual Personal Assistants
Networks	Cognitive Expert Advisors
Computer Devices	Smart Data Discovery
Databases	Smart Workspace
Cognitive Technology	Conversational User Interfaces
Smart software	Smart Robots
Speech recognition	Commercial UAVs (Drones)
Artificial inteligence	Autonomous Vehicles
Neural Interfaces & prosthetics	Natural Language Q&A
Medicine	Personal Analytics
Biochips	Enterprise Taxonomy and Ontology Management
Artificial organs	Data broker PaaS (dbrPaas)
Gene therapy	Context Brokering
Artificial immune system	
Pharmaceutics	
Neural Interfaces & prosthetics	
Surgery	

The matching is done through the colors of the cells. The color of the writing correspond to already developed technology or medical oriented technologies.

END OF THE DOCUMENT