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Dorsoduro 3246
30123 Venezia

A linear regression on productivity: *the importance of sustainable activities*

Thesis Advisor:

Prof.ssa Lucchetta Marcella

Graduate student:

Francesca Cattuzzo

Matricula 865940

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To my parents,
a glow of light in the fog
when I loose the way.

One day I hope
it will all be worth it.

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Introduction

The main aim of this thesis is to demonstrate that caring about sustainability, considering the protection of the environment on the process of production and evolution, investing on green economy and on the transformation to circular wealth, countries, and in particular companies, have the possibility to increase their productivity. Effectively they would have the capability of generating more with the very same amount of resources, so to increase the creation of goods or the provision of services having at disposal a fixed amount of original assets; or it would be available the opportunity of using less, to generate the same output, which means that you can reduce the quantity of stock necessary to produce an equal amount of goods or services. Actually, the logic behind this intuition consists on the fact that spending money and time for matters connected to the reduction of waste, the depletion of Green House Gases (GHG) and/or for the safeguard of the environment, for example, makes it possible for you to enjoy a greater level of efficiency within your enterprise, therefore you will become more productive, you will waste less and save more resources, will be able to create more value, more benefits and positive output, and hopefully, you will become stronger and richer within the market.

Furthermore, the reason why is so important to focus on this topic, is because nowadays the world is dramatically changing due to pollution and the irresponsible exploitation of natural resources. Impressive extreme weather events and changes in the climate are already affecting thousands, million of people around the world damaging the coastlines, reducing crop yields and affecting water resources availability. Mediterranean areas are becoming drier every year, while North Atlantic cyclone is affecting North America and the Caribbean. Just think about locusts that in last January have flooded Eastern Africa because of the abnormal, too high temperatures that have occurred in the territory, which have lead to an over reproduction of these bugs that now are moving towards South-East of Asia. They are eating all the vegetation, crops and grass, damaging not only the vegetables directly eaten by the population but moreover the fodder needed to feed livestock farms. It seems one of the ten plagues of Egypt. Look at Miami, which has to perceive floods any time more frequent that are damaging infrastructures, roads and beaches. Even in our shores every year we are facing a reduction in the coastlines due to the erosion of the ground for the expansion of the sea level. Think about Venice in November 2019 that have perceived the greatest high tide of the last eighty years. Think about wild fires in Australia.

These are all events that are *not directly and effectively* caused by global warming, as Venice has always been subjected to high water phenomenon, which at times can be very destroying; and Australia has always been characterized for droughts periods, sometimes more, sometimes less severe. But indirectly, and even if for a small fraction, these accidents are generated by Climate Change, and representing conditions that are going to be much more recurrent in the future. For sure in the latest years the world is feeling record-breaking temperatures and intense rainfall in different territories every chance more frequent. There is a growing evidence that warming close to 1.5° C above pre-industrial level is locked into the Earth's atmosphere due to past and predicted GHG emissions and extreme weather events like drought periods, floods and intense heat cycles may not be avoided anymore[1] because of the inertia of the system. Past emissions have already committed the world to much of the losses in per capita GDP over few decades. To stabilise the level of emissions they should be reduced of 80% immediately, which is something almost impossible. Climate condition that are estimated to happen once every 100 years, judged to be unprecedented and unusual, are becoming more probable and are expecting to happen once every 10 years leading the world to a big level of climate instability. The fact is that, those responsible for these tragic conditions are human's activities and processes related to the combustion of fossil fuels for transports, to the creation of energy in companies and infrastructure, are connected to deforestation of huge areas to expand the agricultural production of some really important resources for nowadays economy like palm oil, soy, connected to the extension of space dedicated to cattle breeding, and, finally, to the persistent production of non recycled waste, left on the ground or on the ocean threatening dangerously the survival of many species and the biodiversity of marine and coastal environment. There's this idea of ecosystem according to which every economical activity require the use of natural resources as raw materials or sources of energy. We depend on the environment; since prehistory the presence of rivers and breeding ground were essential to establish where to settle, to ensure wealth being and demographic growth of the population, an easy example can be the Egyptian civilization placed near Tigris and Euphrates in Mesopotamia. So there's an intrinsic economic value in the environment and its resources. The problem is that through the years the relationship between humans and the environment has radically changed. Since industrial revolution of 19th century, companies had to become able to produce more with less, in order to gain a competitive advantage; to do so they have searched for

[1] Turn down the heat, confronting the new climate normal, *World Bank 2014*, scientists at the Potsdam Institute for Climate Impact Research and Climate Analytics.

new resources like coal and oil, relatively easy to use and transform, to improve their opportunities. Unfortunately in this way human activities have devastated natural ecosystems, causing disturbances as the Green House Effect and the Ozone Hole, air and ground pollution and the depletion of Earth's natural reserves.

For these reasons, it's easy to understand that is crucial to guarantee a solution to sustain growth and economic expansion in a sustainable and environmentally friendly way, if not because it's ethically right, for our peaceful survival, as the consequences, if we don't change our way of behaving, would be disastrous. And given the fact that, almost every time, is the economy that drives to changes and evolutions in the world, as health, access to the resources and wellness are connected to income and monetary disposal, in this abstract the objective is to prove that, even from an economical and financial point of view, is convenient to invest on sustainable activities. If something is right from an ethical point of view, this should be enough to pursue an objective, sadly sometimes is not always the case. But if it's also convenient and profitable, than for sure the goal has to be achieved.

The discussion is articulated in the following way. In the first chapter there will be a general overview on the actual situation in the world: what is happening to our planet, how things are supposed to change, what can be the possible huge negative results that are going to be felt if actions are not supposed to vary; with specification about the costs to be felt, and the solutions to be taken into account. Afterwards, a general analysis about how Europe, and Italy in particular, are trying to face these problems and come out from the environmental crisis. And finally, some details on the connection between productivity and sustainability, from a theoretical and literature point of view. In the second part of the abstract, going a little bit more in deep into details, there will be an analysis, through a time series linear regression, on four of the most important industries in Italy: agriculture industry, apparel industry, food and beverage industry and construction. The regression will be used to demonstrate that the more they are involved in sustainable activities and the less they are polluting, the more they are becoming productive and efficient over time. Hence the second chapter will be dedicated to a general description of linear regressions, to make readers understand what regressions are, how they are working and why they can be very important; and then there's a study on the choice of the variables, so the regressors, which are going to be considered for the analysis, evaluating why they should be taken into account and how much important they are for our purpose. Finally the third chapter is mainly devoted to comments on the results obtained, specifying in the premises the adjustments and assumptions that have been

made in the computation, and providing information about the tests and diagnostic, which have been considered to ensure that the computation were robust and valid.

From the analysis came out that the productivity of every sector, some more, other less, depends heavily on the degree of sustainability adopted by each industry, stressing the fact that companies should care more about the environment and its protection if they want to feel advantages in terms of greater market share at their disposal, given the fact that is created the possibility to attract customers who care about the ethical way through which your company is run. If enterprises are more sustainable, greater efficiency and greater value will be delivered to customers and thereby even provided to them, as the more your client feel increased benefits perceived, the more they are disposed to pay for companies' products. So the latest conclusion of this thesis, is essentially explaining that the more you care about the environment in which you are settled, the more you spend to regenerate the resources that you exploit, to maintain the biodiversity of your ecosystems, the less you pollute or generate waste and the more you will have continue resources at your disposal for your activity, the lower costs you will perceive, as you find a way to reuse the wasted materials, less environmental taxes you will pay, more clients you will satisfy, providing them greater quality and services. The more you cherish your planet, the more productive and efficient you will become. The more you respect your Earth, the more you respect yourself, and you will effectively perceive these benefits from an ethical, social and monetary point of view.

1. Climate Change, the world is altering

> *"It is fundamental to recognize that climate change is a real and urgent threaten to us all, and that climate change is running faster than what we are. We are not winning this war, and we absolutely must do it. The planet is very resilient, it will not be destroyed, in the future millennium you will see it rounding the side. Humankind has declared a war on nature and nature is striking back in a very violent way. We will be destroyed by climate change, not the planet. This will be for us a clear indication that we absolutely need to change course."* [2]

It's clear to understand that, if processes can be streamlined and at the same time output increased, almost every business would catch the opportunity to do so, but this may also come at

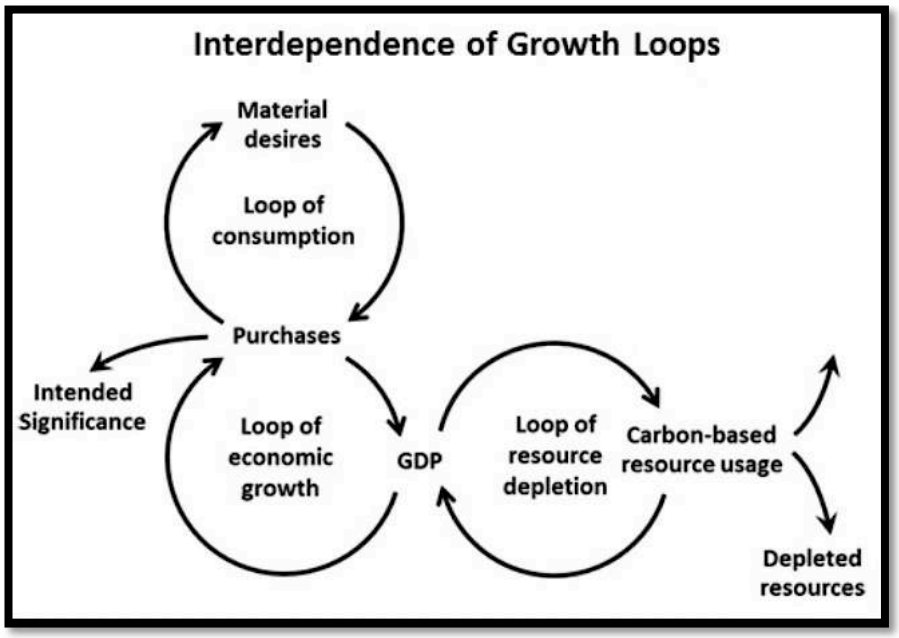
[2] UN Secretary-General Antònio Guterres, UN Climate Change conference COP25

the expense of many other factors and parameters not valuated in the business model of an enterprise or its area of operations. One of the most impactful side effects of increases in the output is the repercussion on the environment.

Many researches have demonstrated that at the end of the last ice age, about 7,000/17,000 years ago, the planet atmosphere warmed rapidly, but then climate started to stabilize and the rate of heat decrease to an acceptable level. On the other hand after the second industrial revolution, over the past 130 years, humans have been warming the Earth 20 times faster than the last ice age, and in the last 40 years, the rate as ha been three times bigger. If we do not become able to cut carbon pollution, that rate could speed to more than 50 times faster than most rapid natural changes, leading to rising probability of major threshold in climate systems to be breached, especially if heat overcome the 2°C above pre-industrial levels. Humans in the latest years have been responsible to cause the greatest amount of activities today harmful for the entire planet and human being itself. And the main driver behind human activities and choices was the continuous and imperturbable search for perpetual growth. But there are limits to Earth's natural resources and thus to any economic growth, which depend on them. Unbounded population's growth, pollution and depletion of natural resources will cause the collapse of physical growth on Earth[3]. We can imagine growth as to be a reinforcing loop, growth sustains growth, and the short term benefits are noticeable: the more growth and profits, the more jobs, resources, quality of life, development of technologies that have enabled innovative product, global travels and rapid communication, efficiencies. But the counterbalanced use of natural resources, needed to feed growth undermine the foundation of growth itself.

[3] Members of the Club of Rome, a group of thinkers in politics, business and science, 1972

Figure 1: a graphical representation of Growth Loops



Source: Karen Higgins, PhD, *Financial Whirlpools*, Elsevier, 2013

According to this, continued emphasis on economic growth as we know it today, is diametrically opposed to sustainability of our planet, there has to be a deep understanding of tensions between short-term growth and long-term survival. In today's world, consumerism is rooted on the behaviour and the habits of people. Economics and, by extension even politicians, do not discuss about the optimal size of the economy, they only concentrate on growing as much as possible. But there's a substantial difference between getting bigger (growth) and getting different (develop), and while you cannot grow forever, you can develop forever: money will move from a person to another, services will be provided and good created, it's not a stagnant situation. As long as the economy will be based on the unsustainable use of natural resources, economic growth cannot be sustained indefinitely. The system should be maintained in a steady state condition, functioning and renewing itself year after year, we can only use resources that can be replenished and regenerated at a greater rate than they can be harvested, and resources that cannot emit wastes any faster that they can be easily absorbed and assimilated into the natural environment[4]. Or we should be able to create or discover renewable sources of energy at a rate equal to the depletion of the previous non-renewable ones. There should be a relatively constant population, economic

[4] H. E. Daly, *Sustainable Growth an Impossibility Theorem,* 1993

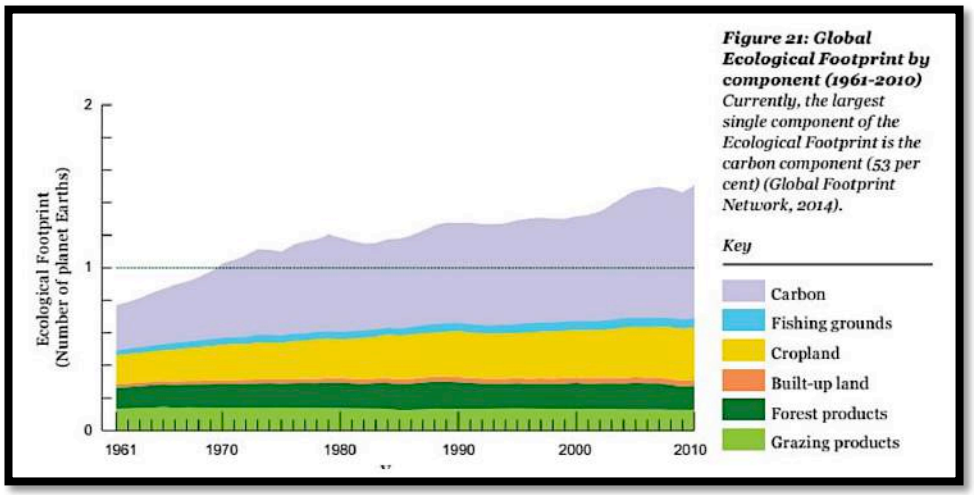
throughput, natural resources supply and use, with only small fluctuations, this means that there must a maximum size to be achieved to exist, and once is achieved, growth has to stop.

Besides, the concept of steady state economy is something very near to the idea of Ecological Footprint. In simple terms, when talking about businesses, it's clear that a project is judged to be viable when the revenues, and so the profits, are greater than the costs, otherwise we are loosing more than what we are actually creating and the idea is not a profitable one. It's also established that there is a limited amount of natural resources that can be exploited from Earth, as fish, trees, meat, soil and so on so forth. If we harvest resources faster than they are replenished, the population will diminish. Moreover the planet has also a limited capacity of absorbing CO_2 and other emissions, and if we exceed the limit, they will accumulate on the atmosphere. So in the case in which we overuse Earth's capacities we are running an ecological deficit, in some way is like as the costs are greater than the revenues. Our maximum budget, is given by "one Earth" so we should use an amount of resources equal or lower than "one Earth" in order to be sustainable (sustainable yield[5]). If the ecological footprint is greater than the budget, than the stock of bio-capacity will diminish over time, ecosystems will collapse, and at some point even the society will. These evaluations are mainly thought when talking about forestry or fisheries management but, in reality, they can be applied to any resource, even soil, water, animal population. Sweden is a country that takes particularly care about this logic, given the fact that most Swedish forests are harvested with a sustainable yield, and for this reason, since 1950s the forests have been increasing over time.

The bad news is that according to Global Footprint Network, humans have been living beyond their ecological means for about 40 years.

[5] "A sustainable yield can be maintained indefinetely because it can be supported by the regenerative capacities of the underlying natural system", Encyclopaedia Britannica

Figure 2: Global Ecological Footprint by component (1961-2010)

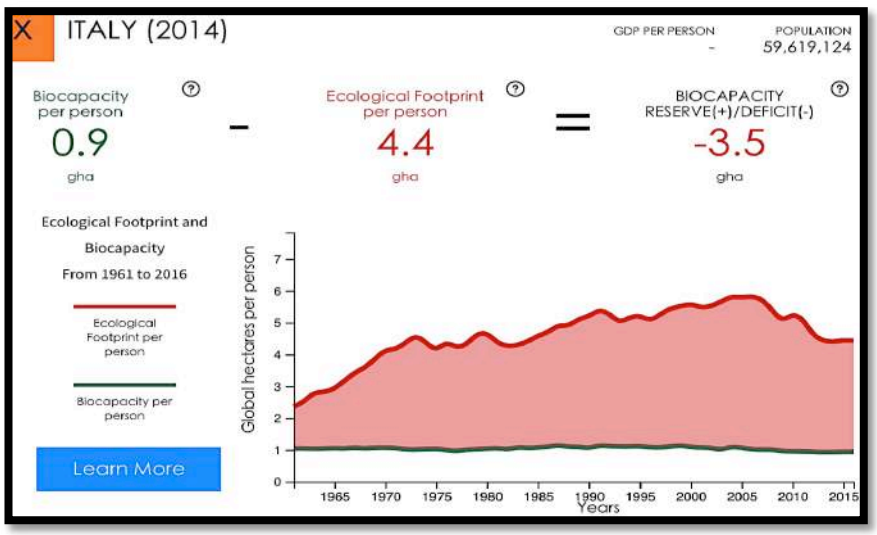


Source: Global Footprint Network, 2014,

According to this image, humans have started to use more than the resources at their disposal in the budget since 1970s. The black horizontal line is to represent one earth's ecological footprint, but as the figure is showing, we would need 1.5 earths in current condition to sustain ourselves indefinitely.

Either looking at Italy in particular, the situation is not comforting.

Figure 3: Italian Ecological Footprint (1961-2016)



Source: National Footprint Accounts 2019 edition (data year 2016); building on World development indicators, the World Bank 2019; U.N. Food and Agriculture Organization[6].

[6] Where the bio-capacity per person stands for the productive area that exist for each resident in that country, and person's ecological footprint is the biological productive areas required to provide everything they consume.

The risk is that not seeing immediate or short-term feedback generated by what we are doing right now, we cannot be able to understand that we are harming our own self-interest. Overusing natural resources provided by earth and overcoming such "tipping points" we would go through *overshoot and collapse*. Some direct effects can be noticed even now, such resource scarcity for example, but it's not enough, and the frightening thing is that no one knows when exactly we will reach the tipping point, but by the time we realize that the collapse is taking place, it probably will be too late.

1.1 Dangers and consequences

A huge body of scientific researches are indicating that Earth climate is rapidly modifying, human activities are changing the composition of the atmosphere and its properties. Over the past 30 years global temperatures have risen continuously and rapidly of about 0.2% per decade and current warming is above 0.8°C preindustrial levels, mainly thanks to combustion of fossil fuels, deforestation and other changes in land-use. All of the ten warmest years have occurred since 1990, and from this year on CO_2 emissions have grown of 60 %; if they would continue to increase at this rate, the chance of limiting global warming to 2°C will be reached in three decades. Consequences can be seen in physical and biological systems as seasons, flowering and egg laying periods, which have occurred 2/3 days earlier each decade in many temperate regions in Northern hemisphere[7]. Unless action is taken very urgently, it will become extremely costly to reduce emissions. With temperatures higher than 2°C above preindustrial levels, the risk of more severe impacts for human lives, will increase substantially and many effects will be locked in for decades if not centuries to come. *What can be the real dangerous consequences and damages caused by any/weak political action and so a higher warming?*

The scientific consensus is defined by a set of documents provided every year by the IPCC (Intergovernmental Panel on Climate Change), which are projecting outcomes through alternative representative concentration patterns (RCP), defining for each of them different trajectories of GHGs emissions over the next century.

RCP 2.6 : emission peak in 2020 and then decline through 2100.

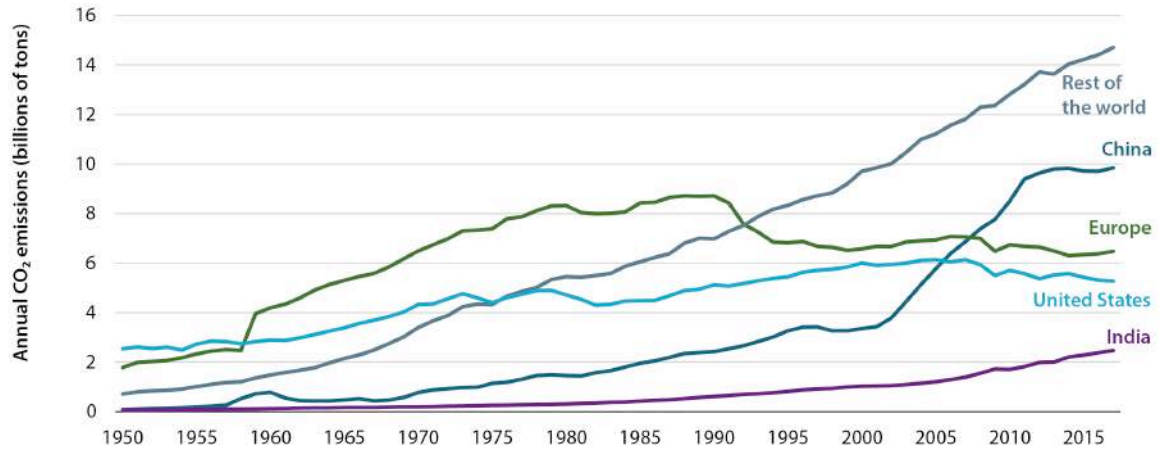
RCP 4.5 : emission peak between 2040 and 2050 and then decline through 2100

RCP 6.0 : emissions continue to rise until 2080 and then decline through 2100

[7] Parmesan and Yohe (2003) and Root et al. (2005) have correlated a shift in timing and distribution of 130 different plant and animal species with observed climate change.

RCP 8.5 : emission rise continually through 2100.

Figure 4: Annual CO2 Emissions by Geographic Region (1950-2017)



Source: Ritchie and Roser (2017), Stanford Institute for Economic Policy Research

Worst projected climate impacts may be avoided maintaining global warming below 1.5°C/2°C[8]. In this way €10 billion per year related to air pollution measures and from €16 to €46 billion of health costs can be saved in Europe. But this will require technological, economic, institutional, behavioural changes and a very strong leadership, and only with these policies RCP 2.6 or RCP 4.5 can be actuated.

In the absence of strong mitigation policies and re-evaluation of targets and emissions (RCP 6.0 and 8.5), is largely agreed that a 4°C warming above preindustrial levels, will be reached by the end of the century.

And over Europe and Central Asia is projected to be above the global mean: around 2.5°C with a 2°C world, and 8.5°C in a 4°C world.

The greenhouse effect is a natural process, which keeps Earth's temperature near 30°C warmer than it would be otherwise, in this way the planet has the capability to support life. The warming effect increases with a logarithmic function, meaning that doubling CO_2 concentrations would lead to an increase 1°C in surface temperature. As it will be discussed in the following chapter, climate change is much more sensitive than it was originally estimated, and moreover it can also accelerate itself due to reduction in natural absorption and release of carbon and methane. Different rainfall patterns and rising temperatures are expected to weaken the natural capability of Earth of absorbing carbon dioxide, leading to an accumulation of CO_2 in the atmosphere created by human activities. Over the past two centuries, 2000 $GtCO_2$ have been released in the atmosphere, and oceans, vegetation and soil have absorbed 60% of them, leaving "just" 800 $GtCO_2$ in the

[8] 450-550 ppm (parts per million) of CO_2 in the atmosphere.

environment. Reduction of tropical forests, as Amazon, in which from 2012 to 2013 deforestation has increased of 29%[9], and thawing of permafrost[10] in Russian Federation, which accounts for 20% of world's forest large permafrost cover regions, could lead to huge release of methane and CO_2 due to self-amplifying feedbacks, with subsequent decrease in Earth's natural carbon sinks. And even if initial higher level of carbon dioxide in the atmosphere can act as fertiliser for plants, increasing carbon absorbed by the land and forest growth, there's an increasing risk of pests, damaging insects and disturbances as fires[11], which lead to widespread tree mortality. Moreover after a century, or less, the effect of CO_2 will become negative, as there's a limit to plant growth, according to water disposal and nutrient, and because of respiration of soil[12]. Even the absorption capability of oceans, which tend to restore the balance with the atmosphere, will decrease significantly in further years due to a number of physical, biological and chemical changes. This could be a great damage considering that seas are estimated to have taken in 84% of the 60% of total heating over the last 40 years[13]. A greater absorption of CO_2 by oceans, will lead to an increased level of salinity, damaging molluscs and plankton, at the base of the food chain, to coral reefs bleaching with their consequent loss, to disruption of the nurse of many commercial fishes, to loss of marine biodiversity, and livelihoods from tourism and fishing. Moreover, reef-building corals are very important for coastal protection, beach formation, fisheries and tourism; reserving more than 10% of them will require to limit global warming to 1.5°C and in any case fishery practices, in many regions, are projected to markedly decrease in any case by 2050 due to migration of the species to cooler water. Observed rates of acidification are the higher of the last 300 millions years.

Talking about biodiversity in general, around 15%/40% of species face extinction with a 2°C warmer planet, as they are unable to adapt rapidly, and if the heat reaches 3°C from 20% to 50% of animals are supposed to disappear. Where 40% are insects, 26% are birds and 15% are mammals. Moreover, once a species disappear, it will be never replaced perfectly by another one, and the interrelation between different animals within the territory will be forever unbalanced,

[9] The Amazon forest capture huge quantities of CO2 and produces 20 billion tonnes of water vapor that partially falls in water basins where it is used to provide drinking water to brazilian population. If deforestation continues rainfalls in the region can decrease of 20% by the end of the century.

[10] Methane emissions have increased of 60% in Northern Siberia since the mid 1970s due to thaw permafrost in lakes. With a 2°C warming, methane emissions will expand of 20/30 percent in boreal Russia, biodiversity will change drastically and timber productivity will decrease. Russia has shown the greatest forest loss from 2000-2012.

[11] The 2003 European heatwave and drought lead to severe wildfires through Spain, Portugal and France, generating losses in agriculture and forestry of about $15 billion (Munich Re 2004)

[12] Friedlingstein et al. (2006) found that all eleven climate models that explicitly include carbon cycle feedbacks showed a weakening of carbon sinks.

[13] Barnett et al. (2005a) and Levitus *et al.* (2005).

given the fact that it is the result of years and years of evolution. Deforestation is a huge threat for animal and vegetal species, too. The cut down of forests to expand agricultural lands and to acquire timber, is reducing dramatically the native nests of many creatures, modifying their optimal environmental conditions and causing their extinction. Furthermore many indigenous people are losing their homes due to this problem and even natural sources for pharmaceutical ingredients[14] are disappearing.

Another important evidence that has to be considered is that even intensive livestock farming is causing quite important damages on the environment, as it's emitting itself 15% of total GHGs. In European Union the industry groups together 6,9 million employees, and the global value is reaching $740 billion. The fact is that among 80% of agricultural lands are used to cultivate resources exploited to feed cattle, but arable land to cultivate fodder is taken from unspoilt areas and forests. Moreover, there's a lot of waste in beef production. Cows and sheep need 1,02 m^2 each, more or less, to be raised, a lot of space. Just 1 ounce of beef requires 15.415 litres of water to be bred, while legumes and vegetables require respectively 4.055 litres and 322 litres per ounce. The 20% of the overall production is lost along the value chain during processes of transformation, in restaurants and butcheries. But the worrying thing is that in the latest fifty years, thanks to better economical condition and financial disposal, the consume of beef has increased dramatically: in the 60s in China average consume was lower than 5 kg per person per year, now is 60 kg per person. In Australia, U.S. and Argentina more than 100 kg of meat per person per year are consumed; on the other hand in Europe, where the average consume is 90 kg per person per year, in Italy is more or less equal to 79 kg per person per year, so we can say we are below the average. From 1960 to 2017 production has increased of 371%, while population, in the same period has grown of 149%. The point is that researches developed by the International Agency for Researches on Cancer, have confirmed red meat to be classified as potentially carcinogenic, and transformed meat (salted, seasoned or smoked) as surely carcinogenic. So it will be surely better for the planet, and our self, personal health to cut, at least to one time per week, the consume of red beef. A probable solution can be the one of increasing the consumption of legumes, as according to experts, to substitute red meat, we could increase of 20% legume's consume, which are occupying less land, consuming less water and resources (15% to 50% less).

Coasts and deltas, tropical regions, mountains, arid and semi-arid areas and the Arctic are all identified as particularly sensitive to climate change. The greatest changes in temperatures will be felt at higher latitudes, in the poles, nowadays 25°C colder than the tropics, where the melting

[14] 40%-50% of drugs in commerce have a natural origin.

effect of snow and ice is making poles becoming blue rather than white, avoiding the Albedo[15] effect, and this will lead to a lower level of reflectivity and so an among average warming. In fact for general warming of about 4°C, coastal zones warm by 3°C, mid-latitudes by 5°C and poles around 8°C. The Arctic is more important than what we think, is like the circulation system of the planet, feeding climate change everywhere, and it has lost 50% of its ice in the last 50 years. We have lost 95% of old ice, and in terms of sea ice volume from 1970 we have lost 75% of it. If it can be assumed to be a kind of insurance policy for the Earth, we are in trouble.

Figure 5: Changes in Columbia Glacier, Alaska USA (1984-2019)

Source: Google Earth images, Columbia Glacier in Alaska

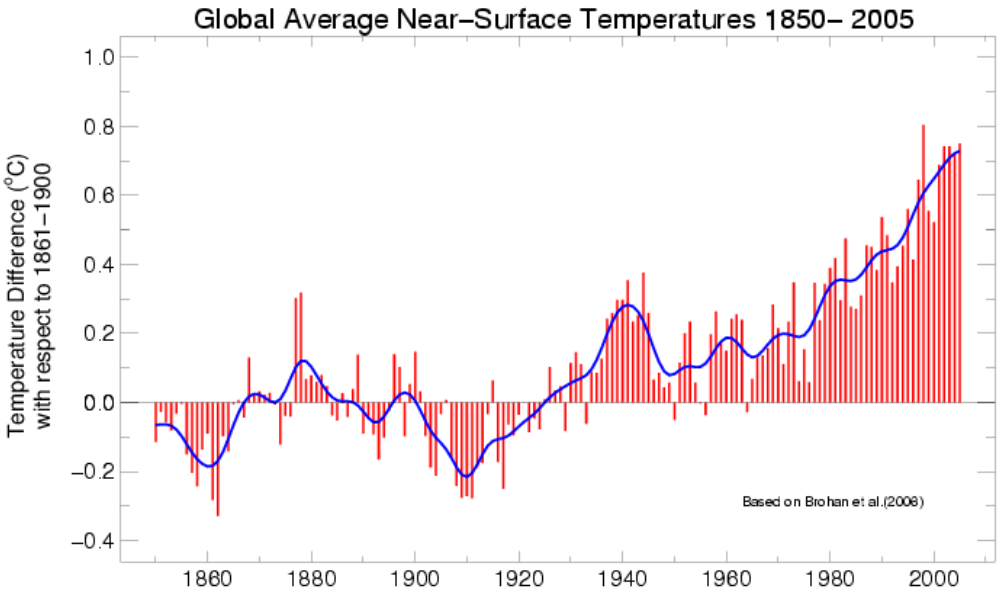
In August 1st 2019, in one day, we lost enough melt in the glacier to fill 4.4 million Olympic sized swimming pool. The problem is that if the Arctic melts, and evolve to something, which is completely different from what its today because of climate change, this would lead to unprecedented dangerous situation. If this is the case, global warming will accelerate by 25% to 40%. It affects jet stream, and so crazy weather will be perceived all through the middle latitudes, and the greater sea-level will feed storm surges, hurricanes and polar vortex coming down through Europe and North America, posing at risk especially small islands. Moreover sea level is rising according to this. If we arrive to a 2-degree warmer world, we will see some of the major cities around the world like Tokyo, Buenos Aires, London, Hong Kong, Venice and New York flooded, just think about Netherlands, where 70% of the population is threatened by an increase of 1m in sea level. If we stay at the 1.5 Paris aspirational target we will save the Arctic summer sea ice and prevent images like this. The Arctic is a barometer of global risk, and what happens there doesn't

[15] If something is white it bounces off sunlight back into the atmosphere, while if it is dark or blue it absorbs more and more heat.

stay there, and what's at stake is not only the geopolitical question or the short-term economic benefits from shipping and extraction, but is actually the future of the humanity itself.

In general, with an average increase in Earth's temperature, extreme heat days would be more frequent while colder days would be any time less, and this is already happening to the planet, but with a 4°C warming scenario, about 50% of global land surface will be covered on average by highly unusual extreme heat[16] and this number increase to 90% by the end of the century. Urban areas will become particularly sensible to heat distresses due to urban heat island and air pollution: office buildings can become difficult to work, requiring a lot of air conditioning, and soil drying will increase causing damages to properties.

Figure 6: Global Average Near-Surface Temperatures (1850-2005)



Source: Brohan et al. (2006)

According to these consequences, crop yields will fall[17]. Even if initially the effect of warming at high latitudes may have positive effects lengthening the growing seasons, further heat generate negative impacts: arable land will decrease, while intensity of pests will increase, damaging temperature thresholds are going to be reached easily. And given the fact that crops are feeding both humans and cattle, not only this will result in a lower affordability of vegetables and higher prices and volatilities, but also would cause livestock vulnerability and mortality, which have to suffer higher temperatures, scarce water and food, leading to beef, milk and poultry prices peak,

[16] In Europe 85% of land regions will be affected by highly unusual extreme heat events, and 55% of the zone by unprecedented heat events by 2100.

[17] With a 2°C warming, crop yields are expected to decrease from 20% to 50% for maize, wheat, grapes, olives and vegetables at mid-latitudes.

generating a multi-sectorial impact. These situations would be particularly dramatic for Europe, where most regions depend heavily on natural resources as gas, forests, glaciers and agriculture in general; but in any case agriculture currently accounts for 24% of world output and has 40% of employees in global population.

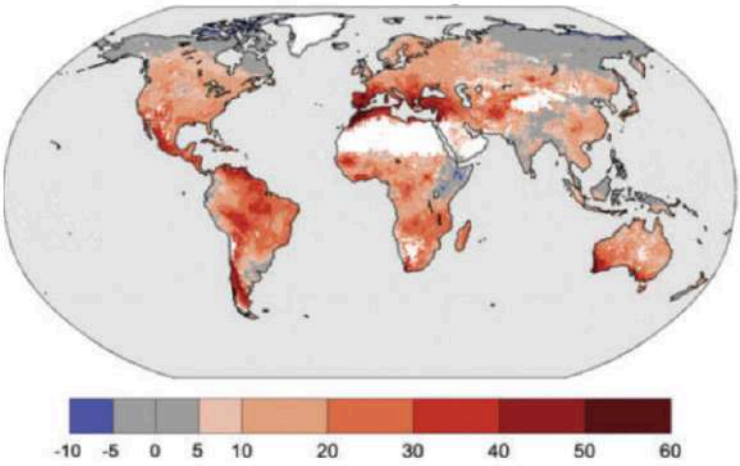
In Italy part of these diseases connected to tropical climate are already affecting the agriculture industry. According to a report provided by Coldiretti, alien species are flooding fields and cultivated hills, devastating the harvest. Asian stink bugs, coming from China, are threatening cultivation, laying more or less 300-400 eggs two times per year, increasing unproportionally. Xylella bacterium is devastating olive's plants in Puglia, where in 2017 three quarters of the fructification was lost because of illness in the harvest, declining 73% of oil production; and the problem is that it is expanding in the Northern area of the country. This problem has caused the government to 300 million euros to try to mitigate the problem and the cut of many trees with hundreds of years, settled in the territory since the dawn of memory. A killer mosquito (Drosophila Suzuuki) has attacked cherries, grapes and berries in many regions. Honey production is affected by Chinese hornets that kill bees, which are already threatened by a huge use of fertilisers and pesticides, by climate change and monocultures. And we should know that bees are not only important for honey production, they are responsible for the pollination of 80% of plants, wild flowers and vegetables around the world.

Climate changes and shift in temperatures and seasonality are multiplying the massacre of huge cultivation and species that are characterizing countries from the dawn of time. And the loss of essential species, as native pollinators for crops or soil organism, that maintain the fertility and the productivity of the land, can be hugely negative for the world in general and its economy. Pollination economic value has been estimated to be equal to $30-60 billion.

Furthermore there will be shifts in the rainfall patterns, partially because warmer air holds more moisture, and moreover new distributions of warm in the planet will lead to changes in large-scale weather regimes, highly unusual and unprecedented heat extremes will be more frequent and are going to impact larger areas. Ecosystems are projected to shift, droughts will characterize Southern places closer to the Equator and floods joined with heavy rains will happen in Northern areas. The Mediterranean area and North Africa will experience significant reductions in rainfalls (from 20% to 30%) and an increasing drying trend (Aridity Index changes up to -60% in a 2°C world, with trends strongly amplified in a 4°C situation in which more than 30% of lands would be classified

to be hyper-arid, arid or semi-arid)[18]. Water availability will become probably a threat in many southern regions, damaging agriculture, almost all industrial production, undermining water resources for human lives and energy generation through hydropower plants[19]. On the other hand precipitation will increase of about 30% at high latitudes, causing heavy precipitation, greater risks of floods for those regions that are not used to witness this high percentage of rain. Developed countries may be involved into climate-induced conflicts in areas that are hardest hit by the impact, facing political and social riots, which they are not used to manage.

Figure 7: The percentile change in the occurence of days under drought conditions by the end of 21st century in a 4°C world.

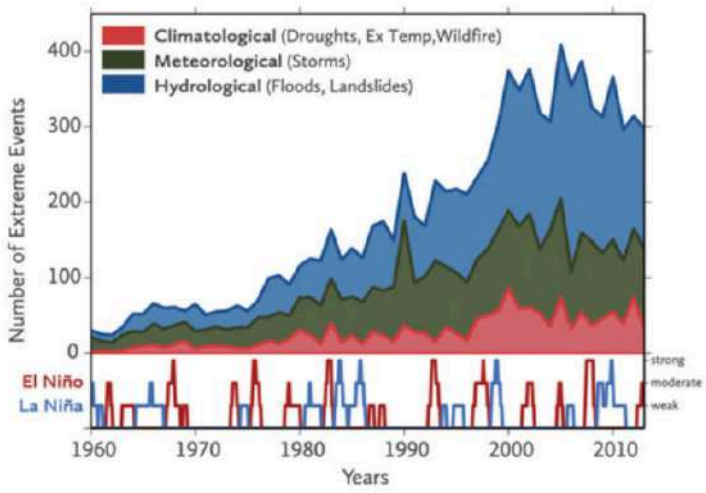


Source: Turn down the Heat, Fifth Assessment Report (AR5) by IPCC

Even El Niño[20] event could change its frequency, and with strong warming in the central Pacific can cause the Indian monsoon to switch from a "dry mode", with a significant reduction in rainfall leading to severe droughts in the West and abundant rains in central and eastern Pacific.

[18] According to a recent study in Hadley Centre, extreme droughts will increase from 3% to 30%, serious droughts may happen every 10 years rather than every 100 years.
[19] Almost 70% of fresh water is used to irrigate crops, 22% for manufacturing and energy and the 8% is used directly by households and businesses fro recreation, sanitization and drinking.
[20] El Niño: a periodic climate phenomenon, which cause a strong warm in oceans water bringing humidity, rain periods and moisture in some areas (Australia, Indonesia, etc.) and dry, cool temperatures in opponent places. Under normal climate conditions happens over 5 or 7 years.

Figure 8: The number of Extreme Events (1960-2016)



Source: Turn down the heat, Fifth Assessment report (AR5) by IPCC

Storms and typhoons, along with many other extreme weather events are thought to become more frequent in a warmer planet, with changes in location and overall quantity[21]. Moreover these events will tend to be more intense and energised, and this expected greater severity is already happening. Recent works have demonstrated that very intense typhoons in the Atlantic Basin have doubled since 1970 as a result from sea-surface temperatures. Another abrupt, large-scale effect connected to climate change could be the possible collapse of the North Atlantic ThermoHaline Circulation (THC), as North Atlantic, Gulf Stream and North Atlantic drift have significant warming effect on climate in Europe and North America, a sustained weakening of THC would cause cooling effect on both regions.

Sea levels will respond more slowly, they are currently rising globally at around 3 mm per year, but they are expected to accelerate the rate of growth, expanding to 9-88 cm until 2100, mainly thanks to melted glaciers and poles and warmer oceans expansion. And this expansion can be dramatically higher if West Antarctic and Greenland are expected to melt, rising levels near to 5-12 m over centuries, putting at threat $2 trillion of world GDP and 5% of world's population. Low-lying coastal regions are particularly densely populated and are expected to experience even further increases in population. In addition, there are a lot of infrastructures concentrated along them as oil refineries, ports, industrial facilities and nuclear stations; the assets of activities in these areas worth $1 trillion. In the same way infrastructure will be damaged even by the severe weather conditions brought by climate change: as the temperature increase, storms are supposed to

[21] Lambert and Fyfe (2006) and Fyfe (2003)

increase exponentially and damage costs are a cubic function of wind speed[22]. Flooding and associated storms are already representing the costliest natural disaster; annual flood disasters costs in Europe are expected to rise from $10 billion today, to $120-150 billion by the end of the century. Alone extreme events costs can represent 0,5%-1% of global GDP by the middle of the century.

With higher temperatures not only the poles are expected to thaw, but even glaciers in the Andes and Central Asia, which are source of water and fertility for population living in those places. Increasing glacial melt poses at risk of flooding these regions and reduced water resources during crop growing seasons will affect strongly the inhabitants of these territories. Since 1960s Central Asia's glaciers have reduced of 3-14% according to the area, and further substantial losses of 50% are expected in a 2°C warmer world. As a result, rivers are expected to shrink, as melted snow from glaciers feed 7 Asian largest rivers, including the 70% of Ganges, which provides water to about 500 million people. In China 23% of Western population (250 million people) depend on glaciers melt-water, and there will be any time less of it available for energy generation in summer season. In South America, the area covered by glaciers has been reduced of one quarter in the past 30 years; many large cities, such as La Paz, Quito, Lima and 40% of agriculture in Andean valleys rely on glaciers water supply. In every projection glaciers in Europe, South America and Central Asia are expected to lose more than a half of their volume, leading to increased run-off of water and significant shortage. And a temperature rise higher than 1.1°C will cause small glaciers like Alps and Marmolada in Italy to melt completely within decades, causing problems of water availability for nearby population[23], and reducing tourisms connected to mountain sports and relative income. There will be a northward shift in economic activities and population, as southern regions will loose competitiveness in agriculture, forestry, there will be rising costs in electricity and scarce water availability.

Other consequences that can be felt during time due to climate change may be related to shocks and stresses, which can undermine poverty reduction and push new groups into poverty. Some individuals or communities don't have the capability to cope with and adapt to external stresses, and this will generate displacement and mass migration, as people are leaving flooded coastlines, drought farms in where they perceive even food insecurity, destroyed crops and areas of extreme natural disasters, to move towards cooler mountains. Disadvantageous groups may remain trapped in adversely risk areas, for the luck of funds or social connection. Since 2008 extreme weather has

[22] Nordhaus (2006) founds that economic damages for hurricanes rise as the ninth power of maximum wind-speed.
[23] As snow-melt fed river basins are very sensitive to climate change, and the Mediterranean region highly depends on mountains headwater.

displaced 22.5 million people and World Bank estimates that climate change can lead to movement of 1.4 million people from South to North America by 2050. This can be a threat to human security, family relations, and health.

The increased incidence and intensity of extreme heat events will probably lead to the appearance of new vector diseases such as dengue fever, tick-borne encephalitis, malaria, as people who lack immunity would be affected. Climate change can expand areas affected by water-borne and food-borne infectious diseases, respiratory and cardiovascular diseases, felt globally as a result of air pollution and heat, reduction in availability of clean water and sanitization[24], illness related to extreme heats or extreme events deaths, and mental illness. Floods can lead to drinking water contamination, salmonellosis, cholera, typhoid, infectious fungal spores[25] and dysentery. These consequences can be particularly dangerous for elderly people and children, highly subjected even to malnutrition with extreme climate conditions. And this lost in the development opportunities in childhood may have lifetime consequences. The World Health Organisation (WHO) evaluated climate change to cause 150.000 deaths each year due to health diseases, which are supposed to increase to 300.000 with just an increase of 1°C in world's temperature.

Some of the most significant impacts will be in the equatorial zone as high temperatures become more and more dangerous as the temperature rise further. Currently 800 million people are at risk of hunger, but if temperature is supposed to increase, they will increase of 30-200 million. In places like Ghana are predicted 160 deaths every 100,000 people. On the other side, in colder regions as Norway, Canada, there will be a decrease in hazardous cold days, 230 deaths fewer per 100,000 residents, as very tight cold temperatures of these areas, will slightly increase. But the whole effect for the world is negative, as 85 people every 100,000 are supposed to die due to higher temperature diseases.

Besides even the energy systems are threatened by disastrous impacts related to climate change. In Europe many countries could face a 6% to 19% decrease in nuclear and fossil-fuelled power plants from 2031-2060 compared with 1971-2000, and increased water and air temperature would cause increased electricity prices, too. Regarding hydropower, which, jointly with thermal sources, is

[24] If temperatures are expected to rise to 2°C, 1-4 billion people will experience water shortage, especially in Africa, Middle East and Southern Europe, Central and South America.

[25] The toxic moulds left in New Orleans after Hurricane Katrina continue to create health problems to inhabitants of the region, (the so-called "Katrina cough").

composing the 20%/40% of European electricity, is expected to decrease in Southern Europe of 1.43% compared to 2005 levels[26].

1.2 The cost of climate change

In order to analyse the problematic from an economical and financial oversight, in this sub-chapter there will be an analysis of the major costs to be considered when we are talking about climate change, to have an idea of the extreme consequences which can be perceived even from a monetary point of view.

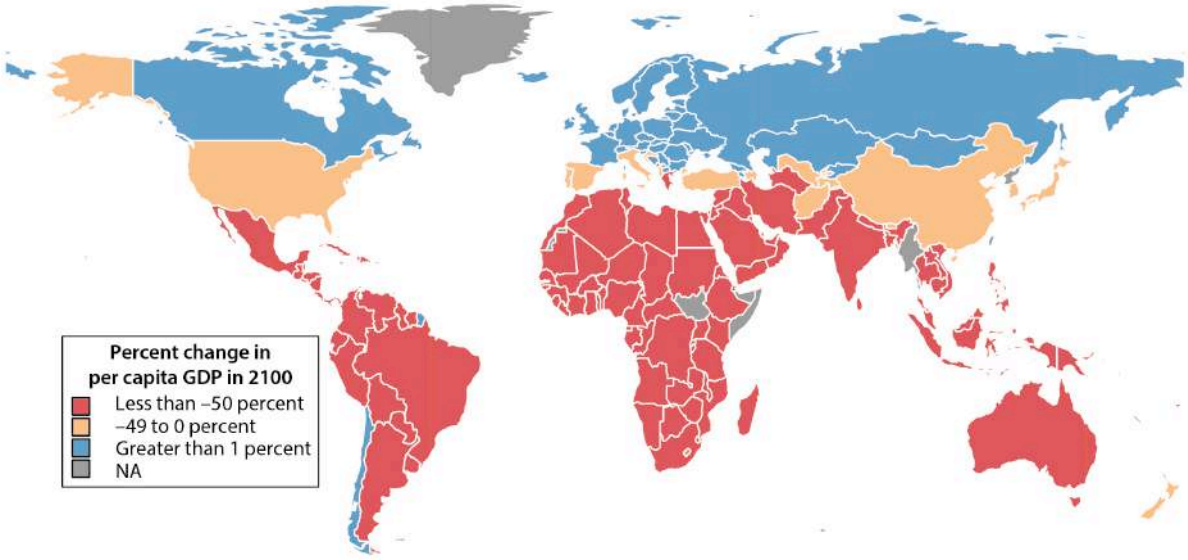
GHG emissions are intrinsic to fossil fuels combustion, but at the very same time they are fundamental to food production and world's energy system, in fact CO_2 represent one of the cheapest way to produce energy. Every farm, company, household emits Green House Gases emissions, which are representing the mother of all externalities[27]: the more uncertain, complex and the larger one, just think about the fact that some of them can remain in the atmosphere for tens of thousands of years. And if you are polluting in the U.S., it contributes to warming in China, and viceversa, so they spread all over the world. Weather affects everything and everyone: energy use, health, agriculture, every aspect of nature, especially in low-income countries, which are the ones contributing less to it[28].

[26] Study by Hamududu and Killingveit (2012)

[27] Externalities (negative): refers to a situation when the effect of production or consumption of goods and services imposes costs on people or entities not involved in the transaction, and these costs are not reflected at all in the prices charged for goods or services, either the external actors are compensated for the negative effects that they borne. The private cost, which includes at least the price, and maybe some other inconveniences, is lower than the social cost, given by the private cost plus the negative externalities.

[28] Cumulatively talking, as China today is emitting more CO_2 than Europe and U.S.. If we consider the amount of GHGs emitted in the atmosphere during years, the greatest percentage was produced by Europe firstly and then U.S., while countries as Latin America, South Asia and Africa, in the past, had almost a null impact on the world, and now are suffering more than others.

Figure 9: Climate Change Effect on per capita GDP in 2100 by country



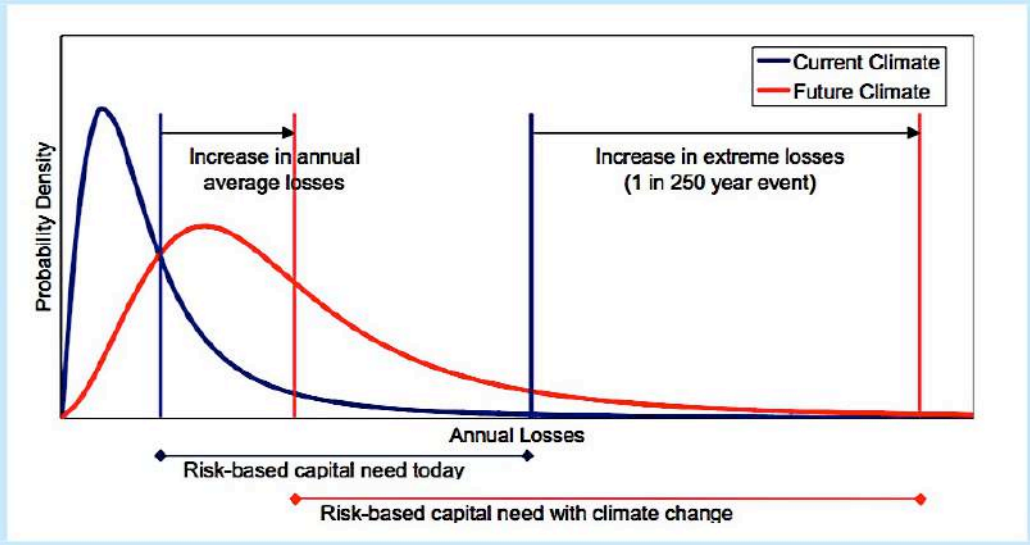
Source: Burke, Hsiang and Miguel (2015), Stanford Institute for Economic Policy Research

If all emissions were priced in January 2009 at € 15 t/CO_2[29], carbon dioxide would have worth 1.5% of world income.

Since 1980, extreme weather has cost $1.6 trillion. Munich Re, one of the world's most important reinsurance enterprises, attributed to climate change the losses of $24 billion for California wildfires[30]. Climate is likely to have severe impacts on more than one sector simultaneously, and the shock may exceed the capacity of the markets, destabilising regions. It can cause the disruption of securities, can change the volumes and prices of goods traded between developed and developing countries. Just to mention one of many problems to be considered, if this is the case, insurances would become too expensive for most people, as they will have to raise the premiums to cover rising costs. But the increase won't be perceived only in the premiums, but even in the amount of capital that insurances need to hold. Will be developed new financial product to gain more access to international capital market and diversify the risks, and possible failures to raise sufficient capital would mean restrictions in insurance coverage, and many insurers may decide to transfer more risks back to the home-owners or businesses. Today the insurance industry holds around $120 billion to cover extreme losses from natural events, but climate change is likely to shift the distribution towards higher values for the losses, in fact if storm intensity increases by 6% as it has been predicted, this could increase insurers' capital requirements by over 90%.

[29] 15€ per tonne of CO_2, applied in the Emissions Trading System of the European Union.
[30] A. Nelsen, *"Climate Change can make insurance too expensive for most people"*, 21st March 2019.

Figure 10: The increase in annual average losses and risk-based capital need with climate change



Source: Association of British insurers 2005

According to estimates, if temperatures are supposed to increase of 2°C, global GDP will drop of 1% in the years, if temperatures rose to 3°C, it will be perceived an expected fall of 1.5% in the GDP every year, and if no action is taken to mitigate pollution and CO_2 emissions, and temperature will raise to 4°C or more, we will loose 3% or more of world's GDP every year from 2010 levels, with a minimum of 5% decrease in consumption. And if we take into account even the non market impacts, as the possible feedback loops in the environment, the cost can reach a 20% cut in per capita consumption, now and forever. Climate change will cause problems to trade, financial markets, through disruption of communications and volatile prices of capital. Environmental Capital is one of the factor generating the final output, if net climate change effects are negative, environmental capital will decrease, and with the same contribution of labour and capital the overall result is going to decrease. Moreover, talking about job positions, those industries, which are threatened mostly by the climate change's risks, are agriculture, forestry and fisheries, and according to this 1.2 billion jobs are supposed to be threatened[31], focusing on fisheries, for example, a 2019 study found that oceans acidification and warming will lead to the extinction of many species, pushing global fish yields down of 4% since 1920, threatening 56 million people employed, and affecting survival of 3 billion people who rely on fish as primary resource. On the other hand 24 million new jobs can be experienced by 2030 if some efforts to stop climate change would be implemented, not considering benefits related to health and environment due to reduction of air pollutants, traffic, biodiversity gain or poverty reduction.

[31] World Employment and Social Outlook 2018

The current size of renewable energies market worth $38 billion, providing employment opportunities to 1.7 million people, the growth in the sector was 25% in 2005, so is rapidly expanding and growing due to current policies, and will continue to grow[32].

The main problem to be considered when talking about the cost of climate change, is connected to the fact that often it has been underestimated by economists and researchers, especially for those scenarios in which temperatures touches levels greater than 1.5°C/2°C above preindustrial levels. We are entering in uncharted situations, where the magnitude and the severity of climate change events are highly uncertain and so, difficult to be captured in climate change models. When scientists are not able to estimate some parameters because of the lack of good data, as for example, the exact temperature at which tipping points are occurring, they simply exclude these scenarios (melting permafrost, accelerated ice sheet collapse, etc.)[33], in order to not assign a value out of fear that they would be "making it up". Furthermore most of the models suffer from the assumption of perpetual and continued economic growth, which as we have said previously would be unsustainable.

The estimations are mainly developed to incorporate damages and impacts of climate change into models through a so called *damage function* in order to assess the impact of climate change on human welfare, and one of the most recognized and honoured is DICE (Dynamic Integrated Climate Economy model) developed by William Nordhaus. Is pretty much important to try to figure out what can be the costs related to changes in climate and environment, even if it has proved to be extremely difficult, in the interest of taking informed decisions about the proper balance between costly emission reduction and climate damages. The 2013 damage function is highly simplified compared to previous ones: it uses estimates of monetized damages coming from climate change events taken from Tol (2009) survey[34] adding an adjustment of 25% to account for non-monetized estimates that have not being considered. The results from these evaluations are showing that if we double the concentration of carbon dioxide within the atmosphere, the Gross Domestic Product will decrease just of few point percentage (about -1.5% on average), but this

[32] IEA's Energy Technology Perspective Report estimates that in 2050 cumulative investments in renewable energies to low down emissions, will be equal to over $13 trillion. And Shell Springboard suggests the market can worth $2 trillion by that year, creating new opportunities for start-up, SME and multinationals. Clean technology investments are becoming mainstream.

[33] Example: The melting of Himalayan glaciers and snow will both generate floods and profoundly affect water supply of communities in which hundreds of millions people live, and this is absent from most assessment models.

[34] Tol (2009) survey: Considers impacts on agriculture and fisheries, water resources, coastal zones, air quality, human health and energy consumption. But omits several important factors (loss of biodiversity, loss of cultural heritage, human lives, ocean acidification, political reactions, mass migration), extreme events (sea-level rise, accelerated climate change as West Antarctic Ice sheet, changes in ocean circulation like Gulf Stream and catastrophic events due to long term warming).

reduction in the welfare will be permanent and is not negligible. Moreover, as announced before, even if GHGs are produced by all countries, especially by richer ones in past preindustrial revolution, these negative effects are perceived everywhere and are greater for low-income countries, as they have less resources to fight against these conditions, they are closer to the equator, so they tend to be already hotter than other countries, and they are mainly supported by industries like agriculture, fisheries, pastoralism and forestry which will be the most affected ones. Poor people's adaptive capacity is often undermined by lower education level, limited alternative options and discriminatory social norms that affect access to labour market. And either climate change will be equal to all regions (like coastal zones) or age groups (elderly people are more at risk due to reduced mobility and strength), and minority groups (migrant, ethnic group), as they can have limited assets, discriminatory social norms and lack of voice. How different groups experience climate change depends on their capability do adapt, access to the resource, income, cultural knowledge. Even different gender will be affected in different ways, rural women's access to land, property rights and financial resources is often restricted compared to men, moreover in some context social norms prevent girls from learning important survival skills[35].

In any case, one of the main concern about damage function, is that it is calibrated for raise in the temperature which stands between 0°C and 3°C, outside this interval the results are biases and inconsistent, but it's important to know that even if we cut today all the emissions of CO_2, emissions will be felt over a long period of time, and due to past emissions, temperature will continue to increase by 0.5°C/1°C. Besides, damages are assumed to not exceed 100% of output; and these are strong justification considering the fact that if we continue to act in this way, not managing the emissions, levels of pollution and waste, temperature will increase of 4°C/5°C. Scientists are growing in confidence that the largest potential impacts and major probability of major threshold in Earth's climate system will happen with temperatures exceeding 2°C above pre-industrial levels: destabilization of ice sheet and glaciers with consequent sea level rise, switch of Amazon from a rainforest into a savannah, stronger tropical cyclones, extreme heat impacts, more intense and frequent floods and droughts, disruption of oceanic and atmospheric circulation, extra GHG burden from thawing Arctic permafrost and finally destruction of biodiversity and collapse of ecosystems.

[35] According to a Climate Risk Assessment (CRA) study conducted by Camp Alatoo in the Kyrgyz Republic in 2013, the country's female population is likely to experience higher climate change risks and vulnerabilities in several situations.

The problem is that many of this impact may be impossible to sustain for humans, which are not able to adapt to these catastrophes, causing the death of millions if not billions of people around the world. If economic assessments are done only looking at output generated by past experience (as the GDP), a lot of variables will be missed, as the effect of mass migration, displacement and conflict, and the risks will not be considered properly. When we base our decisions on experience, this is called *stationarity* but when conditions change so much that experience is no longer reliable, stationarity is lost and forecasts become more and more uncertain, it's impossible to estimate something that has no precedent. Another terrifying, not considered obstacle is the cascade effect, as disasters will not come in isolation, but they will reinforce one another in damaging ways, in some cases they may produce a sequence of serious, sometimes irreversible, problems[36].

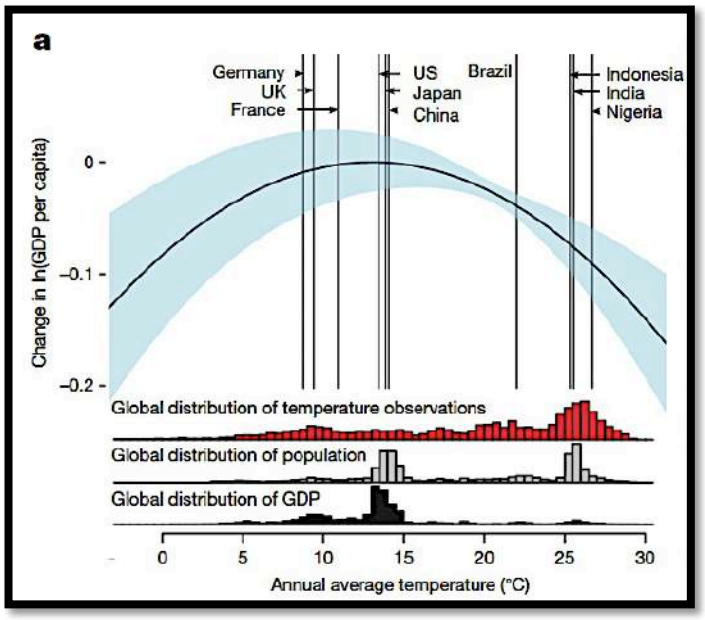
So we can clearly understand, that even if models and formulas are trying to provide us consistent and robust results on which to rely on, sometimes these evaluations cannot be performed in a solid and unbiased way, and for this reason we have to analyse the problem from a qualitative and logical point of view[37].

By the way, at the beginning of this chapter, has been mentioned economic growth and the mismatch between sustainability and a perpetual growth in the economy. In order to reinforce this concept, not only is true that a continuous growth will never be sustainable for our planet because of the on going exploitation of finite resources, but moreover climate change will hamper growth, which will no longer be reliable. A 2015 study by Marshall Burke, Solomon M. Shiang and Edward Miguel at Stanford University and Berkeley University found evidence of a kind of optimal temperature near to an average of 13°C for economic activities, like the one experienced in China, much Europe and Japan. The more temperatures tend to warm over this spot, the more the economy productivity weakens, in fact, near the equator, there are poorer countries where temperatures are sub-optimal due to hot climates. The figure below shows the global relationship between annual average temperature and change in logarithmic gross domestic product (GDP) per capita during 1960–2010 with 90% confidence interval, broken down by poor and rich countries.

[36] Example: Increase heats leads to decrease in food production, which can move to widespread malnutrition and the very same time decrease industrial productivity bringing to economic depressions.

[37] In 2013 Stanford's Jonathan Koomey has suggested that instead of relying on economic cost-benefits analysis, should be shaped as a "working forward toward a goal" as Paris agreement on climate change, where economics will be used to estimate most cost-efficiency policies to meet the targets.

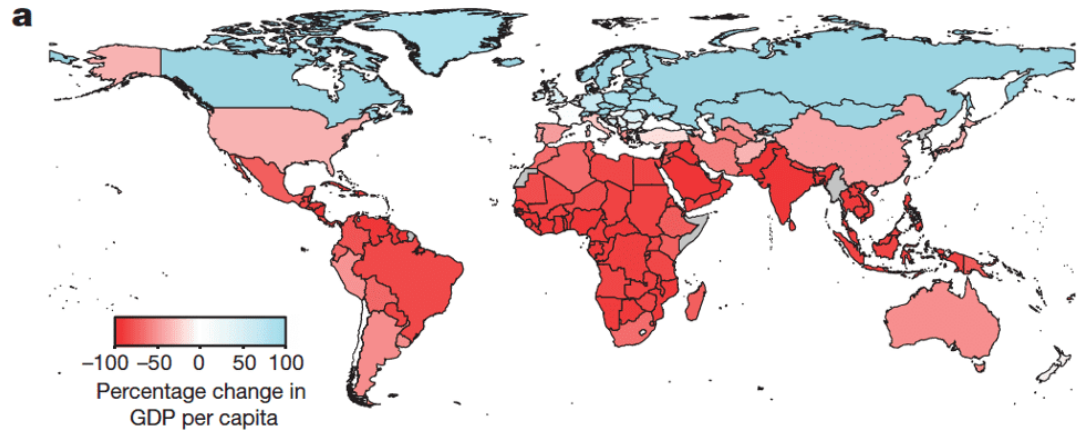
Figure 11: Global distribution of temperatures, population and GDP



Source: Burke et al. (2015), Nature

Normally economists and researches tend to judge low-income countries to be more at risk than high-income ones, which are not going to perceive the impact of global warming that much. However, in this latest research the author have looked at data of the past half century and found that wealthy countries have been as vulnerable as poorer ones to temperatures beyond 13°C. Moreover, there's no evidence that experience with high temperature or technological advances have altered the global response to temperature, which means that the accumulation of technologies, wealth and experience probably will not mitigate global losses. If we continue with this business-as-usual without cutting global warming, 77% of countries will be poorer in 2100 than they would have been if they have taken action towards climate change. Some other nations (from 5% to 43%) may be even poorer in the future than they are today. And even if some countries like Russia and Canada will perceive economic benefits from global warming as they are getting warmer, most of their economic partners will not, because of a slowed growth in the economy. Increasingly negative consequences are expected to be perceived, and those modest, initial benefits will be outweighed by costs as temperature rise. Even those who see climate change as a minor problem agree that with temperature higher than 1.1°C above preindustrial levels damages will exceed benefits, and we are already facing record temperatures above 1°C.

Figure 12: Percentage change in GDP per capita in a 4°C world.



Source: Burke et al. (2015), Nature

In order to find out a proper way to consider and evaluate costs and disadvantages caused by CO_2 emissions was developed in the recent years the idea of Social Cost of Carbon. The concept is based on the definition of externality, already mentioned in the previous pages. Every person is a rational decision maker, it decides whether to purchase or not an item according to costs and benefits that this object/service is providing to itself, no one cares about costs and benefits bared by others. But given the fact that, talking about negative externalities, you are not paying the social costs for a specific good, but only the private cost which is lower, the good, and its related negative externalities, will be overproduced at levels greater than the social optimum, generating a market failure. If, instead, the external costs are in some way internalized by the company, the good will be more expensive, and it will sell less. So if the external costs are globed and fully integrated in the cost of the product, then no externality is occurring. How this is connected with climate change? Pollution is a clear example of negative externality[38]; the costs of emitting carbon dioxide are bared by the society, while those companies responsible for their production perceive all the benefits. We can say that the SCC is defined as the net present value of the incremental damage due to a small increase in carbon dioxide emissions, trying to add up all quantifiable benefits and costs of emitting an additional tonne of CO_2[39], it's a measure used to internalize negative effects within the companies that are producing them. Since CO_2 is emitted today and the negative consequences are going to be felt in the future, SCC incorporate future costs which have to be discounted into today's money. Many countries are using this tool to have an idea of the real

[38] Pollution as negative externality example: a steel company may dump a lot of chemicals in a near lake killing all the fishes and plants close to the area, affecting lives of fishermen and farmers.
[39] Specifically scientists concentrate on Equilibrium Climate Sensitivity, ECS, so how temperature will raise if we double carbon dioxide emissions.

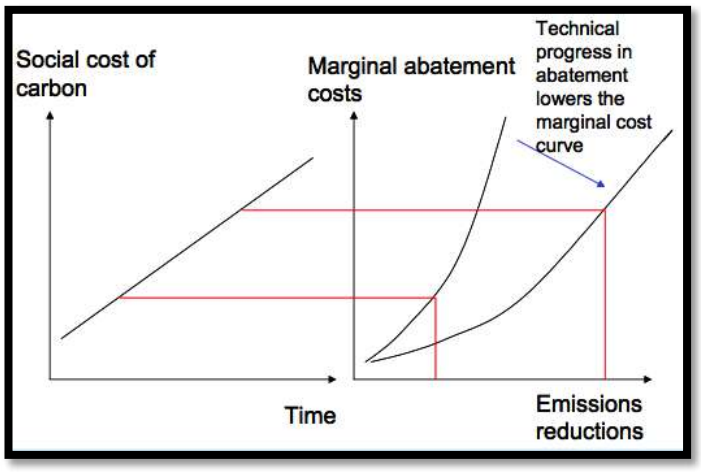
and official cost of pollution to evaluate costs and benefits of an investment decision or a policy: if the SCC is high, than costly climate action will be justified and there will be great benefits from the cut of CO_2 emissions, if vice versa regulation may be more trouble than they are worth. To compute these figures are mainly used three models: DICE (which have been already mentioned), FUND, developed by Richard Tol, and PAGE, estimated by Cambridge University; all of them have four main areas on which to concentrate: socioeconomic projections (ex: how much will population grow by 2100?), climate module (ex: responses in climate according to CO_2 emissions), damage and benefits and a discount rate, as emissions cut costs now, while effects of climate change will be felt over hundreds of years. Each of the four element is uncertain, we don't know exactly how things are supposed to go, given that we don't have any experience about, as said before. Moreover, even in this case, models are just considering quantifiable impacts, to which we can give immediately a monetary value, so some important elements, as biodiversity losses, mass migration, civil conflict and so on, are not taken into account[40].

The models are supposed to calculate how much GDP is reduced by climate impacts, but not considering changes in the GDP rate of growth, causing a tendency to underestimate the effect of climate change. Another essential thing to say is that effects due to temperature changes are not linear, as the consequences are less severe for a change between 0.5°C/1°C rather than for 1.5°C/2°C, so the SCC will be lower if emissions are slightly controlled, that's why the sooner the action is taking place, the better it is, as the more we will wait the more temperatures will increase and the heaviest should be the policies. Furthermore the more efficient are emission-abatement policies and the more developed the technologies, the lower is SCC, even if, in any case, it will increase over time due to rising concentration of emissions in the atmosphere. Efforts to abate emissions have to keep pace with the Social Cost of Carbon[41].

[40] Some argue that until Integrated Assessment Models won't be able to better represent the full range of known climate impacts, they grossly underestimate the risks.

[41] If marginal abatement costs fall, the economy can be fully decarbonised.

Figure 13: Graphical representation of Social Cost of Carbon trend and abatement Costs trend



Fonte 1 Source: N. Stern, Stern Review Report on the Economics of Climate Change

The Intergovernmental Panel on Climate Change, in its latest report, put a value for ECS near to 1.5°C-4.5°C[42], but before talking about estimation about the Social Cost of Carbon related to these temperatures, it's important to specify some essential points.

First of all, the choice of the discounting rate to be used, is crucial.

The traditional assumption is that money today worth more than the very same amount tomorrow, so saved money are accruing interests. This easy assumption can go wrong if consequences of climate change are going to affect future results; in fact if consumption falls along the path, the interest rate can be negative, if inequality rises over time, the discounting rate decrease and the very same if uncertainty increase.

The choice of the discount rate highly affects the SCC. For example, if we think, with an ethical perspective, about future generations to be as important as we are or more, discounting rates should be close to zero. That's why Stern in its review uses a discount rate of 1.4% while U.S. government normally tend to use both rates equal to 3% and 5%, as the higher the rate, the more current generation are assumed to worth more than the future ones. In general we should consider using lower discount rate when we look at time horizons that cross generation, and economists are ok with a rate that stands between 1% and 3% on average.

Given the fact that the SCC can be highly uncertain, an alternative concept used to take action against climate change, is to set a temperature limit first, defining scientific and economic evidence around it along with political and ethical considerations. Then working backwards, it's possible to

[42] Pay attention that if emissions stay as high as they are, we are going to more than triple preindustrial concentration by 2100.

organize a path in line with these warming limits, and so the carbon price consistent with that scheme. This strategy can be useful, as it makes clear what are the objectives to reach and avoids many uncertainties connected to computation of Social Cost of Carbon. Normally this approach is used in Europe, for countries like UK, Germany, France, while in the U.S. and Canada is more diffused the concept of SCC. Another useful practice, from a microeconomic point of view, can be the one of including in balance sheets and income statements of companies revenues and expenses coming from externalities and in the very same way even receivables and payables (as for example Puma is doing). The advantages are connected to the fact that we are able to understand how the company is performing from a social and environmental point of view over a given period of time; some disadvantages may be connected to not being able of evaluating these figures reliably, and to the level of complexity of the financial statements that will tend to increase, making them incomprehensible.

In 2009 Barack Obama ordered to drawn up the first uniform U.S. Social Cost of Carbon, so the Interagency Working Group (IWG) each year takes 150,000 estimates for three different discounting rates (2.5%, 3% and 5%), these are based on 10,000 runs of each of the three model any time changing randomly climate sensitivity. To any model is given equal weight, it's a kind of Monte Carlo simulation, and finally they look at average result. In 2017 the SCC in U.S. was equal to \$39 t/CO_2[43]. In U.S. is currently a factor used for 69 final rules and 80 proposed ones, according to a recent paper[44], regulations as energy plans or fuel-economy standards, implied with SCC, are demonstrating to produce more than \$1 tonne of benefits. Unfortunately to the present day, we don't have idea about how the situation will evolve, as Trump has clearly declared he will end up using Social Cost of Carbon in federal rulemakings. As we can understand, there are many opponents to the SCC, some of them are concerned about the fact that it involves global costs of CO_2, rather than just the national ones. The U.S. national court said: *"Global effects are an appropriate consideration when looking at a national policy. It's worth asking what would happen if the U.S. were to ignore global effects. If other countries were to follow suit, then a large proportion of global climate impacts would be ignored, falling between the cracks".*

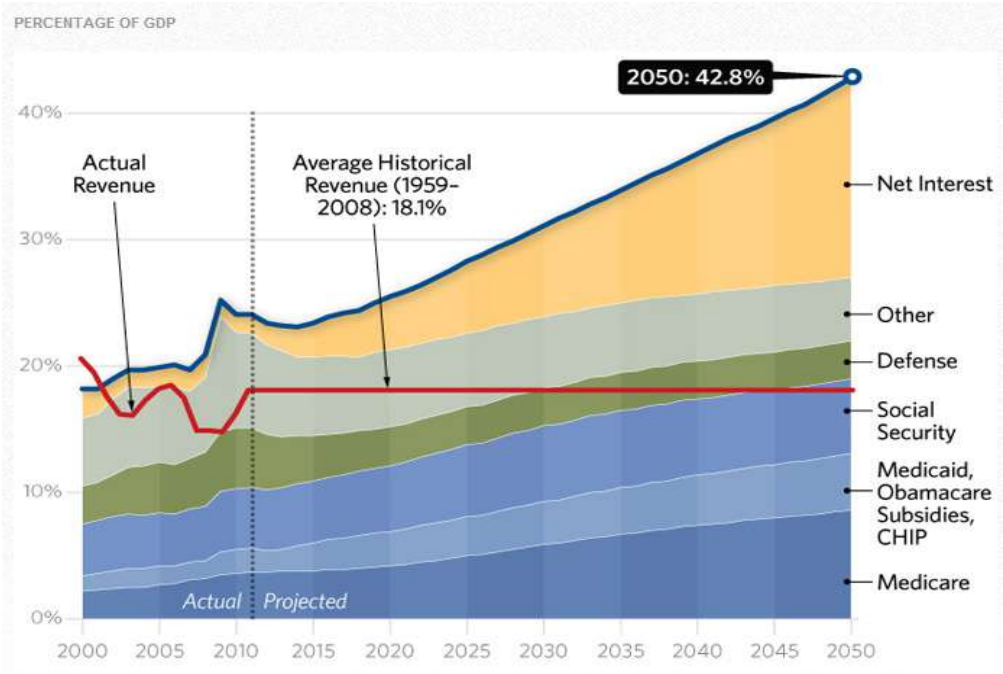
Others are saying that the discount rate is too low, and that current estimations are prioritising future generations, and say an appropriate rate can be 7%. The fact is that, only a 0% discount rate can be justifiable, according to many economists, in order to value future generations as important

[43] A study published by F. Moore and D. Diaz, concluded that the SCC in reality is much more higher than the one used by the government: between \$70 t/CO_2 and \$400 t/CO_2. Moreover given that studies of M. Burke find that continuous global warming will hurt both poor and rich countries, the SCC according to him will be even higher.

[44] W. Nordhaus, *"Revisiting the Social Cost of Carbon",* 21st November 2016, Department of Economics, Yale University

as we are. Using higher discounting rate means that those money have to be used today to be invested elsewhere and generate value for future generations, but clearly the beneficiaries won't be those who effectively need them.

Figure 14: Expenses in GDP trend (2000-2050) per sector



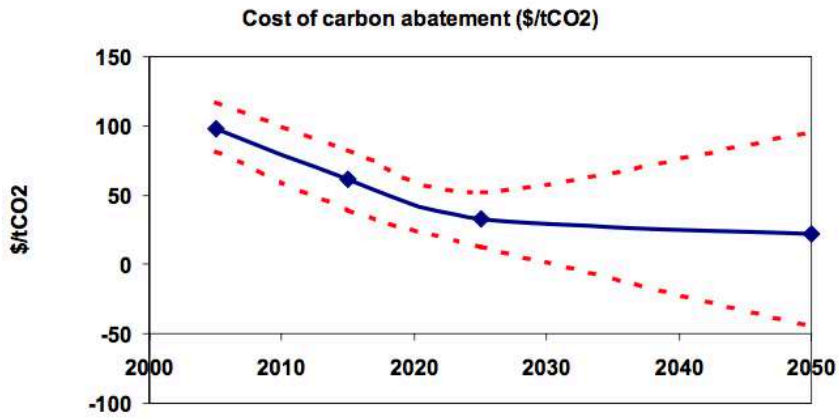
Source: "On energy subsidies and externalities", S. Cloete

As the figure above is showing, the primary problem of climate change is its long-term nature. While short-term externalities can be experienced directly by citizens, who can immediately judge if they are positive or negative and take action towards them, with long-term externalities the world would easily pass the buck to future generation, as they cannot be able to figure out and straight perceive the consequences of what they are doing. That's the reason why is important to take strongly future generations into account.

Someone else has argued that these models are not taking into account the benefits of an increased CO_2, or that the models overestimate the impact of global warming, saying that it's cheaper to adapt rather than avoid climate change. In the IPCC report is clearly stated that an additional increase to 2°C above preindustrial levels will cost from 0.2% to 2% of global GDP, and these losses accelerate with warmer temperature near 3°C. Mitigation policies are expected to reduce growth rates in the economy just of 0.6%, which means that we are moving from a 2.3% to 2.24%, which will be clearly more than offset by the savings from avoiding climate damages above 3°C global warming. Similarly in Stern Review of 2007, he has declared that risks of climate

change can cost between 5% and 20% of GDP, while in contrast, the cost to mitigate these problems are near 1% GDP per year, and they are expected to decrease over the future 20 years.

Figure 15: Cost of carbon abatement in $ per tonne of CO_2



Source: N. Stern, Stern Review Report on the Economics of Climate Change

Moreover an administrative judge in Minnesota in April 2016 announced SCC is *"reasonable and the best available measure"*, witnessed by 15 jurors among which Peabody Energy, a coal giant.

At this point we have clearly understood that carbon pollution creates costs to the society, which are paid via climate damages and reduced economic productivity. So in order to reflect these costs, to guarantee that customers can take informed market decisions, another interesting evolution of this topic is related to the possibility of fixing a carbon tax based on the estimation of the price of pollution.

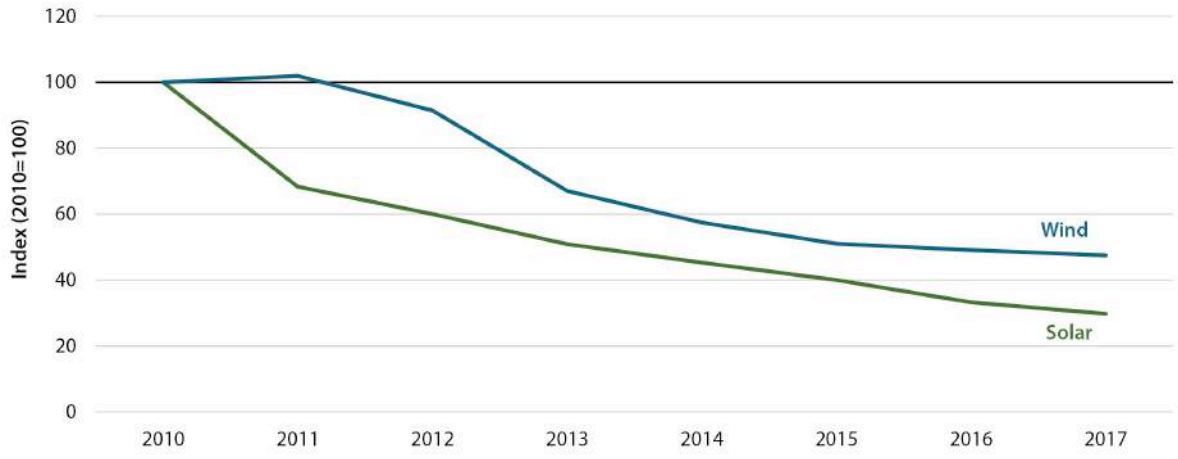
Fifty-seven carbon-pricing initiatives are implemented or scheduled for implementation around the world, heavily concentrated in Asia, Europe and U.S., accordingly with the distribution of emissions, as Europe accounts for 33% global emissions of CO2, U.S. the 25% and Asia 13%[45]. Even chief executives of many of the world's biggest oil companies as Exxon, Italy's Eni, Shell, Total have asked for a global carbon pollution pricing system. They want to highlight the sector's relevance in the global fight against climate change, claiming they are not the "bad guys", but can be part of the solution [46].

[45] In 2020 United States will be pricing only 1% of total GHG emissions, while Europe 5.5% and China 7%.

[46]Oil companies think a global pricing system on carbon will give an economic incentive to private sector to us cleaner sources of energy, and to develop new technologies to capture and store carbon. They urge governments to ditch coal in favour of less polluting energies like gas. It's a fight to ensure the future of oil and gas industry as governments and politicians are ostracising oil companies among investors.

A new study[47] finds that revenues coming from revenue-neutral carbon tax could create 2.8 million jobs and increase GDP of $1.3 trillion. The carbon fee would be simply a tax, applied according to the price assigned to carbon pollution (for example SCC), in order to cut emissions of CO_2 Clearly, sustained emissions cuts, which are not too heavy for the system, are normally up to 1% per year providing even structural changes in the energy structures; higher rates cannot be backed by actual economy: first of all because capital stock lasts a number of years, and for its duration, locks-in the economy, secondly because of preferences and habits of the population that are reluctant to change, and finally it takes time to develop new technologies with lower emissions[48]. So emitters will have to pay according to how much they are polluting and then these money will be re-given back to taxpayers (as monthly refund, for example) in order to offset rising energy costs. As the tax, applied on electricity, oil or natural gas, makes dirty fuels more expensive, it encourages the use of renewable energy, more efficient than the fossil ones, or can lead to the reduction of consumptions. Furthermore renewable energies[49] are becoming more and more cheaper overtime, thanks to cost-reduces advances in technology, learning and increased exploitation of economies of scale, starting to be an essential part of the U.S. energy mix[50].

Figure 16: Change in levelized cost of energy for solar and wind (2010-2017)



Source: Bollinger and Seel 2018, Wiser and Bollinger 2018

[47] REMI (Regional Economic Models Inc)

[48] An exception, for example, can be France between 1977 and 2003, which, thanks to nuclear power, reduced emissions of 6% every year.

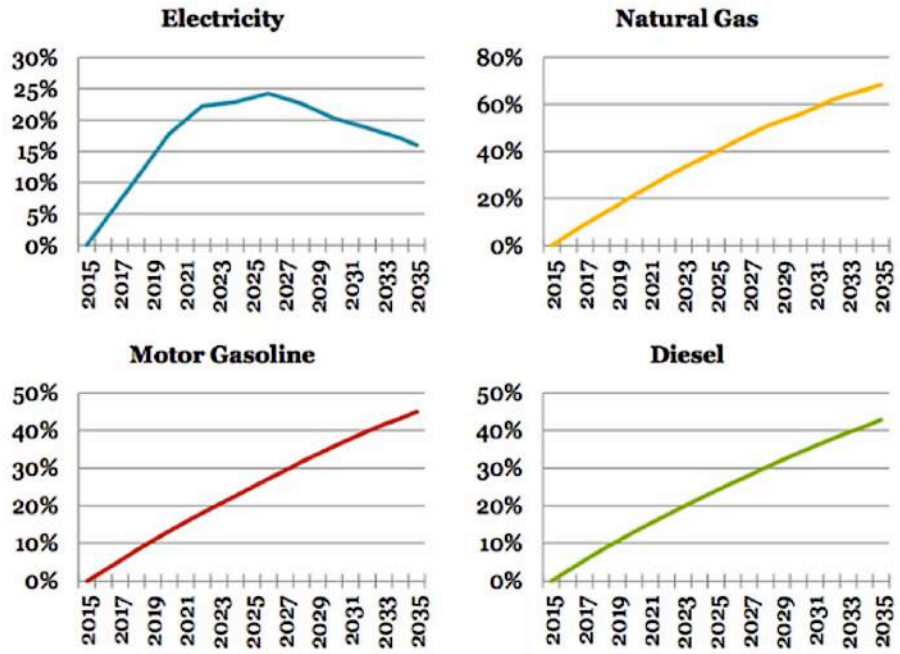
[49] Renewable energies: which can recreate themselves autonomously, as on and offshore wind, waves, solar energy, carbon capture, hydroelectric, nuclear power, bioenergy, hybrid and electric engines.

[50] Renewable energies can in any case continue to cause some problems related to the fact that are yet instantaneous and intermittent (they make power only when the wind blows or the sun shines), so substantial improvement in battery technology may be required. Even bioenergy could lead to problems of competition with agriculture for land and water resources.

So these two effects combined, plus an increase in the efficiency level, can increase savings, reduce waste, increase pretty much the convenience of investing in renewable energies and reduce the consumption of polluting fuels and polluting sources of energy.

This model was put into practice in an attempt in the province of British Columbia in America, where it has reduced emissions of 15% from what they would have been. In addition from 2007 to 2014 B.C's GDP has increased of 12,4% stronger than the Canadian average. An important finding is that according to the research, about two thirds of the tax payers receive more in refunds than they pay in increasing prices for energy, they have a net financial gain in most cases; so through expanding the case to nine possible distinct geographic regions in the U.S., the personal disposable income will increase under a revenue-neutral carbon tax almost in every region except in the fossil fuels-heavy west south[51], overall GDP will increase by $80-90 billions annually with a cumulative increase over $1.3 trillion. The reason why GDP goes up, is because the fee, jointly with the dividends from refunds, is boosting costumers expenses, reducing demand for fossil fuels. Moreover electricity prices will increase for the first decade due to carbon pollution pricing, but then they will begin to decline as long as low-carbon energies will become increasingly cost-effective and widespread (zero-carbon wind, nuclear and solar); while on the other hand general commodities will see their prices increase over time.

Figure 17: Energy commodity prices (national level)



Source: Regional Economic Models Inc (REMI)

[51] Texas, Lousiana, Oklahoma, Arkansas

Even the purpose of reducing emissions of CO_2 will be achieved, as carbon dioxide will be projected to decline 33% after only 10 years, and 52% after 20 years; this reduction in air pollution will be positive even for population health, as general diseases will decrease and 13,000 premature deaths will be prevented annually after 10 years.

In conclusion, what we can understand is that there are many and significant costs connected to pollution and consequential climate change, sometimes even difficult to estimate and quantify, because of the high uncertainty connected to extreme events. These costs are supposed to highly increase if no action is planned to take place towards mitigation of polluting phenomenon, and these liabilities will be felt by future generations in term of health diseases, drop in the economic growth and extreme weather events and catastrophes. The more we wait and the more costs will raise; delaying action now, means more drastic cut tomorrow[52], as probably there will be less room for errors, and the Earth will be sensible to unforeseen changes and risky extreme events. Energy systems are subjected to strong inertia and it's important to avoid to be locked in long-lived carbon technologies, in this way even long-term costs will be decreased. So it's important to reduce emissions to the rate of natural absorption of the planet, to stabilise GHGs and prevent global temperature to rise. And this has to be done both by developed and developing countries, as we have good technologies and an economy strong enough to support it. The good news is that, even if not as much as they should, countries are starting to implement some measures to reduce GHG emissions, mainly in term of carbon taxes, some considering the Social Cost of Carbon, others looking at environmental goals to be achieved and then setting a set of steps to perform. But in order to cut GHGs emissions there has to be a reduction in demand for emission-intensive goods and services, too; an improved efficiency in key sectors, as buildings and transports, with combustibles as hydrogen, biofuels or electric cars; and finally the electricity sector would have to be strongly decarbonized by 2050, through the use of renewables, as nuclear, sources of energy. Any of these actions for the task of climate change shouldn't be considered solely, we have to have a portfolio of different options, and they have to be considered at a global level. Environmental sustainability and the consequent improvement in the efficiency can lead to a win-win opportunity for the ecosystem and world's population. The beneficial positive effects resulting from these activities seems to open new ways to opportunities and wealth to be achieved from an ethical and social point of view, but even from a financial perspective.

[52] For example, if the peak will be reached in 2010 and then emissions are projected to decrease, the rate of reduction should be equal to 3%, if the peak will be in 2020 the rate of reduction should be equal to 4%, if in 2030 6%. (Stern Review on Climate Change).

1.3 How countries are reacting: a focus on Europe and Italy

"Coming up here today, I have no hidden agenda. I am fighting for my future. Losing my future is not like losing an election, or a few points on the stock market. I am here to speak for all generations to come. I am afraid to go out in the sun now, because of the holes in our ozone. I am afraid to breathe the air, because I don't know what chemicals are in it. I used to go fishing in Vancouver, my home, with my Dad until, just a few years ago, we found a fish full of cancers. Did you have to worry of these things when you were my age? I'm only a child and I don't have all the solutions, but I want you to realize, neither do you. If you don't know how to fix it, please stop breaking it. We are your own children. You are deciding what kind of a world we are growing up in. Parents should be able to comfort their children by saying 'Everything is going to be all right, it's not the end of the world, and we are doing the best we can'. But I don't think you can say that to us anymore. Are we even on your list of priorities?"[53]

In 1992 at Rio de Janeiro, there was the first Earth's Summit ONU, in which was approved the United Nation Framework Convention on Climate Change (Unfccc), a convention that has to be replicated every year with the objective to find out a way to stabilise GHGs concentration in the atmosphere and prevent disastrous consequences in the environment. After five years, in 1997, with COP3 (Conference Of the Parties), in Japan, was signed Kyoto's Protocol, to impose to the 55 most industrialised countries to reduce Green House Gases emissions, but things have not changed very much. And time was going on. In 2009 at COP15, in Copenhagen, there were huge expectations, and when no solution was found, the delusion was even bigger. The objective was clear and impressive, but ambassadors were not able to figure out how to tackle the problem in a practical and valid way. The first practical responses were seen in 2015 at COP21 in Paris, where art. 2 has defined that countries have to remain below 2°C warming with respect to preindustrial levels, putting efforts in trying to limit the increase of temperatures beyond 1.5°C. The problem is that, before COP25 of 2019, Donald Trump's United States have already exited the agreement, dragging with them even Saudi Arabia, Australia, Brazil and China, despite cataclysms affecting the whole planet launching red flags to all nations.

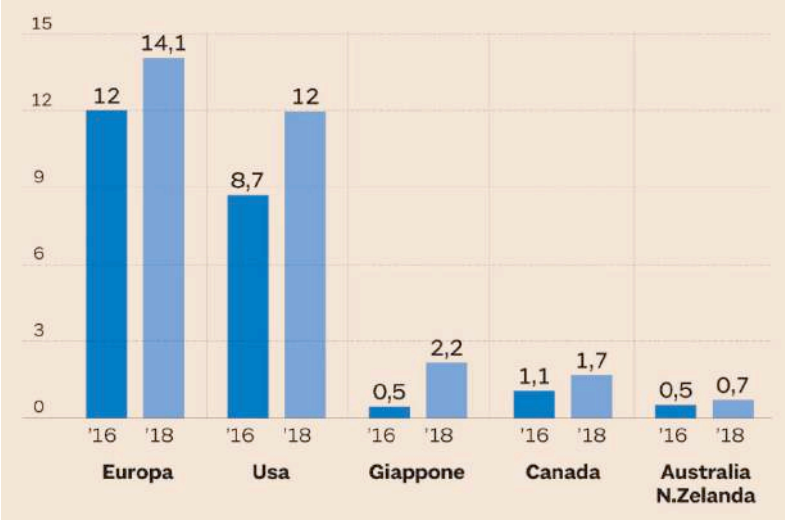
If this is the overall situation around the world, how our continent is effectively fighting against these huge problems, how things are going in our territories?

In Europe, the bases to fight against climate change have been settled and are quite solid. The attention and worries are growing more and more during time, and this is a good news, as it means

[53] A 12 years old Severn Cullis-Suzuki at Rio Summit about climate change in 1992.

that countries, and their representatives, are aware that there's a real threaten to stop and are defining policies and objectives to be respected.

Figure 18: Investments on sustainable assets in thousands dollars



Source: Gsia, Il Sole 24Ore

In some way, is possible to observe a path in the general attention that countries pose over climate change. Even if different nations implement different policies according to their specific characteristics, as the geography, the population, the size, there are some topics which acquire particular attention and that are considered by every country.

First of all the agricultural sector. It is a priority, as it will be the most threatened industry. Some solutions to try to fight against the future challenges are related to discovering droughts-tolerant seeds, some scientists in New Delhi have discovered a rice seed that is able to survive underwater for more than two weeks, trying to expand irrigation systems, or improving the quality of forecasts for seasonal weather, in order to become able to survive to extreme weather conditions that can be particularly damaging for crops. Even protecting fresh-water supply is a concept of huge relevance. Southern European regions, which are expected to face arid and semi-arid conditions, have to find out a way to capture and store available surface and groundwater resources. Whereas in coastal zones the main aim is to protect fresh water from saline intrusion. Moreover there's a need to diversify energy systems, as those countries, which mainly rely on hydropower for electricity, are particularly at risk according to climate change responses. So a major attention has to be put on geothermal, solar and biogas production of energy and would be very important even to improve the efficiency of technologies. Also fishery[54] is very important for many countries, as in the Mediterranean area, in which livelihoods depend mainly on it for their diet, and in which the

[54] Marine fishery, freshwater fishery and aquaculture.

fish market is representing a huge source of income. It would be essential to improve fish management and promote sustainable fish farming, so that to ensure the mechanisms are sustainable and the exploiting activities are respecting the cycle of reproduction of the ecosystem.
The final main concern to be considered is connected to the capability of nations of managing extreme weather events, such as floods, droughts and cyclones, which are predicted to characterize a 2°C warmer world. The most subjected areas have to be prepared to experience and tackle these events trying to avoid the full destruction of their resources, infrastructure and economies.
In 2005, in Europe was launched the European Union Emissions Trading Scheme, the world's first international emissions trading system, working on all 28 member states, plus Lichtenstein, Norway and Iceland. It works fixing a cap on the total amount of certain GHGs emissions to be produced by installations within the system, and this cap decreases any time more so that total emissions are expected to fall during time. It covers 45% of GHGs emissions. Within the system companies receive or buy allowances to emit, and they can be exchanged between enterprises according to needs. If an enterprise emits more than the amount covered by the allowances, heavy fines have to be paid. The possibility of trading these permissions brings flexibility to the mechanism and ensures that emissions are cut minimizing the costs to do so, moreover a carbon taxes incentive the purchase of low-carbon, clean technologies. EU policy aim to increase renewable energies' share in energy consumption mix of, at least, 27%, joined with an increase in efficiency of 30% by 2030.
Human being are living exploiting too much Earth's resources, not considering that we have just one planet at our disposal; production and consumption systems should be completely modified. Circular economy means that we should base our economical systems on services rather than products. This means that once we have finished to use a washing machine or a car, for example, they should be re-given back to the producer, to make sure that a new product will come out from the old one. Clients should not pay for the washing machine or the car, but for the utilization of the service. Today we are still far from this concept, raw materials' consume continue to grow, and in 2020 are estimated to be used 82 billion of raw materials, 30% more than ten years ago. Those companies that try to observe the situation from a regenerative perspective have to create products, which can be dissembled and resembled to re-use materials and reduce consumption of primary resources, in this way the product can be re-handled, without being wasted. Thousands of firms, especially in Europe, have transformed and converted themselves, using as supplying materials already existing products that have already had a life, used resources. In this way they have been able to improve their competitiveness, not only their sustainability, as given the fact that

Europe has scarce primary resources, this can be a possibility to reduce imports and achieve stronger positions from a global point of view. The circular economy rate in Europe today is equal to 11,7%, when the global one is equal to 9%, and it is growing slowly but constantly of 8,3% since 2004. The avant-garde Italian productive system has a circular rate equal to 17,1%, greater even than the one Germany (11,4%); in Italy since centuries there's a strong attention towards recycle and efficiency, as there's a strong tradition of frugality. Is good to know that in 2017 EU had already reduced overall consumption of raw material of 9% compared to 2000. In terms of productivity of consumed resources[55], the improvement is even more noticeable, with a 39% more compared to 2000, and 13% more compared to 2013. Circular economy in Europe can create more than 700 thousands working positions according to European Commission. Nowadays EU imports 90% of oil and 70% of natural gas, so a regenerative system can be the key to unbundle growth from oil and material extraction, reducing production of waste and emissions. The Circular Economy Action Plan, launched in 2015 by EU, resume the strategy of involving the more it's possible companies in creating goods and services reusing existing materials and reducing the more is possible the generation of waste. Before 2025, according to the plan, the 55% of general waste has to be recycled, while specifically, the 65% of packaging has to be recycled, and landfilling would have a maximal rate of 10% by 2035. Already starting from 2014, many European countries have proved to be really efficient in this sense, as Austria, Belgium, Denmark and Germany, Netherlands and Sweden, haven't landfilled any waste.

Besides, the Green Revolution announced by the new European Commission President, Ursula Von der Leyen, is now effectively in writing. The "European Green Deal" is a plan to transform Europe into the first climate neutral continent within 2050, reducing carbon emissions of 50%, or 55%, before 2030. It has the aim to move 1.000 billion investments in ten years, in order to reduce GHGs emissions, stimulate green investments and help companies in the transition to greener operations. The commission is working on a tax on carbon for those companies emitting CO_2, in order to cope the problem, and to protect those ones, which are respecting the environment. EU invest the 25% of all of its funds in this initiative and 35% of InvestEU, providing € 7.5 billion initially. Given the fact that there are many weaker countries, which still rely heavily on carbon as principal source of energy for their economy and sustainment, and for which may be very painful to suddenly cut all the emissions, as Poland, Hungary and Czech Republic, the transition has to be slow and equilibrated, with acceptable financial tools to be used. For example, has been proposed a Fund for transactions, which, jointly with European Bank leverage effect, moves private capital

[55] Consumed unit compared to the unit of GDP.

for 100 billion euros in the following seven years, in order to place these resources in those areas that most require them, so they can have a real aid helping them in the shift to a more sustainable economy[56]. The main idea of this Deal is to transform an environmental challenge into an economic opportunity, considering the fact that investing in green economy can increase chances for production. Copenhagen, where the total amount of bikes is greater than the overall amount of cars, called also "European Green Capital", aims to be the first carbon neutral city by 2025, starting with the substitution of all classical, carbon-fuelled public transports with electric ones. Even Italy has agreed to become climate neutral before 2050, and many municipalities have taken part to the "Patto dei Sindaci", an agreement to ensure that, on a local scale, there's awareness about energy and climate politics, and is interiorized the importance of these topics. The different districts have the duty to implement environmental policies on sectors as the efficiency of buildings through greener alternatives, as green rooftops[57], as urban mobility, circular economy, reduction of waste and green areas. For example, Milan metropolis has planted 10 thousands hectares of forest in the last two decades.

Nowadays 84% of electors are worrying about environmental action proposed by politicians and their attention on tackling climate change when they have to choose who to vote. So, not only it's an international emergency, which requires the attention of every State to be overcome, but also are the consumers that are asking for something different and force the system to change.

The sustainable development and green economy, can be even an opportunity for countries, as if they have sound macroeconomic management, attractive conditions for inward investments and flexible markets, they can hope to win strong shares of the emerging clean energy market. In fact, through implementation of ambitious climate policies and climate change goals, it can be created a fertile ground for the growth of clean energy companies. For example, Hanemann et. al. (2006) analysed the economic impact of California, if it decides to take action immediately implementing policies for the reduction of GHGs emissions. From the research came out that, if it acts now, California can gain a competitive advantage becoming leader in new technologies and industries that will develop globally. They estimate that this could increase Gross State Product of $60 billion, creating 20,000 new jobs. Furthermore, sustainability, jointly with digital technologies, can be a huge opportunity even for small enterprises to enter in the global scenario. Markets are searching for new eco products; consuming less energy, cut waste and recycle and reuse materials

[56] Ten billion euros will be provided to countries and industries mostly affected by climate change.

[57] Small bushes and shrubs are planted on the rooftop of buildings, in order to work as insulator, being able to capture heat during cold seasons and releasing it slowly, and maintaining shady the surface to guarantee coolness during hot seasons.

are all factors that improve efficiency and reduce costs, leading to advantages both in term of health and income statement.

So, talking about the specific situation in Italy, is possible to understand that being able to take action and respond actively to these threaten, at the right moment, not risking to loose too much time waiting consequences to become more invasive, can boost the economic growth, the relevance and magnitude of the country, making it gain a stronger competitive position on the system.

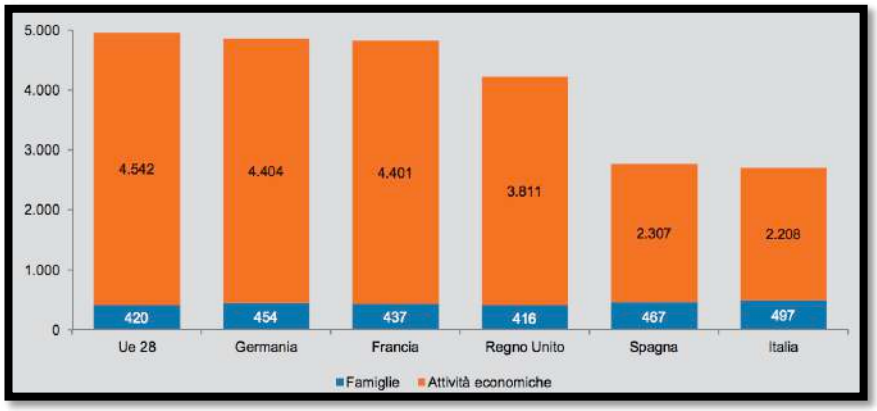
Norms and incentives for electrical automobiles, renewable sources of energy, transports, energy savings, green houses, GHGs emissions reduction, water protection are proliferating.

Thus, in the Italian nation, with respect to 2017 all indicators seem to be quite stable. Only indexes related to air pollution in urban metropolis have a negative dynamic. In 2017 Italian cities recorded level of PM10[58] higher than the one accepted by the law, touching limits of 34% especially in Northern regions. This makes us understand that urban areas are expanding, but maintaining a strong dependency on fossil fuels, instead of relying on more sustainable sources of energy. The release of polluting gases mainly depends on traffic, household-heating systems and productive activities, but the concentration of these gases to level harming health conditions, is connected pretty much on meteorological and geomorphological factors, which can mitigate or exacerbate conditions. Jointly indexes representing hydrogeological risk[59] have shown a negative dynamic, which is something logic, given the fact that in the latest years extreme weather events have increased causing different damages to all Italian cities. GHGs emissions in 2017 have been equal to 7,2 tonnes per capita, as in the previous year, maintaining stable rates since 2014. The 50% of emissions are coming from industries, the 15% from services and 9% from agriculture, while the remaining 24,3% accounts to families for use of appliances and private transport. This value keeps remaining stable since 2003-2005, when a long period of reductions was promoted to cut emissions, which in that period have reached dangerous level of 10,3 tonnes per capita. Analyses have shown that a reduction in the emissions in these years was followed by gains in the efficiency of the economic system. On the other hand positive signs are coming from many other sectors. In the medium-long period, from 2010 to 2017, CO_2 emissions have decreased in general. In Italy is still too high the incidence of fossil fuels, as they account for the 26% of combustibles whereas in Europe normally they account just for 22% of total fuels. In 2016, in our nation, more than one third (34%) of energy consumption was covered by renewable sources of energy, which is a good

[58] Defines the concentration of fine toxic dust within the atmosphere.
[59] Mainly risks connected to landslides and floods.

result, but distant from the most evolved European countries[60]. In any case, Italy was one of the European countries that has recorded greatest progresses compared to all the others (more or less 14 percentage point). Another good fact is related to waste generation, which is starting to assume any time a more central relevance. Even if it represents a source of pressure for the environment because of the direct or indirect consumption of natural resources, it can be an opportunity for the country to improve its efficiency and management cycles. In the Bel Paese, the overall production of waste related to the population is significantly lower than the European average, with 2.705 kg per capita against 4.962 kg per capita in 2016, mainly thanks to economical activities capability of reusing the materials. In the figure below is possible to see the quantity of waste per capita produced by each of major countries member of European Union in 2016, and it's immediately noticeable the good position of Italy. Furthermore, the percentage of recycled waste is equal to 55,5%, 3% more than 2016 and 20% more than 2010, defining a constant improvement.

Figure 19: kg of waste per capita produced according to the industry



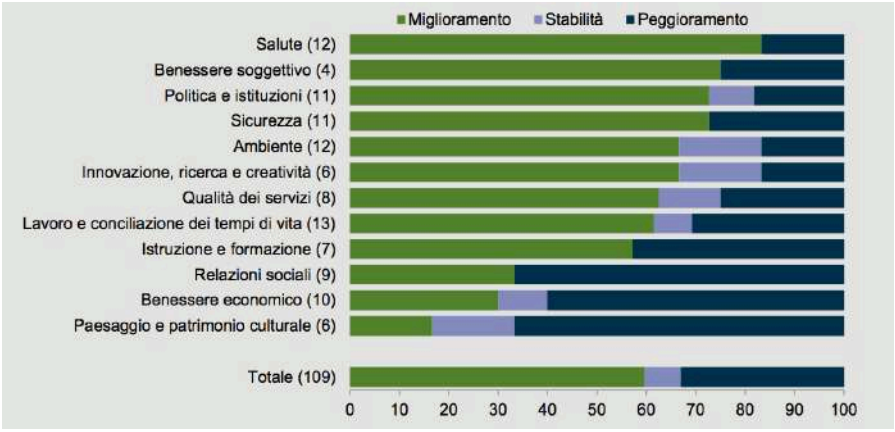
Source: Istat Report 2017, Eurostat Waste statistics

Are growing in the country even concerns about biodiversity. The population highly express it's worries about the possibility of loosing biodiversity, 21% of Italians in 2017, especially concentrated in young people, millennials can be the driver of green revolution, and the percentage is constantly growing since 2012. According to this, the consumption of resources has stabilised over time. CMI, which stands for, Consumption of Internal Material, is slightly decreased of 0,3% in the last year according to Eurostat estimations.

[60] Austria 72,6% and Sweden 64,9%.

Moreover, according to BES project[61], in Italy, in the latest 10 years, evolution has been quite positive, as the 60% of total measures used by the initiative show an improvement in general conditions. The main domains in which improvement are mainly perceived are Health, collective Well-Being, Politics and Institution, Security, Environment, Research and Innovation.

Figure 20: Percentage of improvement in the indicators of well-being divided per cathegory



Source: Istat, benessere e sostenibilità, la misurazione del BES

Talking about the environment, a particularly positive evolution can be noticed in electricity consumption covered by renewable sources of energy have more or less doubled, reaching 31,1% of the total in 2017. And even in Research & Development, the percentage of employees with high level of knowledge is increasing compared to the total, from 13,1% in 2008 to 17,4% in 2017, identifying that creativity and innovation are supposed to increase, boosting the development of more efficient technologies and practices.

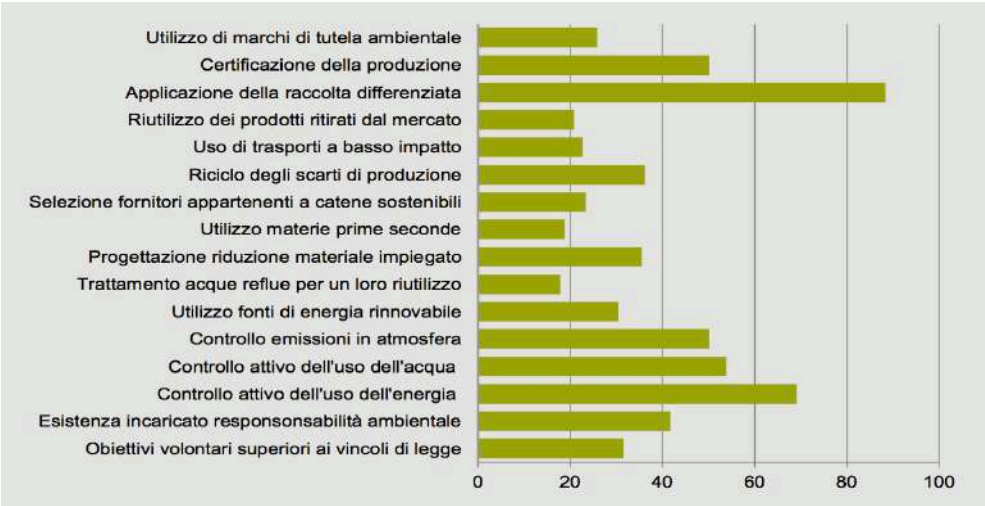
Thanks to green economy the North of Italy in 2019 has experienced 307.000 more labour contract related to green jobs, nowadays is sustainable economy that decides if something is good and profitable or not in the long run. The nation is really competitive from an international point of view, growing pretty much in the exports, and having many industries in which sustainable investments bring to economic benefits. The Italian industry of timber and furniture is third in the world, and first in terms of circular economy, as 93% of panels for construction are recycled. Even in the apparel industry our country is second only to China, earning 6,8% of the global market, and being the second exporter of clothes to China, representing the 17% of imports. Talking about Haute Couture, 58 of the 80 companies that have joined Detox campaign of Green Peace to erase toxic and polluting products from clothes, were italian.

[61] BES is a fundamental benchmark to monitor progresses in Italy and to evaluate public policies. It's a framework build up of 130 indexes representing different topics as the social condition, environmental condition, politics, health, security, etc.

And again, concentrating on agriculture, Italy is leader in Europe, and stands in world summits, as 15,5% of used agricultural surface is bio, whereas in France is 7,5%, in Germany 9,1%, in Spain 9,7%.

Even leadership can encourage responsible behaviours. In fact if the public sector, investors, businesses or communities invest in sustainability and care about the environment, they can provide reassurance that not only take action is possible, but that has wider financial and economic benefits. Nowadays many companies are motivated to enter in the environmental technology market to combine business profitability and environmental responsibility, or to exploit fast-growing opportunities. Being sustainable may be convenient for companies' reputation, to cut costs, to perceive more subsidies, have access to more public auction. Labour and enterprises are determinant in characterizing well-being of the population, since lots of years has been coined the term "Social Responsibility of Companies", as they directly or indirectly are able to influence people and the environment. The impact of their choices and the quality of their behaviour, are and have been essential in reducing negative impacts of process of production in the ecosystem in which they are settled. Environmental sustainability topics are considered any time more as strategic factors that can improve competitiveness of industries and strengthen the relationship between themselves and the territory, with beneficial effects on communities. In order to reduce environmental impacts, the 88,4% of companies are actuating separate collection of waste, and 69,1% of enterprises controls actively energy use through plans and measure to reduce the more is possible the consumes; while one company over two checks continuously water consume and try to reduce emissions in the atmosphere the more is possible. Evidence has shown that the bigger the company and the more it is sustainability oriented, as probably it has more resources to employ for the purpose.

Figure 21: a representation of enterprises with 50, or more, workers, which have planned actions to reduce their environmental impact between 2015-2017[62]



Source: Istat, indagine sull'internazionalizzazione delle imprese.

There are many practical examples of companies in Italy that have demonstrated to move towards more sustainable practices and activities.

Just to mention a few of them, to have practical case studies to consider, Arvedi is one of the most important steel mill of the world. In 1992 it has invented ESP[63], a mechanism through which is possible to connect continuous casting with rolling during the production of steel components and products, it's a process covered by 360 patents. This concept has given the company the possibility of halving the speed necessary to transform molten steel into steel strips of 1 mm, of doubling the productivity and of improving pretty much the quality of the products, which is a very important result considering that 25% of the components are then sold to the automotive value chain to produce automobiles, where safety is essential. Greater productivity, also calls for lower consumption of soil and lower environmental impact: a lot of energy is saved, given the fact that traditional plants have to reheat the substances to produce the strip, while ESP does two things at the same time and continuously; water bills reduce their value of 50% to 60%, as less water is necessary to cool the machineries, and CO_2 emissions are reduced of 70%. Furthermore, the idea of reducing and simplify the productive cycle seems interesting even to other companies, as the steel colossus, Rizhao, which has purchased three lines of ESP, followed by US steel, the Rockefeller of steel markets. This is just to prove that even heavy industry can innovate and become more sustainable, expanding at the very same time its commercial opportunities.

[62] Both for social and environmental aspects, the North-East area of Italy, have been much more successful than the others.

[63] ESP: acronym which stands for Endless Strip Production.

Another admirable example to report, is the initiative of Conai, the National Consortium for packages, which every year organizes a contract notice called "Prevenzione" with a 500.000 € prize to win. More than 250 enterprises have taken part to the action, and it's seven years that the rate continues to increase, which means that environmental sensibility is becoming an important factor of strategy development of companies. Green economy has not only become a marketing tool, is value added, it has turned into an active part of Made in Italy's business plan, as attention to sustainability and circular economy is nowadays an instrument able to create value, redefining the concept of waste, transforming it into a resource. Italy in 2018 was able to recover 80,6% of packages, more or less 10,7 million tonnes, already reaching the objectives defined by the European Union for 2025, and being quite close to those ones fixed for 2030. Economic benefits, according to Conai's estimates, are equal to 995 million € in 2018, with saves in CO_2 corresponding to 113 million €. The biggest problem to be solved is the one connected to plastic packages. Plastic is a very complex material, difficult to treat and recycle, but in the latest years huge development has been made increasing the percentage of material that can be recycled. Thanks to separate collection of waste and eco-design activities of companies, less impactful packaging are created, as in the engineering of an object the 80% of impacts it will have on the environment are defined.

In this regard, Eni, Barilla and Illiria, are part of another national project, called "Rivending" according to which the objective is to transform plastic from a problem into a resource, through the creation of specific bins wherein to throw different materials in different dedicated areas according to their composition, simplifying in this way the process of selection and division of the compounds. Thanks to this solution a lot of costly and dispersive passages are avoided, and virtuous materials are immediately identified, in this way they can be reused easily. Illiria, for example, thanks to this initiative is going to recycle from 20% to 25% of 5 billions plastic coffee shots used every year in Italy in order to reutilize them. Today the company is expanding at an incredible rate, mainly due to the capability of having an innovative and futuristic vision, which have given the enterprise the competence to release value on the environment, people and the community.

Figure 22: Recycling rates for packaging in Italy in 2018 related to European targets for 2025 and 2030

Source: CONAI

On the other hand, talking about water consumption, Italy is the first country in Europe using too much blue gold and recycling too little, with 240 litre per capita consumed against the average 150 litre per capita used in Europe. Being able to purify any time better this resource and especially sewage sludge, which contain precious natural fertilisers as nitrogen and phosphorus, could be a huge positive advantage and benefit for a country, in particular for industries like agriculture, threatened by droughts and by the depletion of phosphorus mines. In our nation, 70.000 tonnes of sludge containing useful resources are produced every year, among them one quarter goes to agriculture, the 10% goes to the dump, and the remaining part is delivered abroad to fully-equiped Nordic countries where it is used to fill Waste-to-Energy plants. Export activities of sludge are generating disposal costs greater than 200 € per tonne, just because in Italy we don't have plants able to dispose of those waste. CAP, an Italian company involved in water supply, has planned to convert the incinerator of Sesto San Giovanni into the first Italian Waste-to-Energy plant, in order to highlight the importance of sewage sludge and at the very same time halve disposal costs. Those muds that cannot be used directly in the agriculture will be dried, reducing the weight and then thermo-valued, so that the ashes full of phosphorus and nitrogen can be used, again, in the agriculture. And even if the traditional idea is that where efficient water plants and services are offered, water is more expensive, it is not. In fact, according to statistics, in Southern Italy, the average monthly expenses are greater (16,87 €) than those spent in Northern areas (12,41 €) where the values are lower than the national average (14,65 €). So it will be more convenient even for the citizens to have plants and machineries able to value and promote the importance of water recycle and depuration, defining a win-win opportunity both for population and the environment.

Again, another virtuous case to consider can be the one of the industrial cluster of leather in Arzignano, where Sicit, a famous tannery, has been able to transform scraps into products appreciated by the market. Are 60 years that the company is involved in the process of transformation of scraps, which come from the production of leather, into bio-stimulants for agriculture and raw materials for chalk value chain. In 2019 Sicit went public, circular economy pays.

Finally, the last majestic case to be considered is the one of NaturaValp. In the last 120 years temperatures on Alps have increased of a little bit less than 2°C, almost two times more than the global average. Snow falls any time less and at any time higher altitudes, ski seasons have reduced and if GHGs emissions are not cut by 2100, there would be no snow below 1.200 m of height. This would be an enormous damage for the economy of the region. NaturaValp is an association founded by tour operators of the territory, involving restaurants, bar, accommodation facilities, farms, shops, shelter and alpine guides with the main aim of organizing activities and initiatives in the area as typical product tastings, climbing, mountaineering alpinism, snowshoeing, tour on glaciers and so on. Through these mechanisms and actions those places that are particularly threatened by climate change, can transform a danger into an opportunity, developing new tools to be used in order to take advantage from negative situations. The municipalities of Bionaz and Valpelline, have moved from 31 thousands units to 44 thousands units, with a growth of 41%, so the results are clearly positive and touchable.

1.4 More sustainable means more productive

As mentioned in the previous section are consumers those ones that are calling for sustainability. According to researchers, 80% of young consumers in Italy are asking for sustainable policies to be implemented, and companies have to look at young consumers, as they are representing the market of the future. The 55% of Italian citizens are used to live in eco-sustainable houses, the 77% uses energy-saving appliances, 68% of buyers claimed that are disposed to pay an additional charge for single-use plastic products in order to discourage the purchase, biological products acquirements continue to grow (4,6% more this year). Sustainability today means competitiveness; consumers are desperately chasing companies that care about the environment. Politic is much more slower than it should be, even compared with enterprises, as the latter are more concerned about clients and their choices, they have to follow the trend. All over the world sustainable

investment funds are gaining immense popularity, just think about green bonds[64] and the increasing relevance of ESG[65] criterion, which nowadays are even used by rating agencies to rank companies. Tens of trillions dollars have been invested around the world in ESG criterions[66], the volume of these transactions is doubled in the last seven years, as investors are becoming more and more aware of the importance to incorporate in their strategies sustainable objectives. In an analysis developed by "il Sole 24Ore", in which have been examined major common market indexes and the relative ones focused on ESG themes, bond yields of green investments have equalized or exceeded the traditional one, both in emerging and developed markets, with the same volatility. Furthermore, these benchmarks can be pretty useful even to identify alpha companies, leaders in the market, as those businesses which, within the years, have been able to reduce sensibly their ecological footprint have realized better performances. According to this, the choice of the composition of investor's portfolios can be highly influenced by ESG parameters, which become one the leading elements to define revenues.

Even sustainability-linked loans, provided to those companies with good results on ESG indexes, have grown of 168% from the previous year, reaching a value equal to $122 billions. The rapid growth of sustainable finance is fed by the ambition of leader companies, banks and governments of being represented as responsible, and by worries and interests of investors, too. Circular economy potential is huge, as even if securities are the most expensive, the main objective of sustainability is to guarantee, in fact, the sustainability of the business, is to maximize productivity of the resources and guarantee the possibility to companies of facing resource scarcity, so to maximize long-term revenues. Worrying about effects of climate change means being conscious about risks connected to properties, soil, infrastructure, environment, or in general disaster caused by extreme weather events. The greatest amount of strategies are represented by those that tend to exclude from portfolios certain market categories as weapon producers or petrol companies, but others are looking at ESG criterions to take proper decisions within the market; about $17.000 billion are invested according to this logic, and 1.500 funds, hugely increased from the 700 funds in 2010. Institutional investors, on the other hand, are actively talking of these topics with partner companies. Moreover countries and governments are participating sincerely to climate change battle through the issuance of Green Bonds. Instruments of sustainable debt are now worthing

[64] Green bonds: government bond related to those projects that have a positive impact on the environment, as energy efficiency, energy production through renewable sources, etc.

[65] ESG: it stands for Environmental, Social and Governance, a parameter utilized in the economic/financial field to identify all those activities related to responsible investments. Used in order to define all those financial operations that consider topics connected to the environment, social field and governance field.

[66] Estimates of Global Financial Stability Report (GFSR).

$465 billions, having perceived a growth of 78% from 2018[67]. With these tools, is possible to finance prestigious environmental project, as renewable energy plants, for example. A lot of companies as Enel, State's railroads, Erg, Intesa San Paolo, Generali are using these instruments to finance construction of trains and recyclable materials, whereas banks are using them to invest in green buildings, clean mobility and waste management. Enel, in particular, is one of the greatest emitter, with the goal of reaching a percentage of installed plants for renewable energies equal to 55% of the total by 2021, and if the objective will not be achieved, it has to pay to investors greater interests. In order to have the kind of "green label", companies have to list clear environmental benefits they want to obtain. On 7th of February the EU government has approved a regulation, in which are defined the macro-areas wherein companies have to work to obtain the resources: climate change mitigation, transition to circular economy, sustainable use and protection of marine resources, control and prevention of pollution and protection and recreation of ecosystem's biodiversity. Green bonds emissions have increased worldwide from 45 billions in 2015 to 168 billions in 2018, while $500 billions are invested today in impact investing, investments with the aim of generating positive impact both in the financial field and the environmental one[68]. The action plan of impact investing is concentrated on four main thematic: financial inclusion of subjects living in developing countries, health condition improvement, access to education and fight against climate change. It can guarantee that financial resources are used to transform breaks and inequalities into social value in an efficient way. Axa Im, an investment fund, thanks to these initiatives, has given the possibility to 110 million people to have access to basic financial resources, as a bank account, has provided eleven new drugs and vaccines to 670 thousands people and has decreased CO_2 emissions of 32 million tonnes. In addition, focusing on sustainability indices makes it possible to identify those opportunities that are more profitable in the long term, which are able to generate greater value, and allows understanding which investments to exclude as price can be highly volatile due to possible extreme events connected to climate change.

Even talking about Italy specifically, in the last two years, investments in these related businesses have increased exponentially, moving from 3 to 52 billion euros, almost half of the 108 billions invested by Europe for these type of intervention.

In August 2019, the Business Roundtable, an association that groups together all major American investment funds, has published a famous declaration in which states that companies in these

[67] Bloomberg New Energy Finance.

[68] Giin Survey, forecast the market will grow of 13% on annual bases, involving flows equal to $37 billions in 2019.

latest years should focus on stakeholder value rather than shareholder value. It has become more important to concentrate on benefits created for employees, clients, suppliers, and local communities rather than on the owners only. We are looking forward to a responsible capitalism, in which enterprises, in order to be successful have to have a good relationship with all their stakeholder and entities around them. Larry Fink, owner of Blackrock, one of the biggest and most powerful investment firms, has declared that financial world is changing and future decisions of his company will be principally looking at more sustainable businesses. According to Fink, every government, company and stockholder has to deal with climate change, and this doesn't mean that profits are no more important, this just means that investment decisions have to be taken having in mind the long-term horizon, not short-term results, being aware about risks connected to climate change. Central Banks are becoming green, too: the president of European Central Bank, Christine Lagarde, has put green development at the head of every strategy this year, FED in San Francisco is doing the same thing. Goldman Sachs, the investment bank, has decided to not finance any more coal power stations that don't cut toxic emissions, and those companies that do not consider ESG criterion will be penalized. Barclay, has stopped financing firms not aligned with Paris climate agreement.

Hens, according to all these notions, finance can be understood to have a key role on this transition to a greener world, it's fundamental to work as a mediator between consumers needs, and the economy. The large and growing market of sustainable economy will need financial resources and tools to sustain investments in developing and new technologies, brokers will be needed to work as joint point between investors and firms, legal services to manage contractual relationships and trading services. These are all essential instruments that can be very relevant in the change.

So it's clear that one of the reasons why companies should consider a greener business plan for their activities is because customers are largely asking for it, both in the product that they purchase and the investments that they make. Asset owner and asset managers can be positive catalysts for the change. And if enterprises want to maintain their position on the global markets or expand their market share, they have to take deeply into account sustainability matters and become more responsible in the action they promote.

But another very important and interesting reason why they should become more environmentally friendly, is because the more companies are ecological, the more they are productive. Not only machines need to operate in a more sustainable way, using less of world's finest resources, but even they should be able to operate without increasing their own needs, which means that they

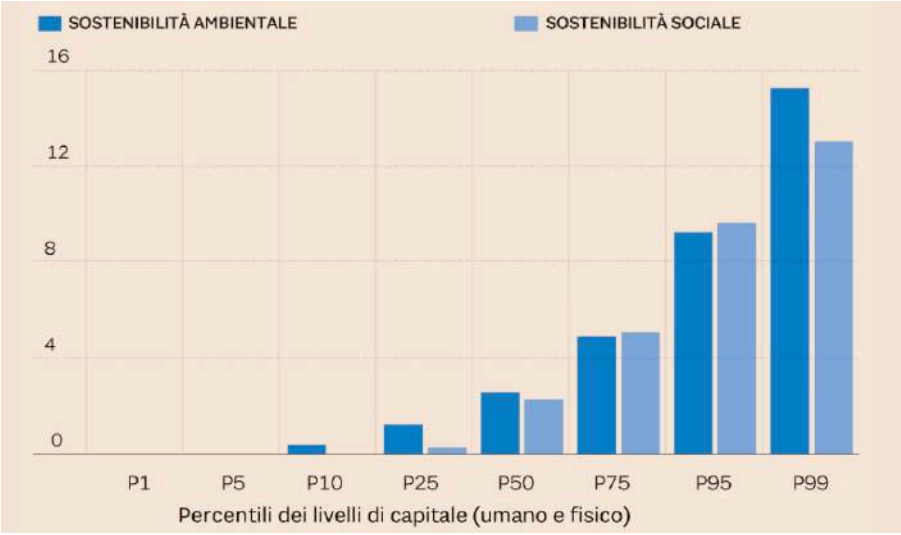
have to become able to create new opportunities to obtain more and use less. New technologies and innovations should be created as productivity and sustainability are not mutually exclusive.
The benefits connected to sustainability can be noticed in term of operative performances, which are more efficient, and economic gains on the market, greater value delivered, better competitive position, due to the fact that you share ethical, economic and natural value with your customers, so they prefer you to others, and greater revenues are going to be perceived thanks to this.
An American study on 74 companies done for 18 industries in 11 countries, including Asia, Europe, North America and Australasia, has revealed that the more enterprises care about the environment and the more they save costs in terms of costs of good sold, saving almost $11.6 billion in total. For example, famous company Kodak, in 1990 began to track its GHGs emissions in order to cut them through a five-year-goal. In order to achieve this objective the company has started to make small assessments on energy focused on different segments of its activity in order to reduce emissions and waste, between 1999 and 2003 these initiatives resulted in savings of $10 million.
In 2017 a research made by Istat[69] on 14.000 Italian enterprises, discovered that being sustainable increases labour productivity[70] of 10,2%. There's a kind of sustainability premium. The analyses, edited on 2018 Report, have taken a sample of companies and for each of them have been considered data about sustainable balance sheets that were crossed with major economic indicators. The main green topics that have been analysed are, for example, the reduction of impacts on the environment and the inclusion of externalities in the value chain of the company. It came out that, as said previously in the upper chapter, the bigger are the companies and the more they are sustainable, first of all because they have more resources to spend in this sense and secondly because they have the obligation to record non financial data, so more information are available. Moreover the 17,6% of enterprises in general, mainly in the Northern area, is highly sustainable, while one third of manufacturing companies is highly sustainable, which means that one every three considers deeply climate change processes, resource exploitation limits and technological development when performs its businesses. In any case 56% of businesses promote activities to protect the environment and 13,4% of them invest in circular economy. And the main driving reasons to do this, are for the 77,6 % connected to image and reputation improvement, for the 60,9% in order to cut the costs and for the 49% to acquire new market segments. The north-east area of the nation has demonstrated to be much more involved and active in these operations,

[69]National Institute of Statistics in Italy
[70] Amount measured in terms of value added per worker.

as according to researches done by North-East Foundation and Cuoa Business, Veneto is the second region for investments in green technologies, 62% of companies have promoted activities to improve well-being of their employees, is the first region for waste separate collection (74%) and have created 45.990 new green jobs. So, given these notions, it's possible to understand that if Italian companies learn how to communicate effectively with markets and governments, they can enter and benefit from a market share of $ 31 trillion of investments for sustainability around the world. In Italy economic growth is stagnant. One of the huge problems of the nation is that it isn't able to cope with a massive public debt, as the amount of money to be repaid back is increasing every year, the interests to be refunded raise, while the economic growth slows down, as in 2019 GDP has increased just of 0,2%, being the last country in Europe for expected growth. Between 2010 and 2016, productivity has increased just of 0,14%, and it's true that after the financial crisis of 2008 the indicator has perceived a halt in general in all countries, but in our nation the phenomenon is alarming since years. Maybe, sustainability can become the new solution to Italian low productivity, one of the possible ways to come out from the crisis.

The main problem of Italy, is that, again, it isn't able to communicate its value to others, these big advantages and resources have to be noticed by others. Thanks to GRI criterion, for example, is possible to use international indices to compare different alternatives and understand which are the most profitable, sustainable and convenient ones. So the very important lesson that the country can learn from these evidences is that it has the tools, the capabilities and the resources to do the best, it just needs to understand how to use them.

Figure 23: Value of Sustainability, % increase in productivity of companies that adopt sustainability criterion compared to others which don't. (2015-2017)



Source: Istat Report 2019, il Sole 24Ore

The more is invested in nature, in sustainability and the more is greater biodiversity, the greater productivity. Ecosystems containing several species are more efficient than the individual ones. An experiment using data from 400 studies has discovered overwhelming evidence that biodiversity in plant kingdom is essential for nutrient assimilation and solar capture, resulting in an increased production of biomass. We can understand plants as to be a kind of soccer team. To win a match you need the star striker, who scores the goal, the keeper to avoid the other team to score, and the supporting players, to pass the ball and defend. Species-rich plant communities are more effective and productive than single-plant areas because first of all there's a higher probability of having "super-species", highly productive and effective in regulating ecological processes, and moreover because different species have different characteristics that complement one another. Climate change and other human impactful activities that are generating species losses with an increasing trend will cause species extinction, compromising the maintenance of goods and services humans depends on and key features required to sustain life on Earth.

Many innovation and solutions to economic problems can be found in nature. In Sardinia, for example, thistle is an invasive plant full of thorns, but biotechnologists have discovered that the oil extracted from the plant contains monomers that can be used in many industrial components, from tires, to cosmetics and lubricants. Thanks to this discovery in 2011 one of the most polluting petrochemical plants has been transformed into a bio-refinery. Moreover the scientist that has invented biodegradable bags to substitute the plastic ones was Italian. Are many the innovation and technologies inspired on nature to reduce drastically environmental impacts, from snake's poison to cure heart diseases and low down pressure[71] to silk worms to produce hyper-resistant textile fibres. A lot of projects are studying larvae and their capabilities to decompose tissue: a very important research in the agro-food business, where they can be used to decompose animal waste in order to generate low-cost micro-proteins used to fed the cattle, in this way will be partially solved the problem of huge waste generated by beef consumption. Apparel industry for many years have tried to become more sustainable utilizing bio-cotton, cultivated in an ecological way, trying to reduce chemicals and dyes. Besides, in the latest periods is trying to create textile fibres from recycled materials, but not only cotton and wool, even plastic, as Pet bottles. Puma, for instance, in order to show its effort on the environmental field, is reporting in all its label, from t-shirts to shoes, environmental costs for the production.

[71] Many drugs work by inhibiting the enzyme that converts angiotensin, avoiding vasoconstriction and hypertension. The inhibitor used is a component of Brazilian viper's poison.

Talking about agriculture, if it is organized in a proper way, so that to ensure that agricultural systems are becoming sort of carbon sinks, soils become more productive, generate more nutrients for plants and is able to capture water more efficiently. With conservative agriculture and culture rotation in Niger, one of the resources' poorest regions in the world, in the 90s they have been able to increase productivity of 5 billion hectares of cultivated lands. Biodiversity has increased, soil quality has increased, too, and gains of farmers have doubled, bringing annual family income to 1.000 $ per family. In India have been created a lot of biogas-alimented units, so that families can use methane instead of timber to cook, reducing timber consumption of 70%. And given that to collect manure, have been built stables, tiger attacks on cattle have reduced. A simple change has re-given hope to small nearby forests, that otherwise would have been depleted for timber production, leading to the extinction of many animal species, like Asian tigers.

Working with nature, and not against it, is something essential to guarantee that things works. We live in a world in which makes sense using natural resources in a responsible way, as it increases productivity, it makes companies more efficient in the long run, and because differently the world will replicate in form of droughts, ecosystem collapse, extreme weather events and epidemics.

People, consumers care about the environment. In a world in which population is growing dramatically, there are 28 megacities that are supposed to grow to 40 by 2030, two thirds of human being will live in urban areas, and individuals want to live in cleaner cities, in sustainable, resilient and healthy areas. If towns want to be competitive have to learn how to flourish. Just look at Singapore, which has a huge population density but at the very same time a very high level of natural resources within itself.

So in conclusion, the main objective of this chapter was to prove that there are many reasons why it should be better to become sustainable and green. First of all because literally customers are asking for it, the population is searching for more eco-friendly products, place where to live, services and activities. Secondly, because it's necessary. We have reached too many tipping points and if we not find a way to stop this too drastic exploitation of resources, this too invasive pollution, if we do not discover ways to produce goods and services in a environmentally friendly way and we do not enter in the equilibrium circle of the ecosystem instead of destroying it, the Earth will collapse. And the planet then, in some way, will recreate itself, after millennium it will re-equilibrate itself, but humanity will not. We are threatening ourselves. In the case this wouldn't be enough, becoming more sustainable means also becoming more productive. If enterprises pollute less, care about biodiversity, if they manage properly waste reusing it, if they have a positive impact on the natural ecosystem, they become more efficient, they spend less costs, they

attract more client, they create more value, and reap higher revenues, and there are a lot of literatures able to prove it.

2. A linear regression

In the literature, we find any time more thesis, declaration and claims about the fact that being sustainable is economically advantageous, that if companies invest in circular economy, recycle of waste and maintenance of biodiversity, they become more efficient and productive. Many writings, essays and theoretical valuations have been made with the proposal of talking about the importance of sustainability and its positive impact on consumptions and economy in general. The problem is that there are already too little practical demonstration of how being greener is positively impacting on productivity, efficiency and development of companies. The damage function, and its reassessments during the years, is able to provide us information about the possible negative impacts, losses and catastrophes caused by climate change. Studies developed by Tol and Stern, previously mentioned, are contributing with information about the Social Cost of Carbon, but are, in any case, data about the costs to be felt in case of a warmer planet, these evaluations are not presenting results about how being environmentally friendly can improve efficiency and so productivity of enterprises. Just few recent researches, as the one of Istat, drawn on a sample of Italian businesses, have shown practical and numerical interpretation of the relationship between sustainability and labour productivity, proving that there's effectively a positive rapport between the two. According to the Italian study, the degree of dependence through variables is even stronger that what can be effectively imagined, as on average the coefficient of correlation between productivity and sustainability is equal to 10%, which means that if the index of sustainability improves, the productivity increases by 10% of this evolution.
In order to contribute to this purpose and determine, from a pragmatic and feasible point of view, the possible connection between sustainability and productivity, in this and the following chapter, there will be an analysis on a linear regression. The problem will be analysed with a statistical perspective: analysing numbers, collected big data and past information recorded on database, so that to create a model in order to explain the relationship between two factors, respectively productivity and sustainability, in this case; trying to look at how these variables have behaved in

the past, have evolved and transformed during the years, and then estimating and evaluating how they are supposed to behave in the future.

The main aim of the linear regression's analysis is to assess at the beginning, *if* there's effectively a relationship between productivity and many different sustainability variables, and then, if there's a connection between variables, *how much intense* is the relation between them. On the calculation are considered even other control variables, too, in order to make assessments robust and valid. The reason why they are considered, is because productivity does not depend only on sustainability alone, there are many other elements to be taken into account, and so, to really understand how much sustainability weights in the decisions to be taken, it's real importance compared to all the other factors, even all the other elements are evaluated on the equation.

Specifically, through the investigation of past data recorded by many industries on principal databases, as Italian Data Bank, European Data Bank and World Data Bank[72], have been designed specific equations that through algorithms and trends examination identify possible connection through different parameters, so that to understand how a defined variable, productivity in this case, moves according to movements in all the others.

The information coming out from these studies can be pretty much useful for both countries in general, and more specifically, for companies. In this specific situation, the thesis is more concentrated on the microeconomic perspective, and so, on how small businesses can benefit from these concepts. For example, if for a specified activity or sector it comes out that the connection between the amount of produced waste and capital productivity can be associated to a coefficient of -15%, this means that if the amount of garbage produced by a given company X working on that sector increases of 30% than capital productivity decrease of 4,5% (given by 15% multiplied for 30%), which is a huge negative result.

According to this, enterprises have the possibility of understanding how their efficiency and productivity changes according to variation on the variables considered, and take proper decisions according to this. Essentially, it is possible to understand what factors impact more on the dependent variable considered, there's the possibility of investigating the isolated impacts of each element, controlling those ones that are more influencing the principal variable. Moreover, in this way it is possible to make prediction on possible outcomes to be perceived if parameters are supposed to increase or decrease in future periods according to some trends, forecasts on the market or technology improvement. For example, if company's sales have increased steadily every

[72] The main sources used to download and scrutiny information and data have been Bloomberg, Eurostat and Istat.

month in the past few years, through a linear regression on sales data is possible to forecast sales in future months.

2.1 How does it works and why it is important

So starting from the very beginning, in order to make things clear, first of all is going to be explained what is a linear regression.

A linear regression is essentially a model that is able to describe and evaluate the relationship that undergo between two parameters, more specifically, the scheme represent the linkage between a dependent variable *y* and an independent variable *x*. The dependent variable, is also called predictor or the factor of interest, as it's the element that has to be explained, is the factor of which we want to know the trend, the movement, the possible future variations. On the other hand, the independent variable is also called, explanatory variable, and looking at the movements of this factor, its up and downs, is possible to estimate a relationship with the variable *y*, given the fact that according to its fluctuations even the dependent variable is moving on a sense or another; the variable *x* is able to explain the factors that influence the predictor according to the degree of impact, defined by the coefficient or "parameter estimate".

It is like an equation:

$$Y = \alpha + \beta x + \mu$$

The variable Y is the dependent variable, the one that is required to be explained according to fluctuations and changes in the *x*, which is the independent variable. The aim is to try to understand how much the dependent variable moves, with movements in the independent variable, if *x* increases how much Y decreases or increases or if it's not moving at all. The coefficient β is effectively measuring how much the predictor is supposed to alter according to changes in the *x,* is the element on which we focus all of our attention, because the greater it is, both in negative or positive side, the more the parameter on which we are interested is affected by variations in the other factors. For example, if the dependent variable is world GDP, and the independent variable is the interest rate, the aim would be the one of understanding how much the GDP changes according to changes in the interest rate. If Beta is equal to -60%, and the interest rate is increased of 3%, it means that the GDP is supposed to decrease of 1,8%. Clearly, if the coefficient is positive, this means that with increases in the independent variable, even the dependent one increase, and vice-versa, they are moving in the very same direction. If, on the

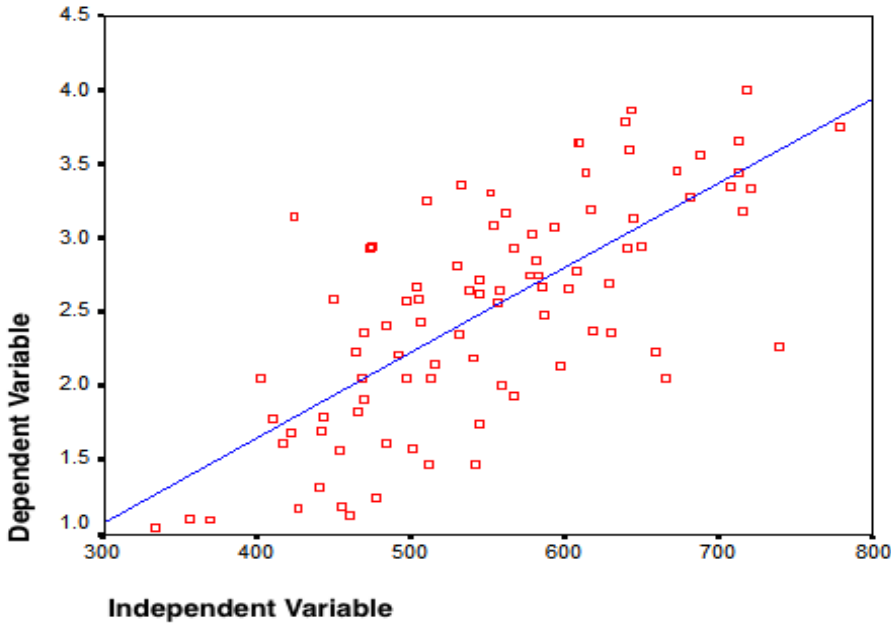
other hand, the coefficient is negative, this means they are moving on two opposite directions, with changes in one the other is shifting oppositely. If, finally, the coefficient β is equal to zero, or really close to zero, there's no correlation between the two, they are independent and not connected in any way. The symbol α is defining all the changes in the dependent factor that are not explained by the independent variable, so if the variable *x* is not supposed to change at all, how much the variable Y changes autonomously. In some way is the fraction of the variable Y that cannot be explained by any parameter, which is completely independent from everything and that moves individually, completely separated by the others. It's the average value of Y. The last factor μ has the aim of controlling the degree of errors. This is because a linear regression is in any case an estimation, is not perfectly deterministic, it's not supposed to give information and data that are exact, perfectly precise and established, there has to be a random disturbance. The existence of it is related to the fact that will be always left out some determinants of Y, there may be errors and random influences in the measurement of Y that cannot be modelled. When we are using a linear regression we are trying to study and evaluate stochastic models, so phenomenon that should be casual, randomly determined. According to this, there can be a path that in some way shows us linearity in some behaves or trends, but they cannot be perfect. Looking at the data we should see random observation that are dispersed the one with respect to the others, not perfectly defined patterns.

Linear regressions can be estimated in mainly three different ways: looking at cross-sectional data, looking at time-series, and through panel data. Cross-sectional data are information about the two variables (independent variable *x* and dependent variable Y), collected looking at a sample of different subjects, which can be individuals, enterprises or industries, fixing the variable time at a specified year or period in general. An example can be the analysis performed by Istat, which has collected information about sustainability indicators and labour productivity for 14.000 enterprises, so for 14.000 different units that have been used as observations. Time-series analysis works on periods, as annual results, trimestral results, monthly results, etc.; so the observations that are used in order to build up the model are the data about some specified periods. The analysis of this thesis has been performed exactly in this way, building up four different analyses on four of the main Italian industries (agriculture, food and beverage, construction and apparel). Essentially in this case have to be collected information about the variables according to time. So let's consider variable Y productivity, data about productivity have to be collected from year 1960 to year 2020 and the very same for variable *x,* in this way there will be 60 observations on which to work. Finally panel data is a combination of the two previous models, the problem with this

methodology is that, even if theoretically it seems to be very exhaustive and complete, it's pretty much confusing and articulated, complicating too much evaluations without providing robust and concrete results. So given its trickiness most of the times is not used.

Taking into account time-series regressions, as they are the one considered in this abstract, but knowing that the following evaluations will be the same for every methodology used, how does a linear regression work? Effectively, once have been collected the information about the two variables, both the dependent and independent one that are going to be used, there will be a set of observations related to every period for each parameter. For example they can be semestral results from 1960 to 2020 of productivity and sustainability, so there will be 120 observations to be used for variable x and Y. The model works trying to figure out what can be an abstract line representing the trend of the relationship between the two variables according to the observations. So having all the different considerations, there's an algorithm that looks at how the variables have moved during time together, if they have a similar or opposite movement, if there's no common trend at all, and in this way tries to identify a possible linear relationship that holds for all the observations, represented as a line.

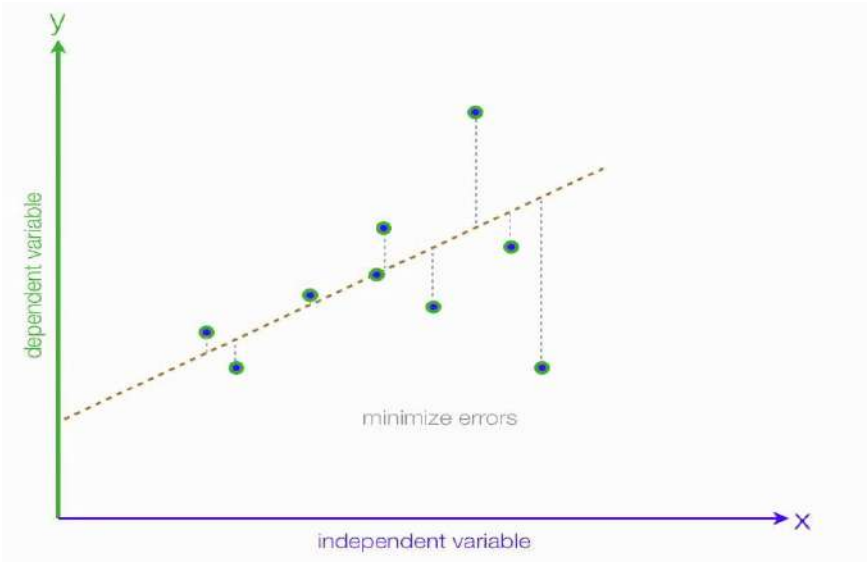
Figure 24: A graphic representation of a linear regression



A graphical representation of a simple linear regression can be useful to make it easy to understand the meaning of the different parameters. All the different red dots are identifying the different observations, so the value of the independent variable associated with the value of the dependent variable for each period that is going to be considered (one dot can be the value for the two

factors in the first semester of 1960, another one the second semester of 1960 and so on in this way). The blue line is the result of the linear regression, where the slope of the curve is identifying Beta; in fact the more the curve is flat, the more the two factors are uncorrelated, as big variations in the *x* don't cause noticeable variations in the Y, instead the bigger the slope, the more pendant is the curve, in a sense or in the other, the more they are highly correlated. The coefficient Alpha is represented by the intercept, as it stands for the part of Y that cannot be explained by any factor, which is completely autonomous. Finally, the errors coefficient (μ) is identified with the sum of the distances that undergo between each dot and the blue line, and its essential for the computation of a linear regression. As a matter of fact, the way through which the regression is evaluated is called Ordinary Least Squares methodology. The method tries to find out the line that ensures the minimum sum of the squares of the distances between each dot and the line. It tries to find the line that minimizes the errors, and so the distances between each observation and the estimates, so that to have more robust and explanatory models. The shorter is the distance between the dots and the line, the more the line is able to capture, to identify and represents the dot in a good way. The reason why are taken into account the squares, is to guarantee that positive and negative signs are not cancelling out with each other, is just to consider a kind of absolute value.

Figure 25: Linear regression represented concentrating on errors and their minimization



Once the regression has been built up, it's fundamental to test if the coefficients that have been found are valid and solid and if the errors are respecting the assumptions. This means that have to be defined confidence intervals for the estimates in order to make sure they are statistically

significant and based on objective data. And errors have to be analysed so that to make sure that they have a normal distribution, they have equal variance (*homoscedasticity*), and the trends are captured on the regression and no fluctuation is left on the errors, which means that between errors there has to be no linear pattern.

Essentially the parameters that have to be mainly considered to test the coefficients and make sure they are robust, valid and statistically correct, are the following: T-test or t-value, P-value, R^2 and adj-R^2 and finally F-statistic.

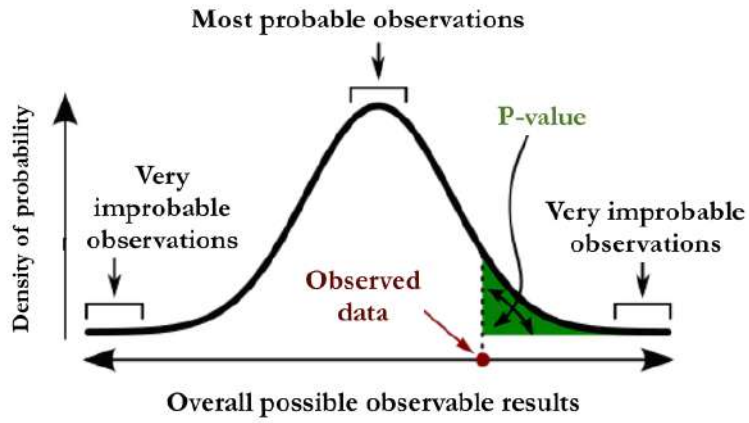
T-test or t-value: it's a methodology used to make sure the estimated coefficient is reliable and significant, statistically talking. Mainly, through this figure, is controlled how far is the fitted value, the estimated coefficient from zero. If β is equal to zero, in fact, it means there's no relationship between *x* and Y, and so it's tested if, from a statistical point of view, the coefficient can be assumed to be distant from the null hypothesis in which β is equal to zero.

$$t = \frac{\hat{\beta}_1 - \beta_{1,0}}{SE(\hat{\beta}_1)} = \frac{\textbf{Estimator} - \textbf{Null hypothesis}}{\textbf{Estimator's standard error}}$$

Knowing that the null hypothesis assumes that β is equal to zero, the greater is the t-value, the better it is, as the more distant is the value of the estimate from the null hypothesis, and the lower is the standard error for the estimator, the more the parameter that comes out from the analysis is effectively not close to zero and can be assumed to exist a relationship between the *x* and the Y.

p-value: this estimate is trying to make us understand what is the probability of observing a value that confirm the null hypothesis. Is the probability of finding a value different from the one in the model, from the estimated one, supposing the truth of the null hypothesis, so Beta equal to zero and no relationship between *x* and Y. It makes us understand if the probable difference between the estimate and the observed result is due two the sample mechanism or is statistically significant. Normally, by default, is fixed a threshold value equal to α = 5%, split in 2,5% on a side and 2,5% on the other side of the normal distribution. This is the probability considered in order to establish if the model is valid or not, this is the threshold that must not be overcome. So if from the analysis the p-value comes out to be greater than 5% means that there's a probability higher than the threshold to find out an observation that confirm the null hypothesis (β = 0 and *x* and Y not correlated at all), so the null hypothesis will be accepted, the coefficient is assumed to be not significant and the regression is not reliable and solid.

Figure 26: Graphical representation of normal distribution and p-value



Looking at the above image, if the p-value is greater than 5% means that we are outside the 95% of confidence interval, and so outside of the place in which can be the most probable observations, we should accept null hypothesis, as the probability of finding observations that do not respect the relationship of the regression is too high. If, instead, the p-value comes out to be lower than 5% our model is good, we should reject null hypothesis as we are within the confidence interval, there's a very low, if not null, probability of finding a situation in which dependent and independent variable are not correlated, and the coefficient Beta is different from the estimated one, so our model is a reliable one.

R^2 and adj-R^2: In order to explain properly these two factors, and recognize why they are fundamental, is important to consider the following formula:

$$R^2 = 1 - \frac{SSE}{SST}$$

SST, *sum of squared total*, is representing the total amount of deviance present in the dataset, considering all the observation and their movements, it globes the behaviour and the trend contained in the sample, the overall population. SSE, *sum of squared errors*, on the other hand is identifying the residual deviance, so the part of the variance present in the dataset that is not captured in the model, the fluctuations, the nature that the estimation hasn't been able to represent. Clearly the lower is the SSE and the better it is, as we want a model that is able to capture the more it's possible the variations in the real data, and according to this the residuals should be at the minimum level, to make sure that almost nothing is left out from the model.

With this respect, R^2 is another figure useful to understand how good our model is; the greater it is and the better the regression, as it's able to capture all the nuances of the attitudes of the variables.

But there's a problem with this factor when there are many independent variables used to explain the dependent one. In fact, the more parameters are included within the equation and the more R^2 tends to increase, as there will be a huge amount of data on which to rely on, and a greater volatility considered within the model, but the more estimates are considered, the more the model will become confusing and chaotic, so effectively it won't be able to tell us anything interesting, it will be even difficult to understand, not giving us the possibility to infer any information. R^2 won't be effectively reliable in these cases, as it isn't able to tell us the goodness and the validity of the regression. That's why it's important to look at the adjusted R^2 rather than simple R^2, as it takes into account this problem, and adjust the figure considering the number of independent variables that are inserted in the model.

F-statistic: it works with the very same logic of the T-statistic but considering regressions in which there's more than one independent variable. When there's only one x, it should be equal to the t-value. According to this, even in this case the greater the value and the better it is, as the values estimated on the model are far from the hypothesis $\beta = 0$.

Talking about the consistency of the errors, even in this case there are many tests to be performed in order to ensure that the linear regression is solid enough to be used as a predictor.

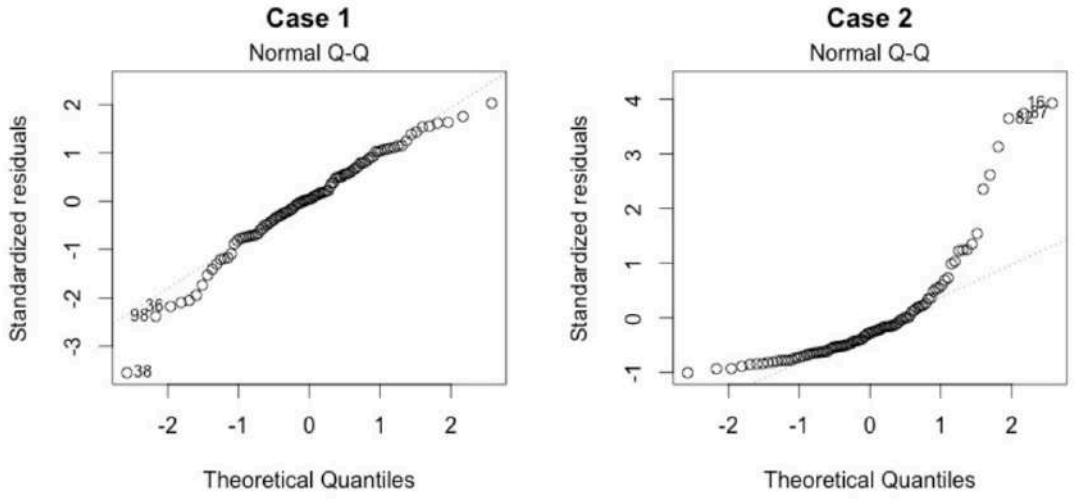
The main valuations to be considered to guarantee that the estimation are good and right, are the following:

1. Normality assumption: the errors must have a normal distribution.
2. Homoscedasticity: the errors have the same but unknown variance.
3. The errors should have a mean equal to zero.
4. Independent errors assumption: the errors must be independent the one on the other.

In this thesis in order to ensure that these assumptions are respected are mainly used graphical representations. According to this, so to evaluate normality assumption will be used the Q-Q plot.

In this first representation if the residuals are well aligned on the straight line, then there's a normal distribution, as they are more or less following the trend of a theoretical perfect normality curve.

Figure 27 : Examples of Q-Q plot to check Normality assumption

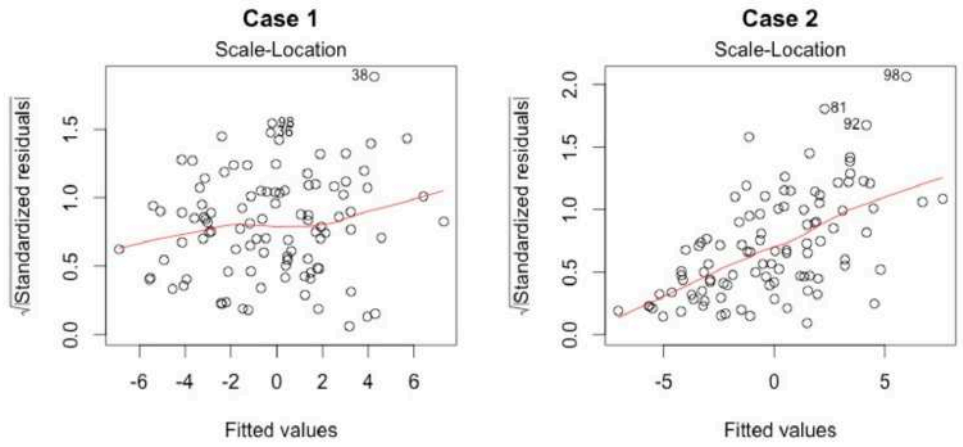


Source: University of Virginia library

As we can see from the images, in the first case the assumption of normality can be assumed to exist, while in the second case it cannot.

The second axiom to respect is evaluated through an analysis of a scale-location plot, also called spread-location plot. In this case the homoscedasticity is respected if it's possible to see a horizontal line with equally random distributed spread points. As can be seen in below images, in the first case residuals are randomly distributed, with a variance that appears to be constant and equal for all the single observations. While in the second case, dots begin to spread from point 5 on causing a trend in the variance that is increasing rather than being constant.

Figure 28: Examples of scale-location plot to check Homoscedasticity

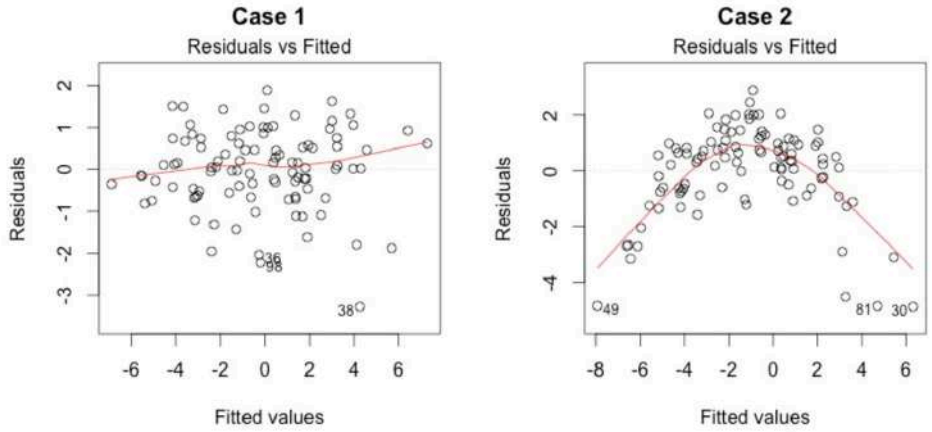


Source: University of Virginia library

Given these representations, in the first case the homoscedasticity characteristic is respected, as errors have the same but unknown variance, whereas in the second it's not.

Finally the last two assumptions are going to be tested with residuals vs. fitted plot. With this representation is possible to understand if there's a linear relationship between errors, and if they have a mean that is different from zero.

Figure 29: Examples of residuals vs. fitted plot to check independency of errors and mean equal to zero.



Source: University of Virginia library

If the two assumptions are respected, it should be possible to see that dots are dispersed randomly around the surface and the red line representing the mean should be more or less in line with value zero in the graph. As it can be seen on the two graphs, in the first case the axioms are, again, respected fully, whereas in the second image there's a kind of pattern in the residuals, which means that there's a relationship between them. So, in the Case 2, the overall linkage through variables is not fully captured by the regression, leaving part of the connections in the errors that are aggregated in a kind of path, violating E(u)= 0 and independency assumptions.

Just to conclude this brief chapter, a very important specification that has to be made is that, normally, as previously mentioned, there won't be just one, and only one, independent variable x, but there will be many. A defined factor Y will never be explained by a single, individual, independent parameter, it's not realistic. Just to recall the previous example that have been made, the world GDP do not depends only on the interest rate, but will depend on the offer of money, on exports, on consumption, and many other elements. It's a choice of the researcher to establish what will be the factors to consider and to not consider. In order to select properly the parameters to take into account within the regression, it will be better to look at factors quite different, independent and uncorrelated between each other. First of all, because in this way it will be possible to capture all the distinct nuances of Y's fluctuations, as the more all the *x*s considered

are distant from each other, the more they are representing particular, different meaning of the dependent variable and have the opportunity of identifying different, small characteristics of Y. Furthermore, another reason why it's very important to select factors that are distant, autonomous and not connected at all, is to avoid multicollinearity. In fact, independent variable connected between each other will provide coefficients that are not robust and that vary drastically even with small changes, causing problems in the interpretation of the model and biased result, which are not telling us anything correct or predictive. In addition, when independent variables are correlated, meaning that one the variable x can be explained as a combination of all the other xs, the R^2 and even the adjusted R^2 would be suspiciously high, making it look like to be right, but it is not. When these two indexes are too high, with values near 90%, it most of the time means that there's multicollinearity within the model, that there are two or more variable correlated, but this means that the provided results are incorrect, unuseful and biased. It's important to not confuse a very unrealistic positive value with a biased outcome, deep attention has to be paid.

Once have been understood what is a linear regression and how does it work, it can be easy to understand why it can come out to be so useful in many situations and fields, not only in the economy. As previously said, with this tool is possible to predict future outcome. Given some historical data, there's the opportunity of analysing the trend and movements of these information during time, cancelling out potential outliers that can lead astray, and thanks to these important insights draw up a possible forecasted future pattern for a specified phenomenon. There's the opportunity of predicting the behaviour of a dependent variable according to the behaviours of few or large number of independent variables. Furthermore, it would be possible to realize what are all the different factors and movements that mostly influence a determined element: it can be discovered that some actions or policies are much more important than what have been thought initially and can cause dramatic changes in the final output. So having these data, a general user can easily figure out what are the most and less fundamental variables to consider in specified analysis, what are the elements mainly responsible for changes and movements in the general output. And estimating, forecasting how these supposed variables are expected to change during time, or having consistent previsions about the market performed by analysts and statisticians, is possible to have an idea of how can modify even the principle variable on which interest is posed. Clearly, black swan events or unexpected growth in the market are not considered in the model, as it is just able to provide possible idea of performances that are in line with previous trend recorded, so huge up and downs or unprecedented situation are not supposed to happen and are not taken into account.

2.2 Final Objective and Choice of the variables

As said many times in the previous chapters, the main objective of this abstract is to demonstrate that exists a relationship between sustainability and productivity in enterprises. It has been already demonstrated, by some American researchers and by the Italian Institute of Statistics (ISTAT), that investing on green economy and sustainable matters pays during time, in terms of productivity, but through this analysis the results should be replicated from another perspective. The focus, in this case, is put on the industries, not on the single entity, the firm itself. One of the main reasons why the evaluations have been performed looking at the whole category, rather than the single element, is because of the lack of information. The data of the single company are secreted, they cannot be disclosed as they are personal and private. So in order to collect specific information from every single Italian enterprise, or you are a National Institution that collects and report evidences about every Italian entity through surveys and national records, guaranteeing privacy and anonymity to the participants, so that to disclose national information that than can be used within the country and at an international level to make assessment and take important political and economical decisions. Or you have a direct contact with companies considered in the study, but there weren't available enough resources and time to contact an amount of enterprises sufficient to have an acceptable sample size, as to produce an analysis in which the observations are the single individuals, in this case companies, there should have been at least 100/150 different subjects. In addition, generally a single company wouldn't disclose sensible and exclusive data to anyone who is not certified, even if privacy is guaranteed, most of the time they would allow the treatment of their personal accounts only to known and authorized members. Choosing whole sectors instead of microeconomic enterprises could seem to be a very generalized approach, as instead of having specific, very detailed and particular results, are used data and information that are grouping together accounts, investments, expenses and general insights of every entity into a single body. The fact is that concentrating on sectors can be, in reality, even more interesting than looking at the single economic business. Indeed when the focal point is set on individual companies there can be biases results, especially if the dataset is not pretty numerous. This happens because single entities can have very disparate and different situations and conditions, representing very particular cases that are specific for each subject. The risk consists in taking into account cases that are too much different between each other, too much subjective, not considering the effective trend of the situation. If the object of the observation, instead, is the

overall industry, there's already a kind of average, normalized observation that is more adjusted and which is reflecting a real fact rather than single outliers, much more insignificant.

The aim would be the one of proving that there's an effective linkage, rapport between sustainability and productivity, that these two factors are not independent and that if a company, working on a specified sector, decides to invest in responsible waste management, in biodiversity maintenance, in circular economy, sooner or later its productivity will increase, generating many advantages in terms of reduced costs, greater efficiency, greater value produced and delivered on the market and greater market share on which to rely on, as it acquires responsible customers searching for environmentally friendly activities. All these effects jointly will ensure that the overall value of the company increases during time, and the positive benefits will be perceived in many different forms: higher quality of the products generated and so higher prices fixed, resulting in greater income produced, positive outcome from an ethical and psychological perspective, as the company will treat the environment in which it's inserted in a better way, the resources won't be depleted at an unsustainable rate and it will be more appreciated by the community; moreover there will be an improvement in the efficiency, so it will be necessary to work less in order to achieve the same result, the resources are used in a more clever and intelligent way, and the future perspective are improving and becoming much more of long-term.

In Italy, the economy mainly is sustained by four very important industries that constitute the bases for a robust and long-term advantage, which are: the agricultural industry, involving both vegetables production and cattle farming; the food and beverage industry, considering the production of food for the retail and general beverage, the apparel industry, considering both haute couture creation and classical lines, for the wholesale, and finally the construction industry, related to house, buildings and infrastructure creation.

For each sector, has been developed a time-series linear regression looking at data available from 2000 to nowadays. Many problems have been discovered in the development of the analysis, especially connected to the unavailability of recorded data due to the actuality and newness of the topic. In fact it's only in the last few years that concerns about climate change and global warming have started to become more relevant and considered by a large amount of population. Before the 2000s, even if there were already researches, studies and warnings about the imminent planet collapse in the case in which things are not supposed to change, they were not taken into account very much, particularly by economists. A common thought was deeply rooted in people mind that these themes were overvalued and not big problems would have been perceived if the production of goods and services and the exploitation of natural resources would have gone on in the natural

and as-usual way. The fact is that natural catastrophes are part of cycles that have characterized life on Earth since the dawn of time, it doesn't matter if they are caused by humans or natural conditions and the planet, as has done in the past, will be able to survive to events like droughts, global warming, extreme weather events and wild fires of the last years, is the economy and human-being itself, which probably will not.

With time passing by people, scientists and economists around the world have understood any time more how much these changes can be essential and very relevant for the existence of life as we know it today and its connected economy; so in the last few years statisticians, general database and registers have started to record and collect some data about sustainability, but they are very recent. According to this, a small number of temporal observations have been discovered to be available, as previously said, just from 2000 to nowadays. In order to solve this problem some adjustments have been made to increase the sample size and respect the trend, the evolution and the complexity of real observed data, they will be explained in detail in the premises in the following chapter.

By the way, at this point there will be an explanation of the variables that have been considered and deeply evaluated to run the linear regression and study the topic. Even in this case, so that to ensure the valuations are as more detailed and correct as possible, many considerations and further analysis have been done.

The dependent variable Y was chosen to be **Total Factor Productivity (TFP)**. In general productivity measures the level of efficiency of a system comparing the output generated with the inputs used to create that output. It represents one of the most studied and analysed variables in nowadays economy, as it can be useful to understand and explain growth in entrepreneurial production. Productivity is one of the element that largely influence competitiveness within the markets, as the more an entity, a company, a sector is productive and the more it will be effective, powerful and attractive compared to the others. Productivity growth for a firm is very important, as it is normally followed by greater income, and higher revenues ensure the capability of meeting obligations to customers, workers, shareholders and governments maintaining an ambitious competitive position or even improving it within the market. Total Factor Productivity is an index used to measure the value of the output generated that cannot be associated to labour and capital specifically, but considers jointly, at the same time, all the factors of production that have contributed in the development of the output and the synergies between them; it is a kind of degree of economic effectiveness. In some way it tries to capture the degree of technical progress, considering the improvement made on the productive inputs, the improvement in well-being.

For the selection of the independent variables, some further considerations have to be taken into account. First of all it doesn't exist a single, comprehensive, general index able to tell us how much a company is sustainable, green and environmentally friendly. So, in order to consider all the possible implications of sustainability, and to take into account all its different characteristics, nuances, have been used some proxies that are trying to represent in the best way the full, various sides of the topic. The variables that have been considered are the following ones.

Adjusted waste generation: this parameter represents the overall amount of waste produced by businesses in the industry during the year, both hazardous and non hazardous trash. It should be negatively correlated with productivity, if the assumptions about sustainability and its positive correlation with productivity are correct. In fact the greater is the amount of total garbage produced, the less green is an enterprise and the less productive it should be. So that to evaluate factors that are the more realistic it's possible, this data have been adjusted considering the percentage of recycle of the country per year, deducting from the gross value the fraction of recycled rubbish. This means that if for example the recycling percentage in Italy in 2008 was equal to 74%, the value of the variable will be decreased of 74% in 2008 for each sector, so to consider just the net effective waste produced by the industry.

Green House Gases Emissions (GHG Emissions): even in this case the value is expressed in tonnes and collects the amount of gases emitted by companies within the sector that can be particularly damaging for the environment. Green House Gases are those substances mainly accountable for global warming, as they have the capability of detaining a big fraction of sunrises that passes through the atmosphere and capture them inside of it, causing the so called Green-house effect. The typologies of substances considered in this specific case have been methane, carbon dioxide and natrium oxide, the ones emitted at larger quantities and the most important. In the same way as before, even this variable should have a negative relation with productivity, as the greater the emission, the more we are harming the planet and the lower should be the level of efficiency.

Environmental Taxes: this value is expressed in million of euros. It exemplifies those taxes, which have as tax basis a physical measure, or attitude (in case of necessity substituted by a proxy), that has a specified and proved negative impact on the society and the environment. They comprehend behaviour against political actions that have the specific intention of protecting the environment, as those certified by CEPA on the management of waste, soil and water protection, air protection, sewage management, biodiversity protection, protection from radiation and noise protection. But there are even taxes on energy products for transports, mainly on oil and diesel

consumption, for stationary uses (natural gas, coal, oil and electricity used in plants), and taxes on CO_2 emissions. Again, even for this parameter, there should be a negative correlation with productivity, as the more taxes a company, or a sector in general, has to pay, the more it pollutes and produce negative effects on the environment, and so they should be opposite the one from the other and go on two different directions.

Sustainability subsidies: talking about sustainability subsidies, this factor is defined in millions of euros and it represents the subsidies offered by the government to companies working in industries that are involved and deeply committed to sustainable activities. Clearly this variable would be positively connected with productivity, as the more subsidies are perceived the greater is the effort to create, develop and persecute sustainable practices. Many projects developed by companies in the environmental field have been financed through these subsidies, especially those connected with chemicals, air, green topics and circular economy. These resources provided by governments have been pretty useful in guaranteeing improvements in the technologies, in the innovation, implementation and monitoring of environmental policies. The main activities on which subsidies are concentrating are Research and Development for environment protection, the management of natural resources, as forests, flora and fauna, the energy resources, mineral management, are focusing on air and climate protection, waste management, soil protection, noise reduction and biodiversity protection.

Environment protection expenses: in this case the figure is represented in thousands of euros and also in this situation, it should be positively correlated to productivity, if the hypothesis that the abstract want to demonstrate is correct. This factor accounts for all the money spent by companies on sustainable practices; the main investments considered are those connected to machineries and plants for the control of pollution in the environment and special accessorize to reduce emissions, to machineries and plants that work exploiting renewable sources of energy and clean technologies and finally to current expenses for environment protection. In some way this parameter has the opportunity of capturing the effort and the involvement of companies in direct and effective practices connected to sustainable activities, is trying to measure the degree of attention the company spends autonomously towards the environment.

Value Added in the Environment: this factor is expressed in billion euros and tries to identify the quantity of goods and services created by companies that can have a positive impact on the natural ecosystem, on its productivity, biodiversity, on its maintenance and protection, and considers the value added directly generated by companies that can improve the condition of the environment in general. It should have a positive impact on productivity clearly.

These are the general variables that have been used to represent sustainability within the regression. For the analysis of the agricultural sector, have been added two more parameters, considered to be sufficiently important, as when talking about agriculture the situation is a little bit more complicated. In fact this industry in particular, is less controlled and thought to be much more traditional and old organized with respect to the others, that's why further estimates have been used. In the latest years, even this sector has started to worry about green economy and has started taking measures to become more environmentally friendly, so there are effective proofs to demonstrate that this industry is sustainable, too, and it's trying to become it even more and more. Unfortunately these actions have started just in the last seven years, so the size of data available is even shorter than the other ones that have been used for sustainability valuation.

Biological cultures: this data represents the percentage of agricultural surfaces that are dedicated to biological cultures in Italy, and should be positively related to productivity. Biological cultures are considered those ones that are respecting the biological life cycle of nature. This objective is mainly reached through rotation of cultures, so that the different typologies of vegetables are not depleting natural resources of soil and the nutrients can be regenerated in a sustainable and responsible way, through tight restriction in the use of fertilizers, pesticides and other toxic substances, OGM organisms are banned, normally are considered natural fertilizers or nutrients that can be found in loco (as manure coming from cattle of the area), and finally considers that cattle are bred in the open air with biological fodder coming from owned or near farms.

Renewable energies: even this measure should be positively correlated with the dependent variable and tries to capture the percentage of agricultural companies in Italy that are using renewable source of energy to sustain their activities. The renewable energies that have been examined are essentially biomass for electricity production, so the combustion of scraps coming from agricultural activities, as timber, sludge from cattle, organic waste, food waste; solar power, wind energy, hydropower and biogas, in general, gases resulting from bacterial fermentation of organic waste as methane, for example.

Once have been illustrated the variables responsible for sustainability evaluation, there's another important assessment to be considered. Clearly, sustainability cannot be the only element influencing total factor productivity, the efficiency of a company depends on many different parameters to be considered, called *control variables*. There are different macro areas and subjects to be taken into account, and the estimation of the importance and the weight of these factors within the equation is something crucial to be done, as they are balancing the valuations. Trying to discover what are the additional categories that can be relevant in the regression makes it possible

to understand the real degree of impact that sustainability has on the efficiency of industries and what can be other elements that are important to improve productivity.

Have been already clarified that in order to become richer, stronger and more competitive within the market, productivity is an essential variable to be considered; the greater it is, the greater the economic development and the greater the income of the industry. But what are essentially the factors that are able to trigger the process of improvement? What are the bases, the necessary elements, which seem to be fundamental to ensure productivity growth?

The macro areas that can be accounted for improvement in productivity have been judged to be effectively four: the **degree of progress** of the industry, so the level of innovation, of evolution and of pioneering technologies that can affect dramatically the efficiency within the market, the **quality of human capital**, so labour productivity, the level of competence, the amount of qualified employees within the industry, which can bring effective improvement through knowledge, competences, experience and capabilities to industries; the **quality of physical capital**, considering capital productivity, the degree of digitalization, factor of advanced engineering in the industry, that are fundamental for the creation of advanced, break-through and innovative materials and product; and, finally, the **level of competitiveness** within the sector, as a higher level of competitiveness can push companies in improving more and more their capabilities, performances and attitudes, being able to reach any time greater and fundamental objective.

Even in this case, in order to represent in the more complete and detailed way it's possible, all the peculiar characteristics of each category many proxies have been used to exemplify the macro sector to be considered. Talking about the degree of progress the variables that have been chosen are the following ones.

Research and Development employees: this value represents the percentage of employees dedicated to research and development within companies included in the industry. The reason why this parameter has been selected, is because probably is able to capture the level of dedication that a specified enterprise has towards innovation, the effort that a company decides to spend in improving its processes, technologies and capabilities. In fact the greater is this value, the more employees are placed by the business in R&D section to find out new solutions useful for the development of the activities. Should be positively connected to productivity. Furthermore through Research and Development is possible to discover new useful materials that can be used for the creation of goods and services, new designs much more sustainable, it can generate the opportunity of seeking further improvements and solve problems encountered along the way.

Innovative activities: it's again a value in percentage, which tries to identify the amount of innovative actions promoted by companies inserted in different industries. It considers innovative activities in terms of creation of break-through processes and products, original marketing campaign, inventive organization of the company and approaches with customers, relationship between employees and in the treatment of the plants and machineries. It should clearly follow the same trend of efficiency.

Expenses on innovation: this figure is expressed in thousands euros, should be positively connected to productivity and globes together all the money spent by enterprises to incentivise innovative productions. It considers the expenses for Research and Development performed internally (intra-muros), costs for the acquisition of Research and development services that are developed by someone else, as universities, other companies, institution and governments (extra-muros), costs for the acquisition of plants, machineries, software and facilities for innovation, and expenses for the acquisition of capabilities from other enterprises or institutions.

In order to express the quality of human capital, further factors have been considered, and they are listed down here.

Labour productivity: labour productivity is identifying the efficiency of labour itself, is a kind of component of total factor productivity. It is calculated dividing the total output produced, for the input of labour that have been used, in terms of hours of labour. Through this factor is possible to demonstrate how effective and productive is labour itself, how much is possible to produce with the labour force at the disposal of the industry. Should be positively connected to TFP and is expressed in percentage.

Qualified Labour: it captures the percentage of qualified employees that have been assumed within companies, dividing the amount of university's graduated employees and high school's graduated employees for the total amount of employees within the sector. It's not said that as someone is graduated, it's surely more intelligent, capable and competent than someone who is not. It's just a proxy used to understand how many people that have spent more time studying, that are assumed to have more knowledge at their disposal and that probably have more competences, are present in the field; to understand how much the industry can be able to improve its potential thanks to human capabilities and knowledge. Positively correlated with productivity.

Competence level: even in this case is a value measured in percentage and it should be highly connected with efficiency. This index has the aim of making it possible to understand the degree of high competences within the industry, so it is trying to evaluate the amount of employees

present within the market that have studied, that have practiced, that have learned how to work in the sector in the best way it's possible. It tries to capture, in some way, the degree of match between what employees want to do and what they are effectively doing. Clearly the higher is the level of workers that are specifically placed in the company, or industry, for which they have developed competences, for which they are better in performances and they have greater capabilities and the better would be for them and the company/industry, too.

Average salary: this factor should be positively correlated with productivity and it's a percentage, too. Constitute an essential figure to evaluate the percentage of people within the sector that perceive an average salary that is high. It's a way to try to understand gratification of employees in working on the industry and even satisfaction of bosses for the efforts that workers put in their companies. It's supposed that the higher the salary, the more employees are supposed to work better, as they are pleased to stay in that company, and the more chiefs are satisfied of the results achieved by the businesses, sot the greater should be the efficiency.

For what concerns the quality of physical capital, on the other hand, the related variables considered in the analysis are defined below.

Capital Productivity: it shows how efficiently capital is used to generate output. It's a percentage, it should be, again, positively connected with productivity and it's given by the ratio between the general output and the physical and intangible capital that have been used to create the products or services. It can be said to be the other face of total factor productivity, jointly with labour productivity, and the greater it is, the more there's the possibility of generating a greater level of output with the very same quantity of capital, and accordingly the higher is the level of efficiency.

Technological Areas: it's a figure expressed in percentage and considers many factors. It tries to take into account the more its possible the grade of technological development within companies. The value takes into account the percentage of companies that in their employees have specialists in ICT, companies that have organized training courses to update competences of employees, enterprises with websites, with automated services and appliances, businesses that exploit online services to commercialize their products and that depend on technologies and internet to sustain their activities. The greater is this factor, and the more the industry will have the potential to create and develop break-through, cutting-edge products and services.

Digitalization factors: essentially this parameter is working in a similar way compared to technological areas, as it's measuring the level of digitalization within enterprises, but looking at other categories to be analysed. It's a percentage and should highly positively connected to productivity. It evaluates the degree of digitalization through the analysis of many important

elements as the capability of doing "networking activities", as the development of digitalization strategies and digitalized competences, as the capability of promoting digitalized initiatives of the public administration and incentives, funds and facilities provided to high degree of digitalization within enterprises.

Industry 4.0: this index captures, in percentage value, the level of efforts spent by industries and activities in following the latest trends and evolution in the field of industry 4.0. The more a general business is involved in processes of technologization, the greatest would be clearly the degree of innovation, of evolution and improvement of tangible and intangible assets in that subject. Specifically the index involves in the computation the amount of companies that use services of cloud computing, of enterprises that exploit the possibility of using robotic mechanisms, appliances and technologies, of businesses that uses 3D printers. It should be positively connected to efficiency, too.

The last few variables that are going to be mentioned are those related to competitiveness. The ones that follow, have the objective of capturing in the best way it's possible, the competitive position that companies or industries have in the market according to their characteristics.

Cost competitiveness: this index should follow the same trend of efficiency, so with increase in the value of cost competitiveness, should increase even productivity, and it's defined by the value added per worker over employee's labour cost and then multiplied for 100. It tries to identify the degree of convenience of labour within companies, as the variable shows the quantity of value added per capita is produced with 100 € of costs for labour per capita. The greater is this value and the more the industry can perceive high efficiency in labour sources, as the costs are not so high compared to the value that is produced.

Changes in the inventory: this factor is a percentage, and it measures the increase or the reduction in inventories within sectors, considering raw materials, semi-finished goods and finished goods. When control over inventories is lost, is lost even the capability of monitoring and controlling profitability and margins. This variable has been chosen because it can, in some way, represent the degree of waste that can be produced by an industry. In fact, supposing we are talking about apparel, inventories are mainly represented by those products that you are not able to sell because they are of the previous collection, for example; they're out of season or do not satisfy tastes of your clients, which more or less are always the same if you have just a single small town store. In this way inventories are suppose to grow and become bigger and bigger during time, causing high costs to be perceived, huge quantity of waste production and difficulties in the management of the situation. On the other hand, if even a small town store has the possibility of

relying on some services as owned online platforms or on specific autonomous websites, which work independently, to which they can sell their inventories, they can easily get a rid of huge quantities of inventories and without lowering prices too much. Just considering the previous example, an apparel store can be able to sell duvets in summer to clients living on the other side of Earth, with no necessity of placing huge discounts to make them attractive. Clearly, if enterprises decides to rely on third entities to sell their products online the incomes will be lower, as there will be some additional expenses and periodic fees to be corresponded to the official website, but in any case the advantages connected to these services are huge. Stores have the possibility of expanding the share of customers with which they have to deal, attracting new clients from all over the world, in this way they will be able to sell their products much more easily and without discounting them to ridiculous prices with which they aren't even able to repay the expenses. According to this revenues will be higher, sales volumes will be higher and even your market share, while waste will be surely lower, avoiding the risk of incinerating or amass huge bulk of products. Clearly this variable would be negatively correlated with productivity, as it represents the changes in the inventory, so in order to identify the best situation it's possible, it should be negative, highly negative, to represent the case in which inventories are reduced, and the greater will be the figure with a negative sign, the higher should be productivity.

Weighted Average Cost of Capital (WACC): This factor is a percentage and represents the costs of capital specifically perceived by companies in the sector, weighting proportionally each category that contributes to the development of the enterprise. It's a rate that companies are expected to pay on average to all its security holders to finance its assets. It considers both equity, and so the money specifically provided by shareholders, actionists and owners of the company, and debt, as bonds, obligation or bank debts perceived by companies to sustain their activities. There are many elements that influence the trend of the WACC, as the percentage of debt or equity, and so the leverage, established by the company, the Beta, so the proportion of risk bared by the industry compared to the overall market, the Risk free rate, the amount of risk perceived in any case, even if money are invested on very secure and safe items. But in general, when the Weighted Average Cost of Capital increases, means that the risks are increasing within the market, and the greater it is the lower would be the value of businesses and activities, that's why it should be negatively correlated with productivity. It's a kind of measure of riskiness, of safeness of the collective investments taken into account. The greater it is, the more money have to be paid by companies to debt holders and shareholders to compute the very same operations and manage the

same exercises, so clearly, the greater it is the lower would be the level of efficiency for the industry.

Export Level: this last factor was taken into account only for agriculture, as it's the industry that mostly exports its product outside the country, so it was judged to be particularly relevant and significant mainly for this sector. Export Level can be a measure of competitiveness as the greater is the amount of goods and services sold outside the nation and probably the more competitive is the sector both nationally and internationally talking. The factor is expressed in thousands euros, and according to what said, the parameter should be positively connected with productivity, and should be able to express the capability of a specified industry to attract customers from all over the world, becoming popular, appreciated and recognized globally.

3. Comments on the result

In this chapter there will be a detailed and specified analysis on the results that have been discovered from the linear regression. Will be defined the variables that mostly are able to affect productivity within companies, will be declared what are the coefficients, the degrees, with which they are able to influence the TFP (Total Factor Productivity) and checked the robustness and solidity of the thesis to be demonstrated, looking at different statistical parameters that are able to make us understand if the outcomes generated are good enough to be considered real and reliable or not. This section can be considered to be the heart of the whole abstract, as it's the moment in which, from a statistical and mathematical perspective, will be understood if effectively sustainability and greener practices can influence directly and positively the productivity of companies and countries and make them become more efficient, more competitive and richer. In order to introduce this part properly, it has to be said that many assessments and evaluations have been done on variables and data in order to overcome some problems. Some information has to be re-managed and adjusted so that to make things work and allow the possibility of constructing a linear regression model, part of the data collected has to be re-handled and re-defined to guarantee that the evaluations can be performed, as many complications have been faced during the development of the model to be studied. For these reasons is very important to say that the obtained result can be affected by these used arrangements, and that the robustness of the model can be not the desired one. This doesn't mean that the estimations and the analysis have been performed without consciousness and mathematical proofs; all the evaluations have been done trying to achieve the best performances, the most solid results and the greater level of statistical

clout. This is just to say that the topic treated is particular, new and unveiled, or at least not as much considered as it should be, and, because of that, there are some tangible boundaries and limitations in the assessment to be done. According to this, all the analyses, computation, assessments and assumptions have been made considering deeply these limits, and trying to overcome them in the best way it's possible through the adjustments that now are going to be explained. Conforming to this, in the following sub-chapter, there will be a full explanation of the premises that have to be considered and deeply taken into account in order to make all the evaluations and then there's the latest explanation of the obtained result, specified for each industry considered. Finally, to conclude, are considered the tests and verifications analysed to ensure statistical solidity of the model.

3.1 Premises

It is very essential to specify, again, that the main and most insidious problem, which had to be considered in the valuation of the regression, was determined and dictated by the lack of data and information. As it has been introduced previously, governments and countries have started to worry about climate change and its consequences on the environment and the economy, just in the latest years. Scientists, citizens of the world and some organization have started concerning about the negative results of the industrial revolutions and the exaggerate exploitation of natural resources many years previously, as the problem has consistently started to become tangible from the 50s if not before. But just in the near 2000s companies and nations have begun to collect information useful to tackle the environmental crisis. Even if the problem is sourced many decades ago, just recently economists have built up models and computation to identify the economical damage connected to it. That's the reason why the dimension of numbers that have to be used to create the regression, the effective temporal observations to be analysed and utilized to generate the equation, is short. For the larger majority of the variables, only 10 yearly data are found; for part of them, as biological cultures for the agriculture, for example, even less. This is because the data have been collected just from year 2008 to nowadays. And this is an effective obstacle to the evaluations, as having a very low amount of observations to be considered, in statistics, can be a huge complication, especially when there are many regressors to be used. When linear regressions are used, the greatest is the amount of data used, the better it is, as there are many different single information, each one independent from the others, that can be used to discover the overall trend. The larger is the amount of information, the more it is possible to

discover the nature, the performance, the progress of the factors analysed, as the basis for the calculation are wide, and for the law of the big numbers, if a huge set of data are taken into account, the outcome observed on average are respecting the trend and representing a realistic situation. Just to make an example, if we have information about world GDP and the interest rate collected for ten years, and we try to investigate if and how much they are connected looking at how they are moving together during this time lapse, some insights can be obtained. But imagine that these ten years are characterized by a deep crisis affecting all interconnected sectors and countries; the outcome provided by the regression can biased, as even if the results are considered to be statistically robust and solid, they are taking into account a period that is too short, and so they are not representing the real and effective relationship between GDP and the interest rate, as they are strongly affected by the particular economic situation. If, on the other hand, 100 years are taken into account, the evaluations are much more representing the truth, as we have a strong initial data basis, we have more information collected, there are more observations capable to tell us what have been the connection between the two parameter, how they are behaving during time, and the economical crisis can come out to be just a single outlier in the overall trend of the variables. The greater the amount of information used, the greater the knowledge of the situation, the set of units that can be provide us important insights; the more the data, the better the understanding of the real and effective condition.

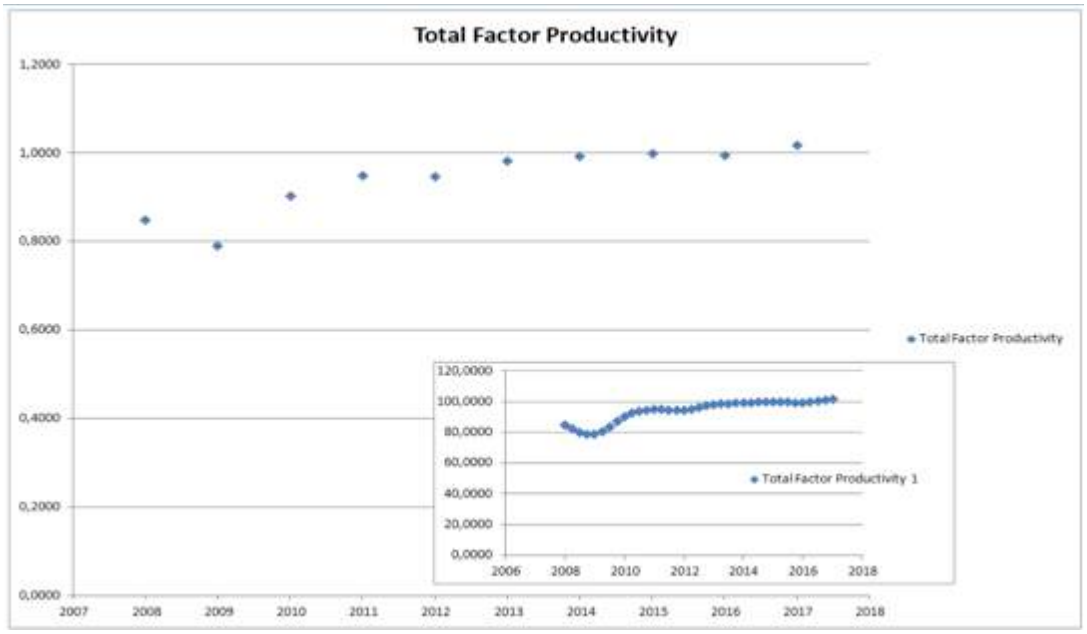
Given the fact that the amount of observations in this case is low, as only 10, or less, data have been collected for the variables used, the first adjustment that have been made was done to increase the frequency of the data.

Trying to perform forecasts on how observations are supposed to move in the future, or supposing to estimate how they have behaved in the previous year, in order to increase the frequency of the information to be used, would have been clearly too much theoretical and nonsense, as any kind of evidence would have been taken into account, the estimation wouldn't have been supported by real data at all, and the information would have been biased and unrealistic. So, a solution to the problem has been thought to be **cubic interpolation**, also known as **spline interpolation**. This mechanism works dividing the intervals that undergo between observations into many other intervals in order to find intermediate data that stays between the real and recorded ones. It is pretty different from polynomial interpolation, which utilizes a single polynomial to approximate the function on the interval analysed, and that is much less precise and elegant in the creation of intermediary observation within the trend. Spline interpolation chooses as much polynomial as the number of intervals in which is subdivided the distance between one

data and the other, and normally they have a very small grade. Furthermore it imposes that there's continuity between first derivatives of polynomials, so that to make sure that the different observations are connected between each other in smooth and strong way. In other words, through these computations, is possible to find out the intermediary results that stand between an observation and another. In the case considered in this abstract, given the fact that are considered annual result from 2008 to nowadays, it is used to find out kind of trimestral data that stay between different annual data recorded, in order to increase the set of observations used. The reason why they are "kind of" trimestral data, is because it is not officially imposed that the sum of the four observations for trimestral data is providing the annual data, as it should be logically. They are considered as to be flow variables, which are fluctuating up and down according to the effective trend registered for the parameter, as, statistically talking, it is crucial to increase the quantity of observations to be considered, their frequency, and to guarantee they are following a sense, a logic, not to ensure to find the exact trimestral results. Moreover, figures are considered in a cumulative way, which means that between two years we have information of the first year, the first year plus the first trimester of the following year, the first year plus the sum of the first and second trimester of the following year, the first year plus the sum of the first, second and third trimester of the following year, then the second year and so on in this way. Basically, having the trend and the curve of movements of annual data, it is possible to discover the single, small observations that are going to be recorded inside each gap from an annual data to another, maintaining the very same nature, scheme in the behaviour. It's a statistical tool used to increase the frequency of the data without modifying the real observations, without manipulating too much real information. Obviously, it's not the same thing as having real intermediary result, real trimestral data, as in reality it could have been that the fluctuations from a trimester to another are different, that there have been ups and downs between one year and another one that are not identified. This formula supposes that the trimestral data captured between the years are moving according to the yearly trend, maintaining the curvature of annual data, while in real situations the half-results can be characterized by larger movements and alterations. That's why this is an effective *manipulation* of data that, when it's not necessary, should not be used, as it is not like having real, observed information. It can happen that effective, recorded quarterly data are moving pretty distantly from the theoretical trend that has been calculated between a year and another, it can be that they are greater or lower than theoretical values, because of some particular conditions or situations that have characterized the variable. But not having real, recorded observations, given the fact that they have not been registered at all or disclosed, this is the best approximation that

can be performed with the information that are available. So that to make it clearer, below is represented how spline interpolation is working for Total Factor Productivity (TFP, the Y independent variable in the regression): in the first image the blue dots are representing the annual result collected from year 2008 to year 2018 and the general trend, the function of the variable, so how it is moving over time. In the y-axis is represented the value that the function assumes over time, while in the x-axis the temporal line. In the second picture, can be understood the result of spline interpolation: the gaps, the intervals between annual data have been filled with intermediary observations that are fully respecting the fluctuations of annual results, the shape of recorded information. The figures x.25, x.50, x.75[73] in the x-axis are identifying, in some way, the cumulative trimestral results that have been mentioned before, where .25 is used to define the first trimester, that goes from January to March, .50 for the first and second trimesters summed together, so from January to June, and the .75 for the first, the second and the third trimesters summed together, so from January to September. It is possible to clearly understand that the halfway results generated are fully respecting the trend of the original yearly data, with a smooth, elegant and precise curvature.

Figure 30: An example of how Spline Interpolation is performing in TFP (Total Factor Productivity)



[73] In this case the "x" is to define the year taken into account in that case. But it's important to understand that if we are looking at 2001.25, 2001.50, 2001.75 we are not taking into account, in a cumulative sense, the first, second and third trimester of year 2001 but the trimesters of 2002. It can be understood as 2001 plus a quarter of year (and so the first trimester of year 2002), 2001 plus half of year (first and second trimester of 2002 summed together), 2001 plus three quarters of a year (first, second and third trimester summed together). It would be easy to find out the real value of trimesters just solving a system of equations with 4 unknowns, as we have cumulative results and yearly data, but from a statistical perspective it's not important, that's why are just considered cumulative results as they are.

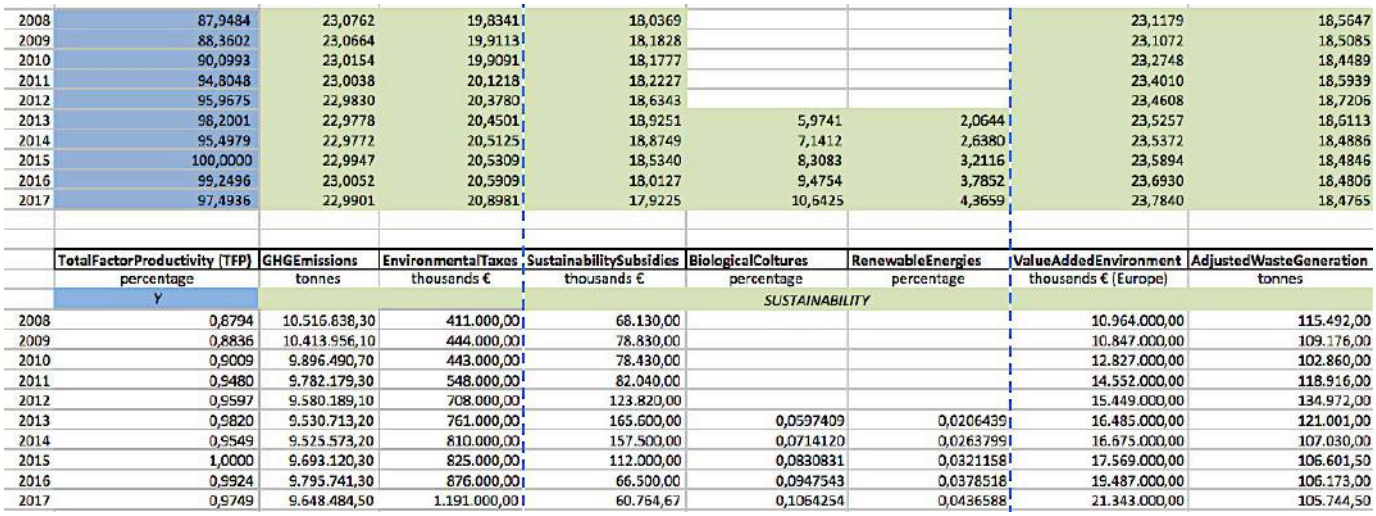
This transformation was applied to all the variables and parameters that have been used, both the regressors, the independent variables and the Y dependent factor to be considered. In this way the frequency of the data used has increased from *ten* observations on average, to *forty* observations, which is a good result[74].

In addition, a second adjustment that has been considered before of running the regression was the transformation of part of the variables through **natural logarithm**. In fact, as said in the previous chapter, some regressors are expressed in tonnes, other in thousands or billion euros and others in percentage. The problem, in this case, is connected to the fact that using the parameters in this way, as they are, with different unit of measurement and different scales, the coefficients, which should provide information about the connection between productivity and the given factors considered, are going to be very disparate and uninformative. This means that some of the Betas can come out to be extremely high, while others extremely low, making it difficult to understand and interpret the results in a proper way, and not guaranteeing the possibility of taking legitimate decisions and evaluations according to them. As an example, there can be a coefficient equal to 100.000.000 for the variables expressed in percentage, and equal to 0,0000000002 for those ones expressed in thousands euros, making the model become completely inappropriate to produce any kind of policy or informed decision. This happens because the variables are very distant and different the one from the others and so, in order to try to overcome the problem of "disequilibrium" that undergoes between them, the computations, the system attribute very strange coefficients to factors in order to balance their weights, which otherwise would be too much contrasting. So a regression, which should be able to help people in comprehending a problem and understanding how to solve it, would not work as it should do. It is like you were said "If you want to improve the degree of productivity within your company, you should decrease Green-house Gases emissions of 0,0000003 in tonnes, and improve the average salary of your employees of 100.000.000 in percentage" it doesn't really make sense, it's not direct, not immediate, not simple either straightforward. And a model that should simplify processes and make people easily understand what they should do if they want to achieve some results, is neither clear, nor unequivocal, it's rubbish. That's the reason why, in order to rescale all the variables, and work with a uniform and adequate unit of measurement, it has been taken the natural logarithm of those variables expressed in tonnes and billions/thousands euros. In this way parameters are all balanced at the very same level, all with the very same scale and the results from the regression will

[74] Tables with all the data that have been used can be found at the end of the thesis in the section "Tables", with this regard the figures referred to this part are collected in Table 1, with overall database used to run the regression.

be much more clear and easy to understand and to portray. In addition, the natural logarithm is also useful because it makes it possible to improve symmetry in the distribution of the parameters, making their trend be more Normal, which, for statistical assumptions, is something very important, as all the computation are done assuming to have a normal distribution in the variables.

Figure 31: An example of logarithmic transformation of the variables to uniform the scale



2008	87,9484	23,0762	19,8341	18,0369			23,1179	18,5647
2009	88,3602	23,0664	19,9113	18,1828			23,1072	18,5085
2010	90,0993	23,0154	19,9091	18,1777			23,2748	18,4489
2011	94,8048	23,0038	20,1218	18,2227			23,4010	18,5939
2012	95,9675	22,9830	20,3780	18,6343			23,4608	18,7206
2013	98,2001	22,9778	20,4501	18,9251	5,9741	2,0644	23,5257	18,6113
2014	95,4979	22,9772	20,5125	18,8749	7,1412	2,6380	23,5372	18,4886
2015	100,0000	22,9947	20,5309	18,5340	8,3083	3,2116	23,5894	18,4846
2016	99,2496	23,0052	20,5909	18,0127	9,4754	3,7852	23,6930	18,4806
2017	97,4936	22,9901	20,8981	17,9225	10,6425	4,3659	23,7840	18,4765

	TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	BiologicalCoItures	RenewableEnergies	ValueAddedEnvironment	AdjustedWasteGeneration
	percentage	tonnes	thousands €	thousands €	percentage	percentage	thousands € (Europe)	tonnes
	Y				SUSTAINABILITY			
2008	0,8794	10.516.838,30	411.000,00	68.130,00			10.964.000,00	115.492,00
2009	0,8836	10.413.956,10	444.000,00	78.830,00			10.847.000,00	109.176,00
2010	0,9009	9.896.490,70	443.000,00	78.430,00			12.827.000,00	102.860,00
2011	0,9480	9.782.179,30	548.000,00	82.040,00			14.552.000,00	118.916,00
2012	0,9597	9.580.189,10	708.000,00	123.820,00			15.449.000,00	134.972,00
2013	0,9820	9.530.713,20	761.000,00	165.600,00	0,0597409	0,0206439	16.485.000,00	121.001,00
2014	0,9549	9.525.573,20	810.000,00	157.500,00	0,0714120	0,0263799	16.675.000,00	107.030,00
2015	1,0000	9.693.120,30	825.000,00	112.000,00	0,0830831	0,0321158	17.569.000,00	106.601,50
2016	0,9924	9.795.741,30	876.000,00	66.500,00	0,0947543	0,0378518	19.487.000,00	106.173,00
2017	0,9749	9.648.484,50	1.191.000,00	60.764,67	0,1064254	0,0436588	21.343.000,00	105.744,50

As shown in the upward image, taken from part of the Excel file used to perform the analysis of Agricultural Sector, it can be understood how parameters have been rescaled looking at the highlighted numbers, which are the transformed version of the below ones[75]. It is possible to notice immediately that thanks to natural logarithms, those factors that previously were extremely high compared to percentages, as GHG Emissions compared with Biological Cultures for example, after the rearrangement, are expressed with the same unit of measurement, making it possible to obtain results from the assessment that are easy to understand, interpret and from which is possible to capture insights useful to take decisions and make evaluations on what has to be done.

If the different variables were inserted in the model without rescaling them, it would be like comparing apple with bananas and the outcome provided by the equation wouldn't be able to define any useful suggestion. The model would have been raw, inelegant and cryptic. In this way, instead, they are all equalized to each other to ensure the possibility of comparing them easily and investigate the model properly, being able of taking, then, informed decision and valuable insights.

[75] The overall data can be found in the section "Tables" under the name Table 2: Transformation with natural logarithms.

Furthermore an additional adjustment that has been done was considering **time lags**. In fact, it should be evaluated that part of the parameters taken into account are not going to influence the dependent variable Y with the same speed, in the same way it is influenced by some others. There can be some factors that require less time to affect Total Factor Productivity, and some others that require more. It may depend on many different facts: the financial sector, for example, tends to be pretty fast, as variations, fluctuations and changes are caused continuously by the operations performed by different actors working on the field, and the consequences of these activities can be felt immediately, as they are recorded almost perfectly on time. Demand and offer are moving relentlessly according to the requests of people around the world for goods and services, and even interests rates are directly and immediately shifting according to this. As the European interest rates can modify fastly according to changes in the offer of money, for example. On the other hand some economical factors such as GDP, productivity, money offer, unemployment rate and efficiency or effectiveness of operations run by companies or countries are much more slow, it takes more time for them to perceive the consequences of some defined actions or policies. They are not feeling directly the consequences of activities performed by citizens, or at least, not with the same immediacy with which financial markets perceive them; they depend on many elements to be taken into account and it takes time for changes to be recorded on database. While in financial markets changes are recorded immediately and transmitted with high frequency, the real market, the goods and services market, to record changes and fluctuations takes longer time. It's a typical characteristic. In relation to this, a movement in the European interest rate, for example, can take a year to affect the European GDP, as time is required to evaluate and record variations in the economic factor. For this reasons, when hypothetical calculation are made, it has to be considered the interest rate of one year before. If we are building up a regression in which GDP is the dependent variable, and we are considering the data of year 2018, for example, it should be compared with the interest rate of 2017, as it's the interest rate of the previous year affecting the GDP with one year of delay. Essentially lag means delay, it is trying to capture how much those data set at some point in time are influencing other data fixed at a later point in time. Lag is a fixed amount of passing time; it happens that effectively one set of observations in a time series is plotted (lagged) against a second later set of data. It's a shift in time lines of part of some data, which then are compared to other data. Essentially, in this specific case, it should be considered that many of the independent variables used within the regression are affecting productivity with delays.

If a supposed company decides to reduce its Green-house Gases emissions to meet some sustainable goals and become greener, the effects caused by this choice on productivity are thought to not be perceived immediately. Another useful example to understand the situation properly, can be the effect of the Weighted Average Cost of Capital on Total Factor Productivity. As it was said before, financial variables tend to move much more quickly than economical, real factors. Variations in financial markets depend on human behaviour, choices and feelings and the fluctuations caused by people's decisions are recorded immediately within servers, while to understand how the movements on financial variables have affected real economy, and systems more time is required. Variation in stock prices, movements in the stock exchange can be analysed in real time, whereas economical data normally are recorded yearly. According to this, a change in the WACC, which tries to represent the level of risk, the degree of reliability of an industry, in this case, from the point of view of the investors, is going to affect the productivity of that industry after a year probably. Consequently, in order to evaluate comprehensively and thoroughly how a sector's productivity is going to be affected by the various regressors taken into account, and referring to those parameters with the aim of addressing the level of competitiveness within an industry, it would be evident that the Weighted Average Cost of Capital is going do be defined with a time lag of one year. Given the fact that this index is representing the amount of money that should be repaid back to shareholders and debt holders for the resources they have lend to the company, the greater it is, the less they trust on the enterprise, the more money has to be used to perform the same operations, as there's a lack of solidity, of robustness in the market. This investor's feeling won't affect directly the productivity, it will take time, as even if the result of human thoughts in financial exchanges are recorded immediately, to see how they are affecting productivity it will need more or less a year, at least, to be effectively registered. The very same happens with the factors Changes in Inventory and Export Level for agricultural sector. The first variable captures, in some way, the capability of a company of using in an efficient way all the products it has at its disposal. The lower it is, the more a given business is able to get a rid of the additional unsold good accumulated on the warehouses reselling them through online platforms or to other retailers. It's clear, that in this situation, too, the changes in inventory of the previous year, are going to affect company's productivity the following year. This is because if, during the period, we are able to re-exploit the extra resources coming from the previous period, which haven't been appreciated in the shop, then the consequences are felt in that specific year when they are found a new replacement, and so a year later. Concentrating on Exports Level, on the other hand, the lag is just of six months. It has been estimated that, for what concerns exports, probably the time

required to produce effects on productivity is a little bit lower as there's a more direct, easier and straight connection between the two. The relationship is more linear, so it goes faster.

Even many variables related to sustainability macro-category have been considered with a year or more of time lag: Green-house gases emissions, jointly with Environmental Taxes and Adjusted Waste generation, have been considered with a year and a half of delay, while Environment Protection Expenses and Value Added in the environment with two years of delay; Sustainability subsidies with six month of delay, the same as Biological Cultures and Renewable Energies for the Agricultural sector. These lags seem to be reasonable as talking about Environment Protection Expenses and Value Added in the environment, the focus is put on variables that are representing the amount of money spent to protect nature that sustain the industry and to add value and resources on the ecosystem in which the company is working. The advantages that can be felt by enterprises in their activities through the performance of these operations are connected to growth in biodiversity of the natural resources exploited by the sector, which means that in the future there will be more and better materials to be used as the ground has more nutrients to sustain survival and wealth of species, there's a greater possibility of having "super-species", much more productive, of having primary resources that grow better and faster, and assets would have the possibility of growing in a sustainable way regenerating those members that are taken from businesses with a continuous term. According to this, it's easy to understand that these consequences cannot be felt directly and quickly on productivity, but it will take time and consistency for enterprises to join these benefits. Talking about Sustainability Subsidies, on the other hand, the delay considered is lower, as are taken into account real and effective financial resources that governments are providing to companies if they are maintaining a defined level of sustainability in their activities, so probably the effect that this capital will have on TFP would be much more direct, consistent and tangible in the short term. For what concerns Biological Cultures and Renewable sources of energy for the agricultural sector, even in this case are considered just six month of lag, as albeit these two regressors should have a positive impact that normally should be noticed in a longer period of time for other industries maybe involved in manufacturing activities, or heavy industry, the sector considered is deeply connected with nature, bio-dynamics, bio-cycles and changes in climate and environmental condition, that's the reason why a short time lag is evaluated. The positive effects connected to the misuse of pesticides, the respect of natural cycle for cultures and the closeness of materials and resources used for the agricultural activities, which are all characteristics of biological cultures, can be felt pretty soon. And the very same happens when are used Renewable Sources of energy rather than fossil fuels

that are contaminating the soil, the air and the nutrients necessary for plants and animals to survive. So the short time lag depends on the fact that the nature of the activities and the typology of products guaranteed are strictly related to environment and natural ecosystems. Finally when considering the Adjusted Waste Generation's, Greenhouse gases emissions' and Environmental taxes' variables, the delay is assumed to be equal to 1,5 year as even in this case the negative effect are not going to be that immediate. Referring to the creation of waste and the emission of greenhouse gases, this is because effectively, even in this case, it's not so easy to find a direct connection between them and productivity, the relationship is complex and intricate, it takes time for these effects to be perceived. The more products are discarded instead of being reused, the more the materials are wasted rather than recycled, the less garbage is organized in separate waste collection, the more CO_2, methane and other toxic gases are emitted on the atmosphere as the machines are old, crumbling and fuels for engines are primitive and out-dated, the lower will be the productivity of that plant, and the more this disadvantage will be felt over the years. But it takes time to be felt, it's not a matter of months. Concentrating on Environmental Taxes, instead, the delay considered is so long because, normally, even if we are talking about real capital and financial resources subtracted to companies according to their level of pollution, and so the negative impact should be felt quite immediately, as for the subsidies, which are the opposite thing, it takes a long time for governmental authorities to investigate and understand in reality how much degree of pollution can be attributed to a company or to another. These tariffs are applied on a basis calculated on the quantity of contaminations produced by a business on ground, air, groundwater and natural primary resources in general, but clearly, it's pretty difficult to charge these expenses to private entities, as authorities still haven't been able to discover efficient and productive methodologies to define these taxable values. For this reason the lag considered is so long despite the nature of the figure. Referring to variables connected to the degree of progress, just R&D Expenses and R&D Employees are considered with a year of delay. This actually happens because if the percentage of workers dedicated to researches and development or the expenses related to it are going to increase in a determined case, only in the following period probably, it will be possible to notice the differences carried by the choice. If today more people concentrate on developing new practices, on searching new technologies and mechanism to be exploited, on creating new materials and solution for goods and services, and if more money are spent for the purpose of innovation, only tomorrow it will be possible to understand if the result are appreciated or not. Something very similar has been evaluated for Industry 4.0 and Tech Areas, when referring to capital productivity. A year lag is considered even in this case, as for the very

same reasons explained before, if investments are made on websites development, online platforms creation, advanced and technologized appliances and machineries, on Information and Communication Technologies, only a year later, in the following period, the feasible benefits are going to be felt effectively and tangibly.

The last important premise that has to be attentively mentioned is related to the **reduction of the regressors** to be used within the model. Many times during the abstract it has been said that one of the main and greatest obstacles met in the development of this project was the lack of data to be used, and this problem came out to be much more insidious than what was thought. In fact, even using spline interpolation and with the increase of frequency of observations to be considered, the amount of information is too low compared with the quantity of independent variables used in the equation. Basically it happens that the very high quantity of regressors are capturing all the degree of freedom from the real observations, as the more parameters are inserted the more observations are necessary to estimate coefficients, otherwise results come out to be difficult to be interpreted, the model result to be too complex and estimations are instable. Degrees of freedom are fundamentally defining the possibility for a given variable to freely vary in the data sample; they are representing the minimum number of observations necessary to evaluate the level of knowledge contained in a specified population. When the amount of observations is wide and heterogeneous, variables are able to move, to adapt and identify and capture an effective trend within the information collected, on the contrary if the data collected are low compared to parameters, the model comes out to be over-fitted. An over-fitted model has the characteristic of not telling to the observers anything interesting or useful, as the statistical equation is essentially adapting to observed data. There are, in proportion, more factors than the information able to explain them. The analysis would come out to be too much near and close to desired result than what it should be in reality, and so it won't be able to predict and forecast properly data for the future. When the regression is performed, it can be immediately noticed that there's a possible problem of over-fitting as using fully all the regressors mentioned before, the Adjusted R^2 comes out to be equal to 1, which means that the model should be 100% correct and fully able to predict all possible future fluctuations, something impossible. The *x*'s variables have all deeply significant coefficients, with p-values lower than 0.001 %, which is, again, suspiciously too optimistic. While the Betas come out to be not reasonable, as, for example, R&D Expenses seems to be negatively correlated with productivity, jointly with Labour and Capital Productivity, something very strange and unrealistic as the positive connection between these three factors and Total Factor Productivity is immediately perceivable even theoretically; Adjusted Waste Generation, on the

other hand, result to be positively correlated jointly with Weighted Average Cost of Capital, and even in this case is something that sounds very strange. Furthermore, if the errors are analysed through White-Noise check, bad results are shown, as the values for the frequencies are overcoming the boundaries for normality, which means that the mean between the errors is not equal to zero and they don't have the same but unknown variance. Essentially White-Noise is a random signal that should have equal intensities at every frequency to guarantee that the variables and the related observation are random, stochastic, uncorrelated and independent. But if the intensities in the different frequencies are not within a given interval, this means that there's correlation between the errors of the parameters and part of the trend of the observations is left outside of the regression and the estimations. Moreover, even looking at Q-Q plot, the normality assumption is not respected and even Residual vs. Fitted plot for independency and zero mean, and Scale-Location plot for homoscedasticity are violated.

Assumed that there's an effective problem of over-fitting, which is logical, given the very high amount of regressors, that are almost 20, against the low quantity of observations, that sometimes are 40, sometimes, for other variables, even less, a solution has to be found. Initially it has been thought to rely on a stepwise regression. It is a particular type of regression that should be able to exclude autonomously those variables that seem to be less correlated with the principle variable Y, looking at AIC (Akaike Information Criterion), an index that estimates the quality of the model in relation to the quality of any other possible equation that can be used alternatively, it chooses the best model over all the models that can be used. It works choosing the model with the lowest AIC, so the one that is able to capture most variations within real data with minimum error compared to the others. The fact is that, if too many independent parameters are inserted, the system comes out to be almost perfect, with any adjustment or variation to be made, with the same problems exposed before: Adj-R^2 equal to 1, and unrealistic coefficients with very low p-values. The index is not providing me any tool to reduce the number of regressors. Furthermore if two, or more, factors are correlated between each other, the coefficients come out to be unreasonable and strange and the significance of the estimates can be affected by this correlation and produce biased and unreal results. So variables that reasonably should be important and positively correlated seem to be irrelevant and negatively correlated or vice versa, with very high coefficients, huge intercept and strange figures. Even stepwise regression cannot be used.

The amount of variables used for each industry has to be drastically reduced, which means that we have to pass from almost twenty to three or maximum four independent parameters. How this can be done?

Three different analyses have been used: a qualitative analysis through the investigation of graphs and trends, a quantitative analysis looking at the degree of correlation between dependent variable and independent factors and finally, another mixed analysis, considering both quantitative and qualitative parameters, looking at the degree of plausibility, probability and realism of the results in terms of figures for Betas and intercept, Adj-R^2, p-values for the coefficients and errors' analyses.

First of all, considering the graphical representation, the insight consists in trying to understand what are those factors that have a trend, a fluctuation that seems to be reasonable consistently with the movements of productivity. This means that the aim is to try to capture what parameters respect more than others the assumptions and the theories related to their relationship with Total Factor Productivity, it's a kind of visual inspection of correlation. For example, if, according to graphs, with passing time, Innovative Activities are increasing and so it is TFP, than Innovative Activities variable is respecting the theoretical premises, as it should be positively correlated with productivity, given the fact that the more an enterprise produces break-through materials, futuristic machineries and has ingenious ideas, the more it should be productive, and effectively it is. If, on the other hand, it can be noticed that when Changes in Inventories are increasing, even Y variable is increasing, than this factor is not in line with the logical assumptions that have been made, as if goods in companies' warehouses are increasing, the level of productivity should decrease, as they are not able to fully exploit the resources and capabilities they have at their disposal. According to this, this factor should be discarded. So the main objective is to discover what are those parameters that seem to follow the acceptable, fair and legitimate conditions imposed initially in a better way and eliminate the others. Have to remain only those elements that even if analysed only logically and theoretically, are in line with the natural and wisdom ideas of nowadays.

Secondly, the quantitative analysis of correlation is something very straightforward. In the very same way it has been done in the previous passage, even in this case, the final goal is to reduce the amount of regressors to be used choosing only those ones that have an optimal rate of correlation with the dependent variable Y. "Optimal rate of correlation" because it doesn't have to be too high, like 98%/-98%, otherwise it means that the two are moving almost perfectly in the same/opposite direction, and anything new is captured. If the percentage of correlation is that high, means that a variable too much similar to the dependent one is taken into account as a regressor, they are very close to be equal, and so in this way, there won't be any new, interesting, curious nuance or characteristic of the dependent variable explained with the parameter, as they are the same thing, so there's no insight taken from this. At the very same time has to be checked

that correlation should not be close to zero, as if this is the case, there's no relationship at all between the Y factor and the specified parameter, and so the factor, again, is not providing any information about the changes and development in productivity. In conclusion the aim is to look at those variables that have a correlation between 20%/-20% and 90%/-90% maximum, and not consider all the others outside of the interval.

Once these two judgements have been done, the amount of factors considered should be already reduced and filtered pretty much, having just a half of the initial variables to be taken into account for the final regression to be performed.

At this point, the final evaluation that has to be considered is more a common sense, clever and savvy analysis. In this occasion, have to be picked up randomly three, four or at most five regressors per time, choosing a variable for each macro-category to be evaluated, which means one for the sustainability level, one for the degree of progress, one for capital productivity, one for labour productivity and one for the degree of competitiveness, and insert them within the model, changing continuously the combination of factors selected for each industry, trying to discover those ones that produce the most acceptable result. Casually all the three or four regressors that have been chosen, have to be changed constantly with others remained in the list of the optimal ones, trying all the different possible combination of them, clearly maintaining fixed the rule of the principal macro-categories to be inserted (one variable per category). The macro-areas mentioned should be the main drivers of productivity within the economy, that's the reason why a variable for each of them has to be considered, if possible. In this way all the details relative to productivity should be hopefully discovered, all the different sides and aspects of the concept. Modifying always the parameters considered and looking at all the possible combination for all the four industries investigated, at the end, the optimal mix should be found.

A good intuition when the variables to be inserted have to be chosen, is to pick up those ones that are highly correlated with one, or more, variables that have not been selected, to capture more than one insight with a single factor. If, for example, Export Level has a correlation with Biological Cultures equal to 98%, and a correlation with WACC equal to -91%, this means that the first variable can be chosen to compute the equation for the regression, while the other two can be excluded to leave the position to other factors much more significant and less correlated with each other. At the end, the coefficient for the Export Level, given the very high relationship of the latter positively with Biological Cultures and negatively with WACC, can be used even to explain their trend, their movements with TFP, even if they have not being inserted in the formula, because they are following, in some way, the fluctuations of Export Level. So if, the final

regressors would have been Export Level, Adjusted Waste Generation and Cost Competitiveness, there would be information about the connection between productivity and these three factors, but there will be even partial, probable and potential insights captured by the coefficient of Export Level, about TFP and its connection with Biological cultures and WACC, and the very same can happen with Adjusted Waste Generation and Cost Competitiveness and other connected variables. So it's important to choose at most five parameters that represent the five different macro-categories, not connected at all between each other, or at least the less is possible, and likely highly correlated with some other factors that came out to be important after the first two analyses but are not chosen within the model, in order to partially explain even their relation and linkage with productivity.

But how are selected the most reasonable and plausible regressors?

Looking at the values for the coefficients, the intercept, the p-values, the Adj-R^2 and the graphs for the check of errors statistical assumptions.

This means that, if the intercept comes out to be extremely high, both in the negative or positive side, if the coefficient, too, are too high or too low, like an intercept equal to 1000 and a coefficient equal to 800, the hypothesis will be discarded, as they are not reasonable, the results are extremely unrealistic under a logical point of view. The extreme values cannot be justified or interpreted in real and practical situations, they cannot be plausibly and logically used to explain an effective dilemma. If the Adjusted R^2 is too high, with a value equal to 1 or 0.9, or when it's too low, as 0.3, the hypothesis will be rejected. This because in the first case the results are too optimistic to be real, given that a statistical model has to have a certain level of randomness and stochastic processes, it cannot be a 100% right, otherwise it will mean that it is fully and perfectly possible to predict what is going to happen in the future without any doubt, and that events are following a determined, clear and straight path, something impossible. While in the second case is not enough explanatory to provide us informative and useful data and information, is not able to capture a proper relationship between variables. So are going to be considered only those mix of independent factors for which the Adj-R^2 has a plausible value, lower than 90% and higher than 60%, and according to which intercepts and coefficients have a pragmatic, rational and logical estimate. Looking at the p-values, they should inform us about the significance of the coefficients, they should collect the probability with which the betas can be wrong and not reveal an effective linkage in real situations; the lower they are the better it is. So are maintained only those hypothesis in which the coefficients, for all the independent variables, have p-values lower than 5%, which means that there's a probability lower than 5% of finding a case in a real and practical

situation in which the relationship between that factor and the dependent variable Y is different from the one given by the regression, is something else than the Beta. And finally are considered the graphical representation to check errors' statistical assumptions, which means that are detained only those combination of independent variables for each industry that are guaranteeing the respect of zero mean of errors, homoscedasticity of errors, uncorrelation of errors and normal distribution of errors hypotheses. So looking at the graphs mentioned in the previous chapter, are individuated those mix of regressors that ensure the optimal respect of errors assumptions, and that exemplify realistic and feasible solutions. Are taken into account only those solutions that, in the best way it's possible, comply with the postulation expressed for statistical errors.

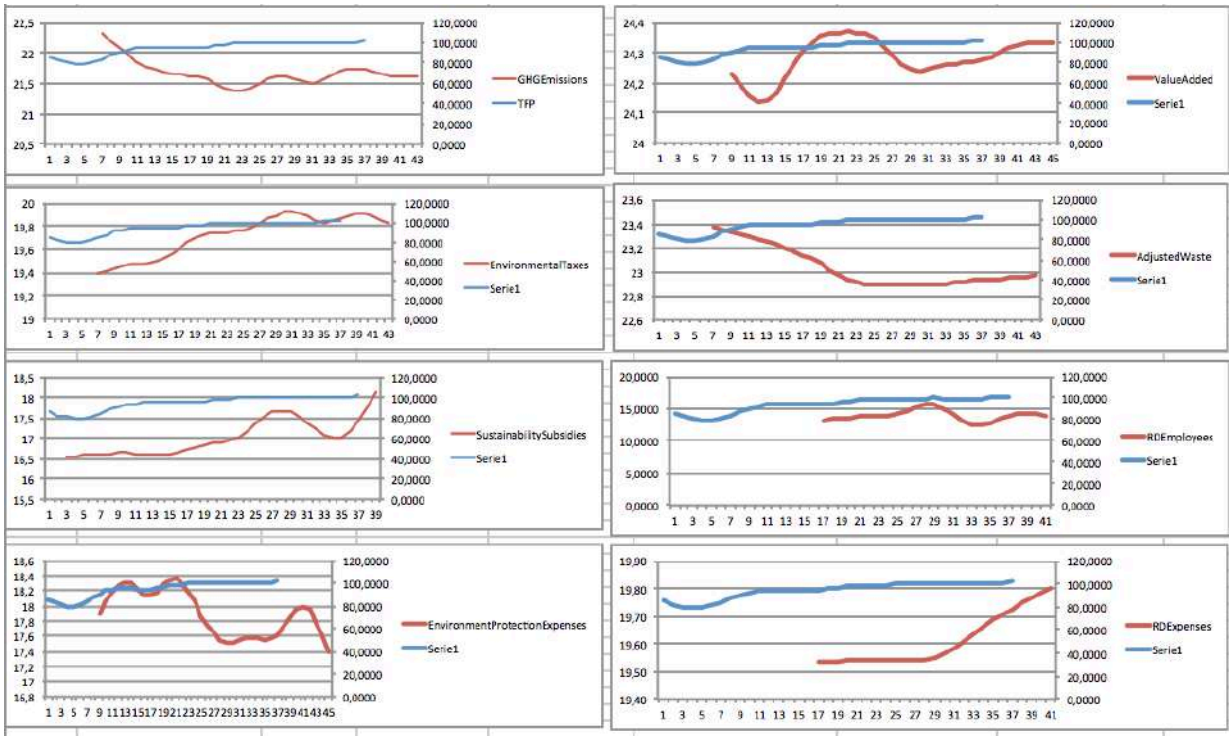
These are the evaluations to be performed intelligently to try to discover what are the most important three or four regressors that can be used for the final linear regression's judgement. These three particular evaluations, mixed together, considered jointly, should be able to provide us information about how to reduce the amount of variables to be considered, taking into account just the more relevant ones, the most crucial.

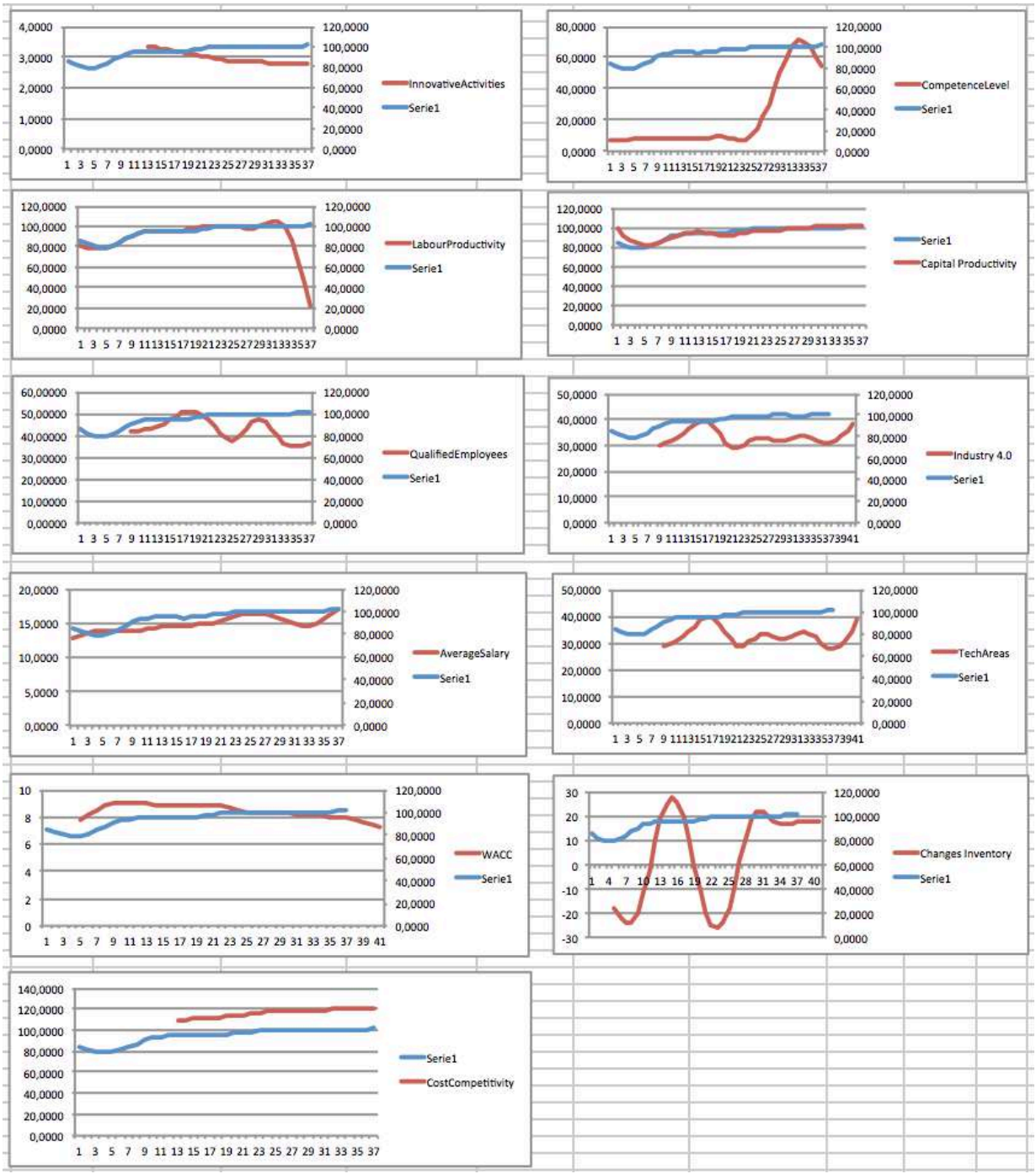
And in the following, short subchapters will be defined for each industry the most relevant 8/10 independent variables to be taken into account. There will be the first filters mechanisms to squeeze the quantity of regressors to be evaluated, to be effectively used at the end. The figures and numbers expressed in the consecutive branches are the result of the first two analysis mentioned before, so the evaluation of the graphical trends of the variables jointly with the dependent variable Y, and the check of correlations between each factor and Total Factor Productivity. Then, in chapter 3.2, there will be the comments on the result, for each sector taken into account, expressed accordingly to the choice of the regressors that ensure the most plausible Adj-R^2, values for intercept and coefficient, p-values and that respect assumptions for the errors. So the outcome of the third, mixed analysis, the common sense evaluation that is performed at the end, to choose among all the different possible combination of independent parameters, would be defined in the next affiliate.

3.1.1 Apparel

For what concerns the Apparel industry, the below graphs are defining the movements, the fluctuations of Total Factor Productivity (TFP), the dependent variable, in relation with movements of all the other factors. The connection between all the independent variables and Y. Where "Serie 1" is identifying Total Factor Productivity in every chart.

Figure 32: Graphical trend representation of TFP and the other independent variables for apparel industry





These are the trends represented for dependent and independent variables.

Then, in below computations, the analysis of correlation indexes between variables.

#Correlation between Total Factor Productivity and x's independent variables

cor(TotalFactorProductivity..TFP.,GHGEmissions,use="pairwise")

-0.8057935

```
cor(TotalFactorProductivity..TFP.,EnvironmentalTaxes,use="pairwise")
 0.8878105
cor(TotalFactorProductivity..TFP.,SustainabilitySubsidies,use="pairwise")
 0.6921459
cor(TotalFactorProductivity..TFP.,EnvironmentProtectionExpenses,use="pairwise")
 -0.6373524
cor(TotalFactorProductivity..TFP.,ValueAddedEnvironment,use="pairwise")
0.4192831
cor(TotalFactorProductivity..TFP.,AdjustedWasteGeneration,use="pairwise")
-0.9152045
cor(TotalFactorProductivity..TFP.,RDemployees,use="pairwise")
0.2375765
cor(TotalFactorProductivity..TFP.,RDexpenses,use="pairwise")
0.6134792
cor(TotalFactorProductivity..TFP.,InnovativeActivities,use="pairwise")
-0.965527
cor(TotalFactorProductivity..TFP.,LabourProductivity,use="pairwise")
0.1846382
cor(TotalFactorProductivity..TFP.,QualifiedEmployees,use="pairwise")
-0.4669981
cor(TotalFactorProductivity..TFP.,AverageSalary,use="pairwise")
0.8093628
cor(TotalFactorProductivity..TFP.,CompetenceLevel,use="pairwise")
0.5303903
cor(TotalFactorProductivity..TFP.,CapitalProductivity,use="pairwise")
0.8812075
cor(TotalFactorProductivity..TFP.,TechAreas,use="pairwise")
-0.3400024
cor(TotalFactorProductivity..TFP.,Industry4.0,use="pairwise")
-0.3559544
cor(TotalFactorProductivity..TFP.,WACC,use="pairwise")
-0.1333517
cor(TotalFactorProductivity..TFP.,CostCompetitivity,use="pairwise")
0.9637022
cor(TotalFactorProductivity..TFP.,ChangesInventory,use="pairwise")
0.4391724
```

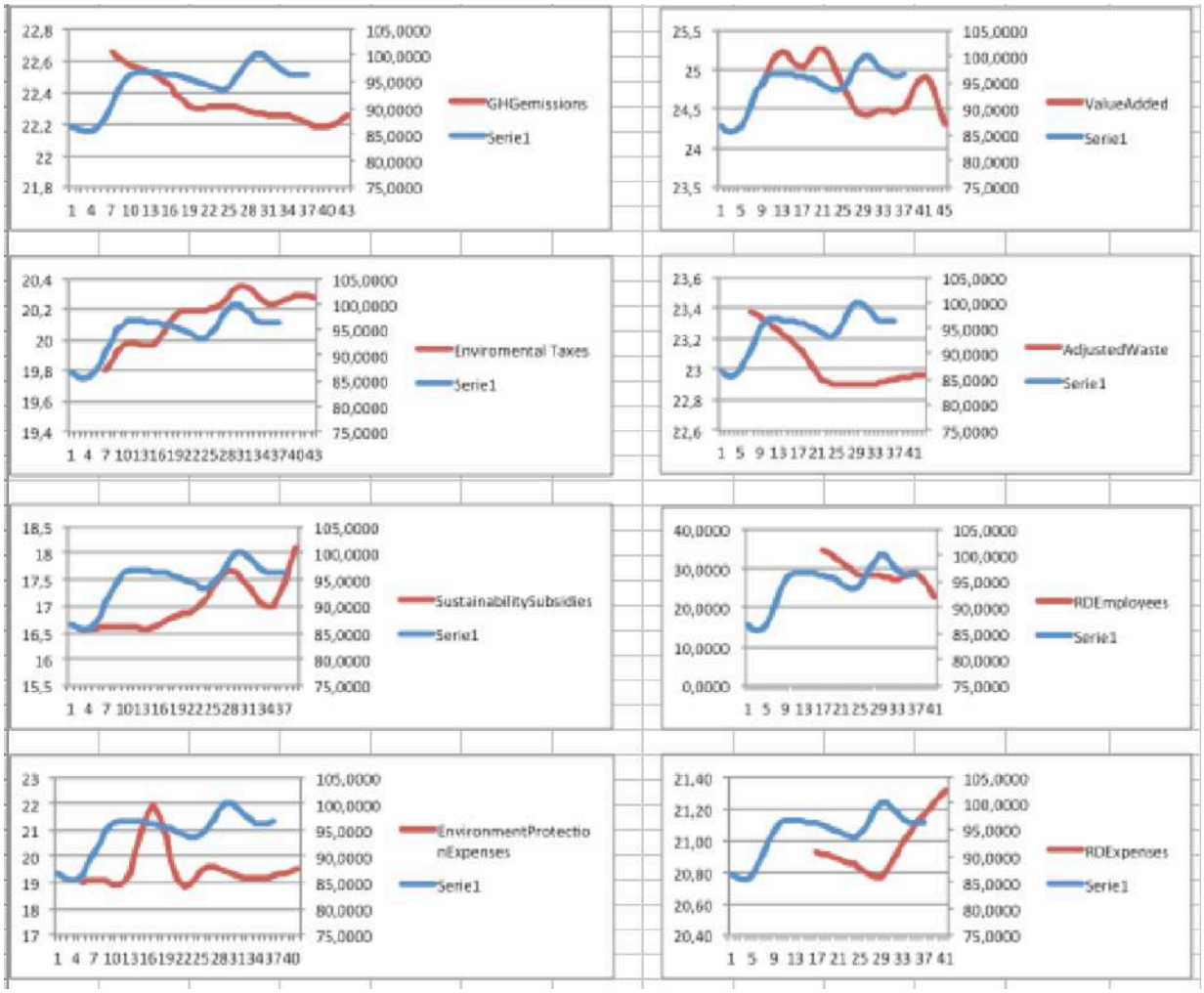
According to what is shown through the charts, with graphical representation of factors trends, and to what defined by correlation indexes the most relevant and impactful variables that should

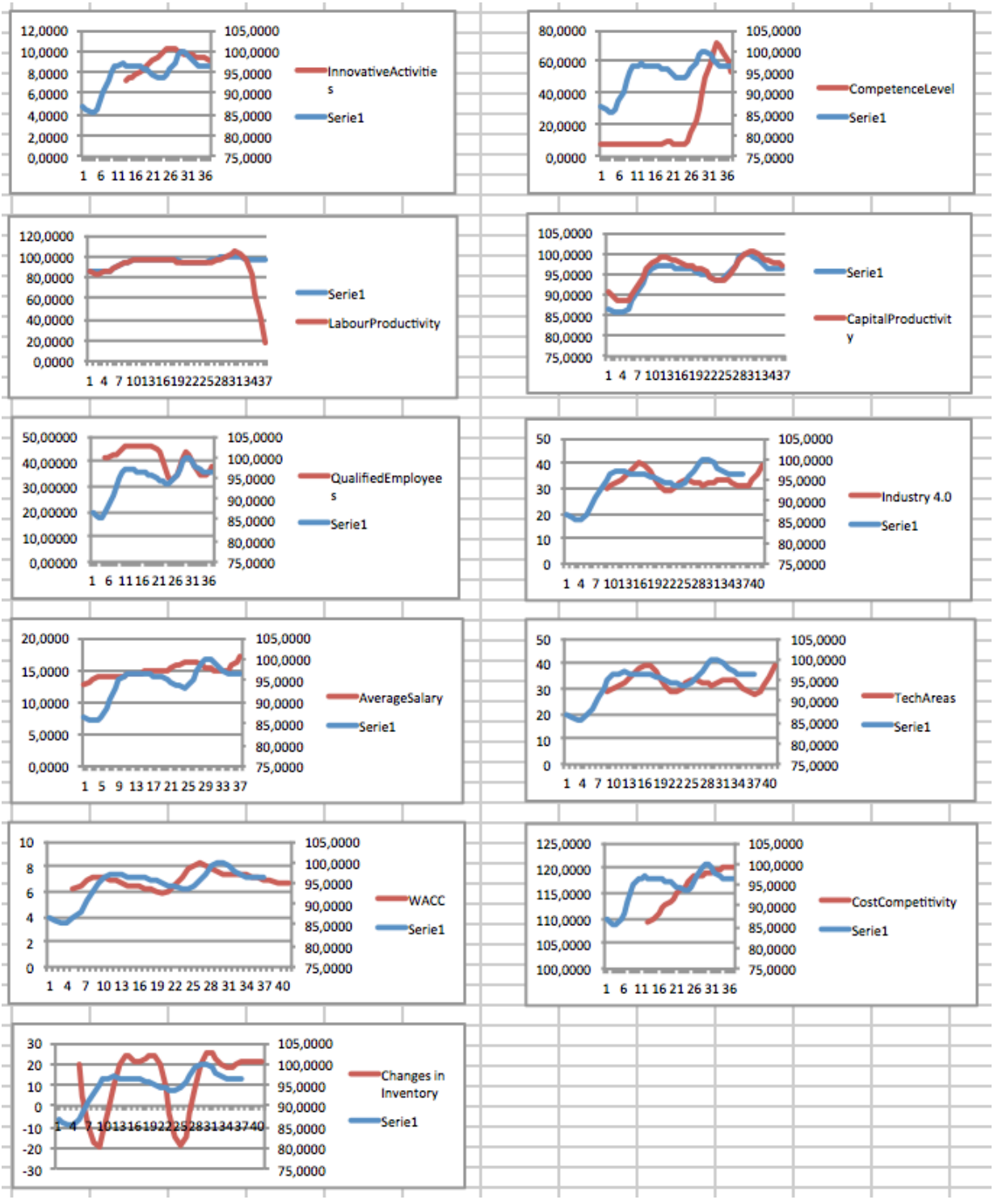
be taken into account for the analysis are: **Greenhouse Gases Emissions**, **Sustainability Subsidies**, **Value Added in the Environment**, **Competence Level**, **R&D Expenses**, **Average Salary**, **Capital Productivity** and **WACC**. These are those parameters that, looking at the ups and downs during time, and analysing the degree of linkage between them and TFP, the strength of their relationship with Y, are the most significative. The others seem to be too much distant in the fluctuations, are not moving on a reasonable path, or too low/too much correlated.

3.1.2 Food and Beverage

Talking about the food and beverage industry, the underlying graphs are trying to capture the trends of overall regressors compared with the dependent variable.
Again, "Serie 1" identifies Total Factor Productivity.

Figure 33: Graphical trend representation of TFP and the other independent variables for food and beverage industry





And then the correlation indexes between Total Factor productivity and independent factors are analysing quantitatively the connection between Y factor and the overall regressors.

#Correlation between Total Factor Productivity and x's independent variables

cor(TotalFactorProductivity..TFP.,GHGEmissions,use="pairwise")

-0.4056755

```
cor(TotalFactorProductivity..TFP.,EnvironmentalTaxes,use="pairwise")
0.5390457
cor(TotalFactorProductivity..TFP.,SustainabilitySubsidies,use="pairwise")
0.5412762
cor(TotalFactorProductivity..TFP.,EnvironmentProtectionExpenses,use="pairwise")
0.1846653
cor(TotalFactorProductivity..TFP.,ValueAddedEnvironment,use="pairwise")
-0.5830473
cor(TotalFactorProductivity..TFP.,AdjustedWasteGeneration,use="pairwise")
-0.351226
cor(TotalFactorProductivity..TFP.,RDemployees,use="pairwise")
-0.4178316
cor(TotalFactorProductivity..TFP.,RDexpenses,use="pairwise")
-0.1419238
cor(TotalFactorProductivity..TFP.,InnovativeActivities,use="pairwise")
0.04603254
cor(TotalFactorProductivity..TFP.,LabourProductivity,use="pairwise")
0.1525373
cor(TotalFactorProductivity..TFP.,QualifiedEmployees,use="pairwise")
0.08410883
cor(TotalFactorProductivity..TFP.,AverageSalary,use="pairwise")
0.5800729
cor(TotalFactorProductivity..TFP.,CompetenceLevel,use="pairwise")
0.4809745
cor(TotalFactorProductivity..TFP.,CapitalProductivity,use="pairwise")
0.9694696
cor(TotalFactorProductivity..TFP.,TechAreas,use="pairwise")
0.1414722
cor(TotalFactorProductivity..TFP.,Industry4.0,use="pairwise")
0.1379964
cor(TotalFactorProductivity..TFP.,WACC,use="pairwise")
0.3487753
cor(TotalFactorProductivity..TFP.,CostCompetitivity,use="pairwise")
0.2645875
cor(TotalFactorProductivity..TFP.,ChangesInventory,use="pairwise")
0.341979
```

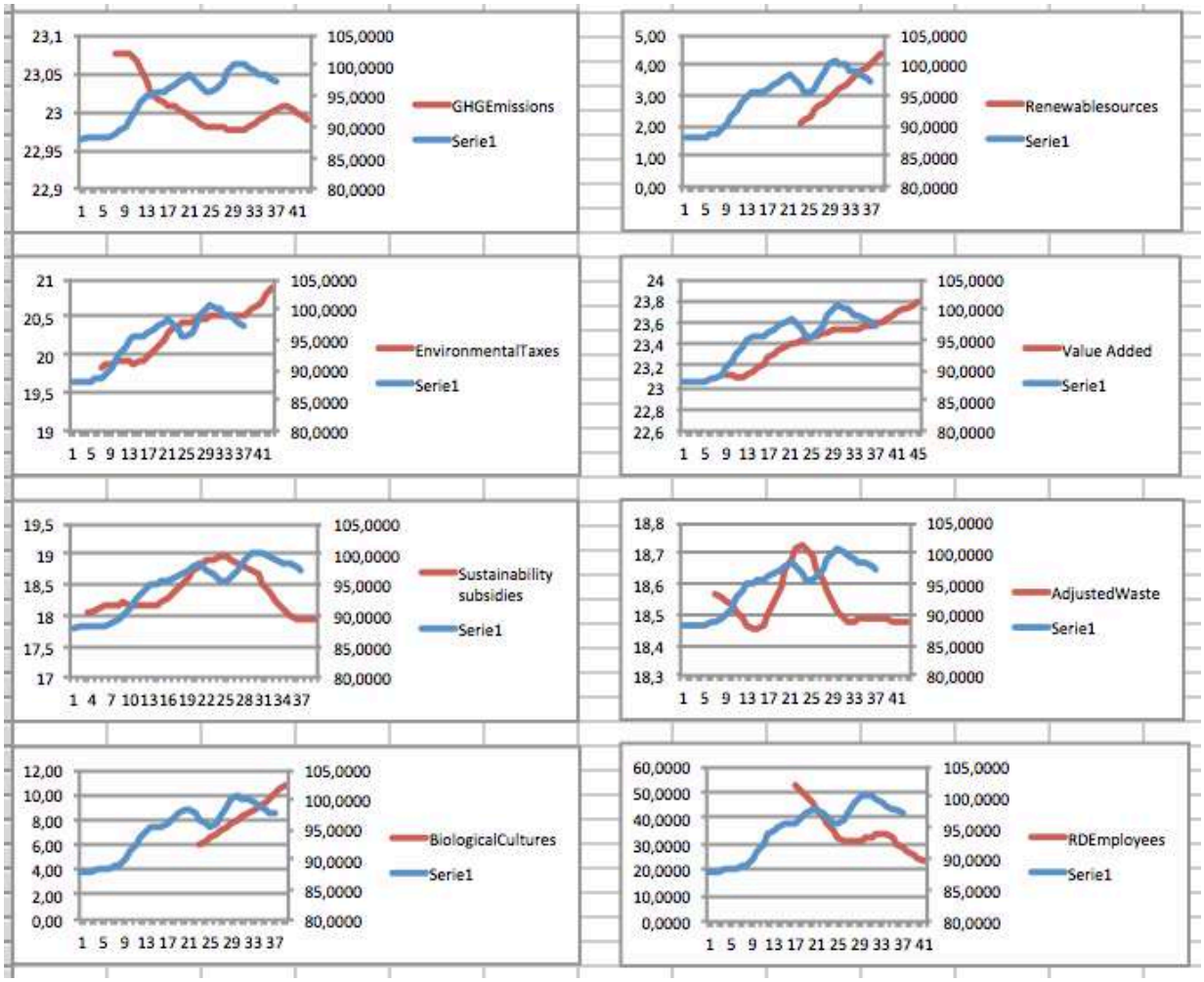
Given the calculus and the graphical trends representation the first skimming process of the Food and Beverage industry has resulted in ten potential variables to be considered, which are

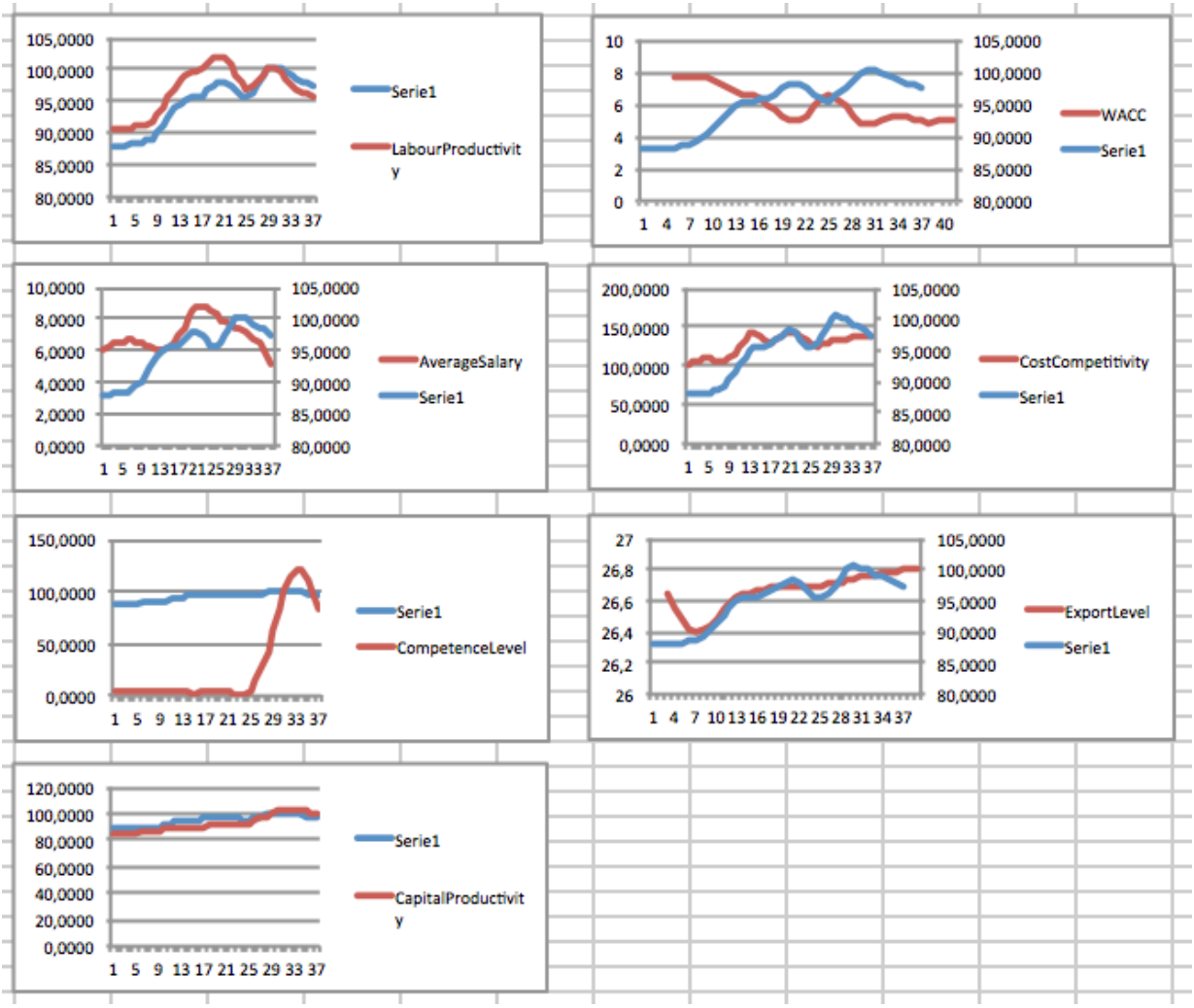
respectively: **Greenhouse Gases Emissions**, **Sustainability Subsidies**, **Adjusted Waste Generation**, **Environment Protection Expenses**, **Qualified Employees**, **Average Salary**, **Competence Level**, **Capital Productivity**, **Industry 4.0** and **Cost Competitivity**. A combination of three or four of these parameters will, at the end, be able to provide us information about the most important drivers in companies' productivity.

3.1.3 Agriculture

The third sector to be evaluated is the Agricultural one, and the underneath charts are providing information about the temporal fluctuations of Y variable according to movement in the independent parameters.

Figure 34: Graphical trend representation of TFP and the other independent variables for agriculture industry.





Even in this case "Serie 1" is fully representing the trend of Total Factor Productivity, so the dependent element of the regression.

Here below, then, the values for the correlation indexes in the agricultural industry.

#Correlation between Total Factor Productivity and x's independent variables

cor(TotalFactorProductivity..TFP.,GHGEmissions,use="pairwise")

-0.9020903

cor(TotalFactorProductivity..TFP.,EnvironmentalTaxes,use="pairwise")

0.7977833

cor(TotalFactorProductivity..TFP.,SustainabilitySubsidies,use="pairwise")

0.4638513

cor(TotalFactorProductivity..TFP.,BiologicalCultures,use="pairwise")

0.4877198

cor(TotalFactorProductivity..TFP.,RenewableEnergies,use="pairwise")

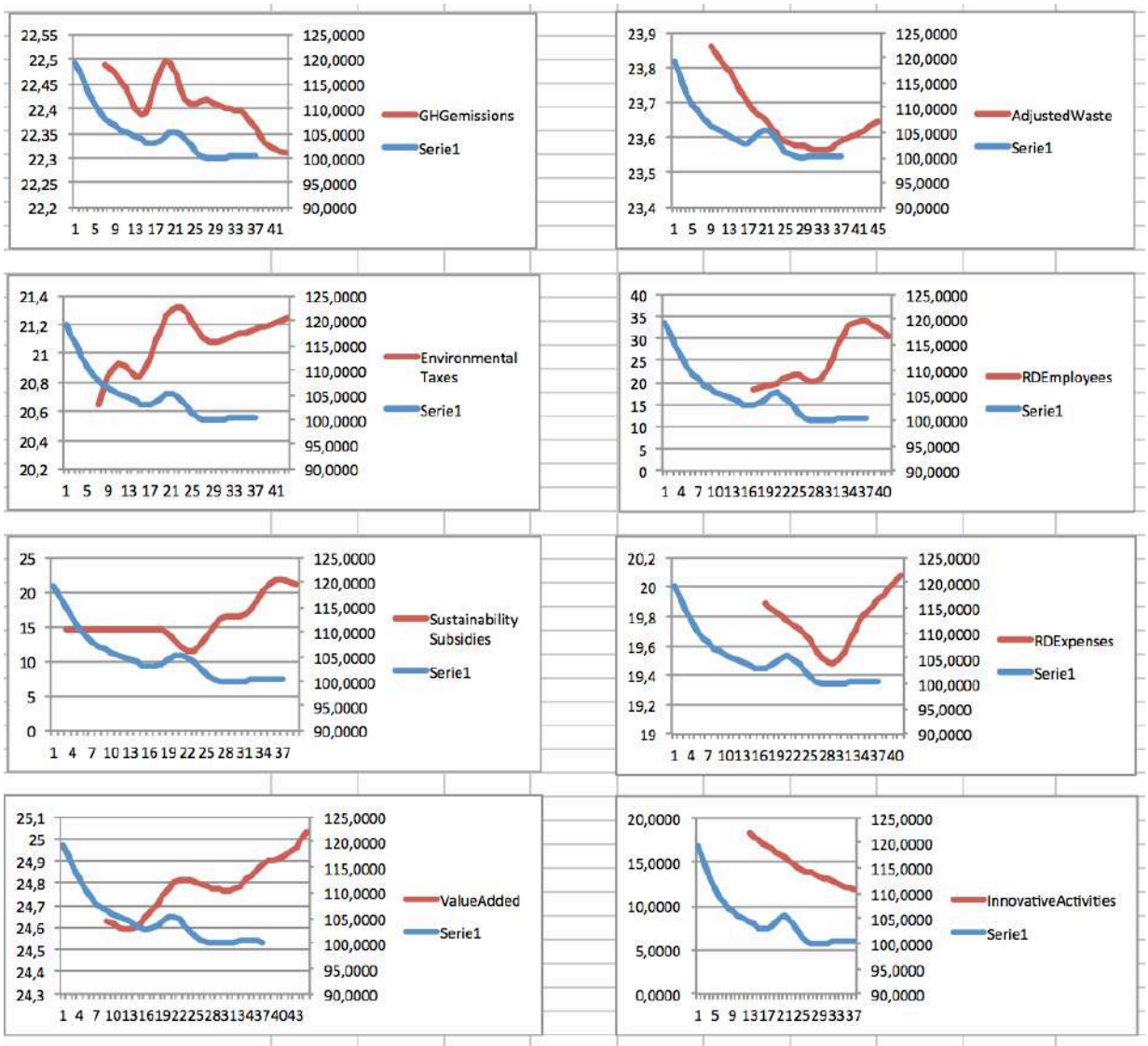
```
0.4873061
cor(TotalFactorProductivity..TFP.,ValueAddedEnvironment,use="pairwise")
0.8310275
cor(TotalFactorProductivity..TFP.,AdjustedWasteGeneration,use="pairwise")
-0.005420448
cor(TotalFactorProductivity..TFP.,RDemployees,use="pairwise")
-0.3406606
cor(TotalFactorProductivity..TFP.,LabourProductivity,use="pairwise")
0.8719984
cor(TotalFactorProductivity..TFP.,AverageSalary,use="pairwise")
0.3851124
cor(TotalFactorProductivity..TFP.,CompetenceLevel,use="pairwise")
0.603188
cor(TotalFactorProductivity..TFP.,CapitalProductivity,use="pairwise")
0.8876058
cor(TotalFactorProductivity..TFP.,WACC,use="pairwise")
-0.953724
cor(TotalFactorProductivity..TFP.,CostCompetitivity,use="pairwise")
0.8799684
cor(TotalFactorProductivity..TFP.,ExportLevel,use="pairwise")
0.8890737
```

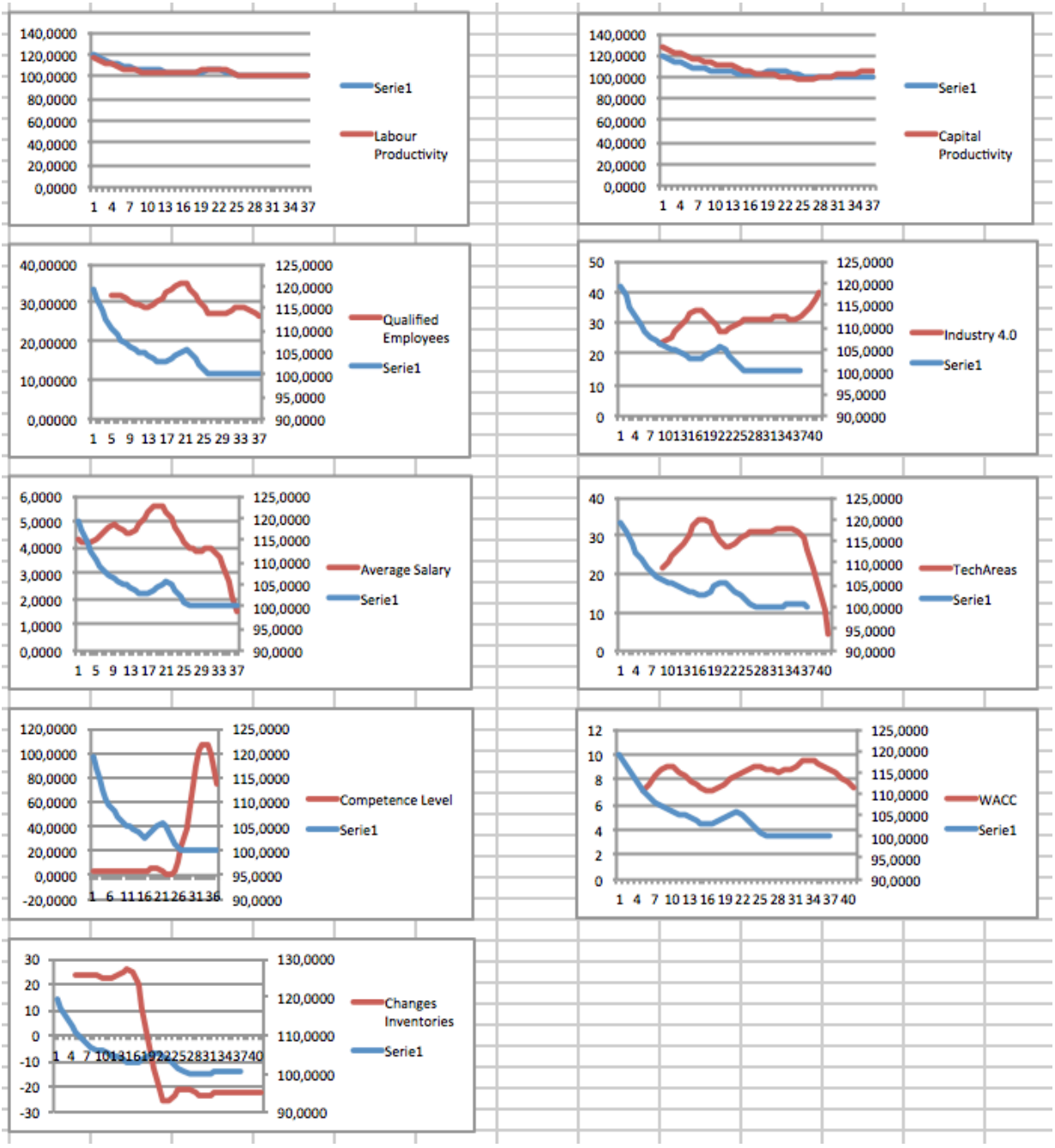
According to the results provided by the two analysis, the qualitative one, checking the behaviour and the fluctuations of factors during time, and quantitative one, controlling the degree of correlation, the linkages between factors, the most crucial variables to be taken into account are the upcoming ones: **Greenhouse Gases Emissions**, **Sustainability Subsidies**, **Value Added in Environment**, **Labour Productivity**, **Average Salary**, **Competence Level**, **Capital Productivity**, **WACC**, **Cost Competitivity**, **Biological Cultures**, **Renewable Energies** and **Export Level**. Those parameters, which have just been listed, are defining the first filtered figures that will represent the base for the following calculation. Mixing these factors on group of three or four, changing continuously and randomly the variables to discover the optimal combination, the final regression will be run at the end.

3.1.4 Construction

Even for what refers to construction have been analysed the temporal changes for all the regressors to be potentially used within the final judgement and the dependent variable, so Total Factor Productivity.

Figure 34: Graphical trend representation of TFP and the other independent variables for construction industry





And finally, for this industry, too, have been computed correlation indexes between all factors and Y variable in order to investigate from a quantitative, logical perspective the power of the relationship among them.

#Correlation between Total Factor Productivity and x's independent variables

cor(TotalFactorProductivity..TFP.,GHGEmissions,use="pairwise")

0.754102

cor(TotalFactorProductivity..TFP.,EnvironmentalTaxes,use="pairwise")

-0.4654065

```
cor(TotalFactorProductivity..TFP.,SustainabilitySubsidies,use="pairwise")
-0.479432
cor(TotalFactorProductivity..TFP.,ValueAddedEnvironment,use="pairwise")
-0.6050252
cor(TotalFactorProductivity..TFP.,AdjustedWasteGeneration,use="pairwise")
0.8267806
cor(TotalFactorProductivity..TFP.,RDemployees,use="pairwise")
-0.5520983
cor(TotalFactorProductivity..TFP.,RDexpenses,use="pairwise")
0.4765487
cor(TotalFactorProductivity..TFP.,InnovativeActivities,use="pairwise")
0.7965273
cor(TotalFactorProductivity..TFP.,LabourProductivity,use="pairwise")
0.9795228
cor(TotalFactorProductivity..TFP.,QualifiedEmployees,use="pairwise")
0.6590049
cor(TotalFactorProductivity..TFP.,AverageSalary,use="pairwise")
0.2924704
cor(TotalFactorProductivity..TFP.,CompetenceLevel,use="pairwise")
-0.5447487
cor(TotalFactorProductivity..TFP.,CapitalProductivity,use="pairwise")
0.906381
cor(TotalFactorProductivity..TFP.,TechAreas,use="pairwise")
-0.5795814
cor(TotalFactorProductivity..TFP.,Industry4.0,use="pairwise")
-0.6711333
cor(TotalFactorProductivity..TFP.,WACC,use="pairwise")
-0.5309779
cor(TotalFactorProductivity..TFP.,CostCompetitivity,use="pairwise")
-0.6742732
cor(TotalFactorProductivity..TFP.,ChangesInventory,use="pairwise")
0.7111179
```

Given these outcomes, for what concerns construction, it is possible to notice even only looking at graphs that there seems to be no relation between productivity and sustainability, as all the indicators used as proxy of environmental activities are not following a logical and reasonable direction. When Greenhouse gases Emissions and Adjusted Waste should be negatively correlated with TFP, they are positively connected. While Value added in the Environment and Sustainability

Subsidies, which should have a positive coefficient of correlation, are not following the same direction. So, according to this, just with an initial summary analysis it can be immediately noticed that the sector, probably, is not that much sustainable from an environmental point of view. The only variable that apparently seems to be consistent with this hypothesis is the one related to Environmental Taxes, as it is reasonably negatively connected with productivity. The main problem in this case, is related to the fact that in all industries Environmental Taxes are growing following, more or less, the very same trend. This growth in the variable, shown by the temporal fluctuations, can be the result of an improved consciousness and awareness of countries towards environmental problems and imminent consequences of them, which means that simply the factor is growing in volume because nations are becoming anytime more present and active in the fight against climate change as they have figured out that it is an effective and tangible problem with which to deal, and so they are strengthening and developing the tools they have at their disposal to tackle the negative situation. But this means that the plausible negative linkage between Y variable and the factor Environmental Taxes, can be biased as, again, the trend of the latter can be dictated and determined by governmental timing in adopting measurement to contain pollution rather than to possible movements in productivity, as the independent factor has a similar trend for all the industries but in any of them it has shown an effective linkage with productivity. This means that maybe, the linkage between Y and this specific *x*, is just a result of coincidence. Knowing the fact, it can be understood that there's no sustainability variable to be used in the regression, and accordingly, the given industry is not that much involved in environment protection and development activities. The only parameters that after the two valuations remain to try to discover the optimal combination to run the final regression are: **R&D Expenses**, **Innovative Activities**, **Qualified Employees**, **Capital Productivity**, **WACC** and **Average Salary**.

3.2 Judgements on the final outcome

At this point, everything is ready to run the regressions for the different industries, to discover the most reasonable and realistic combination of factors to be taken into account through the third mixed analysis mentioned before, and finally, analyse and comment the result obtained by the best mix of variables to discover possible insights to be captured about the relations between the different factors used and productivity. In the following subchapters there will be the valuations of the regression that have been considered for each industry according to the premises mentioned before. It will be already shown the most appropriate combination of factors, not considering all

the random tests that have been performed for each sector to discover the optimal solutions. There will be a descriptive analysis of the outcomes obtained, so that to explain effectively the meaning of obtained values for coefficients and intercepts, and to make sure that is well understood how the model is going to be interpreted and read. Furthermore, are going to be considered some practical, real and effective examples of behaviours maintained by companies working on these sectors in Italy, so that to complete the mathematical conjectures with notions and literature that sustain the thesis that should be demonstrated with this abstract. So for each category, some additional information about how the problem is practically treated in Italy are considered to make the valuations more solid.

3.2.1 Apparel

Talking about the industry of clothes, the best combination of variables have been found using Greenhouse Gases Emissions to represent the sustainability variables, Average Salary for the quality of human capital and the Weighted Average Cost of Capital for the degree of competitiveness. As have been said in the previous chapter, if one or two of the variables chosen for the regression are highly connected with some other factors that have not been considered, part of the insights between the latters and productivity can be captured by those variables within the regression. In fact, one of the reasons why these parameters have been considered, is because WACC is highly correlated with R&D Expenses, with a coefficient of -91% while Average Salary with Capital productivity, even if with a lower rate equal to 63%. So, in some way, the two selected factors are globing inside of them, are representing, even the degree of progress of the industry and the quality of physical capital. WACC and Average Salary are catching even information connected to related classes of conditions and capacities of machineries, plant and equipment, and of the level of innovation and development. These two indexes are embodying nuances and characteristics of productivity connected to more than one macro-area. According to this it can be supposed that, more or less, all the macro-category responsible for changes in productivity have been considered and taken into account appropriately.

Figure 36: Results of linear regression on Apparel industry

```
Call:
lm(formula = TotalFactorProductivity..TFP. ~ GHGEmissions + AverageSalary +
    WACC)

Residuals:
    Min      1Q  Median      3Q     Max
-4.3100 -0.7732  0.0985  1.0063  2.4601

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  373.4512    41.0216   9.104 1.02e-09 ***
GHGEmissions -11.6532     1.4958  -7.791 2.23e-08 ***
AverageSalary  0.8802     0.4979   1.768 0.088406 .
WACC          -4.3668     0.9859  -4.429 0.000141 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.474 on 27 degrees of freedom
  (14 observations deleted due to missingness)
Multiple R-squared:  0.8837,    Adjusted R-squared:  0.8708
F-statistic: 68.42 on 3 and 27 DF,  p-value: 9.716e-13
```

As can be seen in the above image showing the outcome produced by the linear regression, there's a high connection between productivity and sustainability. In order to analyse properly the result, first of all it has to be noticed that all the coefficients are coming out to be substantially significant, with a probability of finding a different result from the one defined by the equation, lower than 1 over 1.000; an exception is just for the Beta related to Average Salary, as the probability of finding different values is lower than 10%, but the t-value is in any case sufficiently high and the overall p-value of the equation, almost equal to zero, so the given figures are robust and solid. For every coefficient, and for the intercept, too, it is possible to see that the T-value obtains good estimates, in fact, it is pretty high and far from zero for each figure. As mentioned previously, its value is given by the coefficients, or the intercept, over the standard deviation, which represents the standard errors for each estimate and so the probability of having a result distant from the obtained one. And the lower is the SE compared to values, the higher it will be the T-value, and the better it is. In this specific situation it is high enough in all cases. Looking at the value of the estimates, on the other hand, the value for the intercept is very high, meaning that probably a big part of Total Factor Productivity is independent from the factors taken into account, it is autonomous and varies according to specific factors that are not connected to the considered categories. For what concerns the independent variables, average salary seems to be very little relevant and impacting, as it is responsible just for positive changes of 0,9% in productivity if

things are supposed to vary. Referring to the degree of competitiveness, instead, it can be noticed that *WACC is negatively correlated with productivity, with a coefficient equal to 4%,* which means that fluctuations in the risk perceptions of investors, both debt-holders and shareholders, can cause some problems in companies' productivity. The coefficient is not that high, but considering the level of volatility and instability of financial markets, a 4% beta can be in any case very relevant. Given the fact that ups and down are very frequent and can be dramatically characterized by big jumps, the effects on productivity risk to be severe. The Weighted Average Cost of Capital is representing the reliability that customers believe the industry has, the solidity of the sector; this means that, probably the opinion and the feelings of the market are essential for the success of the industry, which is reasonable, considering that fashion industry is guided by tastes, feelings, emotion, sense of art and freedom, that customers perceive from the product they purchase. It is very connected to the final clients. Finally, *Greenhouse Gases Emissions have a coefficient equal to -11%, which means that if the generation of pollutant is increasing, due to production boosts, for example, then productivity is supposed to decrease of 11%*. If greenhouse gases emissions increase of 40%, then productivity will decrease of 4,7%, this is a huge shift. So even sustainability factor seems to be very relevant in the sector. The reasons behind this very high connection between TFP and GHG Emissions is possibly related to the fact that their primary resources are coming from the environment: as cotton, flax, hemp and jute, are derived from plants, and wool, come from animals as sheep, alpaca and rabbit. So, according to this, damages in the ecosystems are going to directly affect the income that they require to fuel their production. Or maybe the deep linkage can be referred to the very high water requirement exercised by the industry, especially for leather product. In the textile sector water it's fundamental to colour fibers, to wash materials, to tan leather pieces and remove the fat residuals, and water availability is facing very serious problems of reduction and contamination due to climate change and irresponsible actions promoted by many enterprises. But if water availability diminishes, the apparel industry will suffer from this. So the connection between TFP and GHG emissions seems to be plausible. "Green is the new black" says Barclays in the report of January 2020, as public is any time more looking at sustainability. The social-environmental risk impacts on the growth capability of businesses, as if they want to remain competitive during time and provide continuity to their activities, they have to become greener and sustainable. There's a growing interest towards the environment through millennial customers, investors and in the regulation; 39% of financial investments today are represented by social responsibility's investments. If companies want to be chosen among others by investors they have to be sustainable. Moreover, developing a greener business model to be followed allows

enterprises even to save some resources, as future climate change costs can lead to many problems in textile production, given the fact that, for example, water is supposed to decrease in the future, and it is fundamental in the apparel sector. So being ready in advance to face the dramatic consequences of a new, warmer planet, can be advantageous. According to this, many companies are moving to greener mechanisms, activities and processes to meet sustainable needs and evolutions. The National Italian party for fashion has instituted Green Carpets fashion awards in which many designers and fashion houses have embraced the idea of shifting to an environmentally-friendly concept of fashion. Stella McCartney has won the prize in the latest meeting, promoting a 75% sustainable collection made of recycling materials. Nowadays the new goal is to be able to produce textiles and fabrics made of "agricultural scraps" as artichoke leaves, residuals of pruning coming from olives and cherries trees, chestnut balls and similar. There's even someone who uses graphite to colour fabrics to create technological clothing. Tessuti di Sondrio, a leader company in the production of textiles made of flax, hemp and cotton, uses photovoltaic panels to create electricity to be used within the company and a plant that warms the ambient through heat recovery from waste water. Furthermore, colours are natural, made with water; organic cotton is cultivated without pesticides. Thanks to these attitudes the company has the possibility of using a certified label, which ensures the biological treatment of the materials with a very low impact on the environment, that provides to the name of the company a fame for high-quality products, deep attention for customers and value chain and prestige. Prada in the fall/winter fashion show for 2020/2021 have created clothes using recycled materials as nylon and econyl coming from plastic garbage taken from oceans. Even Gucci has attributed a value to sustainability, sharing its environmental balance sheet and income statement since 2017, and announcing to have become completely carbon neutral and with zero emissions in 2019. The CEO of the company has announced it has started to use organic fibers, regenerated nylon and the enterprise has definitely renounced to furs. In 2025 it has predicted, jointly with the whole group Kering[76], to reduce its global impact by 40%, knowing that in the years between 2015 and 2018 environmental impacts have reduced of 14%. Talking about leather sector, Montebello tannery continuously monitors the impact of every squared meter of leather produced and at the very same time uses renewable sources of energy for its plants. Machineries are fed with recycled water and the painting used outside of buildings is particularly designed to capture smog present in the atmosphere around the area. Primary resources are mainly "zero kilometre", coming from

[76] Kering Group: it is a fashionable society that globes together and owns brands as Gucci, Yves Saint Laurent, Bottega Veneta, Balenciaga, Alexander McQueen and Brioni.

scraps produced by near butcheries, where otherwise they would have been treated as waste difficult to recycle. Moreover, given that income materials are fresh and not damaged, the technology is salt-free, it doesn't use salt to maintain the properties of product, and this is important, as it is difficult to waste appropriately.

Also the fast fashion industry is starting to show some interests on sustainability, as H&M wants to produce at least the 60% of its product using recycled resources and relying fully on sustainable sources of energy.

Having these general information, it's clear that apparel industry is substantially connected to sustainability and environmental matters, both from a mathematical and theoretical perspective; and that its productivity strongly depend on it, together with other factors, clearly, to guarantee improvement and development. It's crucial, nowadays, for companies to become greener and more focused on environmentally friendly processes; not only because in this way the productivity should increase, and so even the value of the enterprise itself, but even because customers and investors are asking for it, and we have seen that even the feelings and sensations that the market has towards the company are very important, if not essential, for the success of the activity. So it can be concluded that, as statistical evidences have shown, sustainability is very meaningful and relevant for this industry, and companies have already shown to understand the situation, moving towards this direction.

3.2.2 Food and Beverage

Referring to Food and Beverage industry, the variables that came out to be the most appropriate and relevant to run the final and ultimate regression, have been: Greenhouse Gases Emissions for what concerns sustainability, Qualified Employees to represent the quality of human capital and Capital Productivity for the quality of physical capital. Even in this case, have been noticed that the variable related to sustainability has a deep and strong correlation with Cost Competitiveness, equal to -92%, which means that GHG Emissions not only can be responsible to capture insights and information about the degree of environmental activities and efforts performed and run by the enterprises, but moreover, they can reflect and represent partially even the degree of competitiveness. This seems to be a very useful intuition. A very powerful, intense linkage between these two factors may suggest the competitive position of companies within the industry, and the market in general, is highly influenced negatively by the level of pollutant emissions generated by the business itself. The more a given enterprise has obsolete, traditional, musty

machineries, processes and plants, the more the activity are performed inefficiently, with a lot of waste and unnecessary losses of resources, energies and product due to the very low level of innovation and efficacy in the business, the higher would be the emissions of pollutants, as they are particularly associated to activities run in an old, out-dated way, with very low level of innovation, and the worse would be the competitive position of the company within the market. The reason behind this, can be associated again, to the fact that markets are directly driven by customers, by their needs, by their necessities and wants. And are effectively clients that are asking for greener product and services, they worry about the environment, they are disposed to spend a little bit more to purchase something that is more sustainable. This is creating space to another share in the market arena represented by sustainable activities, which have the possibility of gaining more just because they are perceived to be of higher quality. According to this, the greener the processes and the better the products and services offered, the better the competitive position in the economy, the higher the prices that can be settled, the greater the value delivered, the more satisfied the customers, the greater the worthiness of that enterprise. In some way those businesses that are able to reorganize assets, attributes and abilities in a more environmentally-friendly way, are able to develop sustainable competitive advantage, and even investors are searching for them. Shareholders and debt holders want to discover opportunities that last in time, that are a bargain, as they are able to maintain their value against many difficulties. The aim is to search for those investments in which the money spent for the acquisition of the stocks of a given company are effectively representing the intrinsic, real value of the good purchased, not inflated, unrealistic values. Effectively, when some sustainable parameters and indicators are respected, it is like an activity is protecting itself from risks, from possible losses; it is transforming its processes into something more in line, more respectful of the ecosystem, and in this way it will rely less on huge exploitation of natural resources, using them in a responsible way, it will gain efficiency in the procedures to be developed, it will spend less time, resources, human efforts and money. And the most important thing, is that if the environment is supposed to vary dramatically due to climate change, which is a scenario not that much unrealistic given the estimates exposed in the first chapter, those companies that have performed this sustainable transformation, have already protected themselves from huge, potential shift to be actuated lately, so they are bearing much less risks, and this is very important for todays investors that think about possible future evolution of a given situation. More sustainable companies, in the case the world is supposed to change according to changes in the environmental characteristics, have already prepared themselves to rely less on natural resources, or at least to use them in a responsible, efficient and regenerative way,

they have already learned how to improve their capabilities being more in equilibrium with the ecosystem around them, they have already understood how to redefine their activities and processes to use in the best way all the primary resources, labour force and capabilities that they have. And these type of businesses had had the time to do this with slow, appropriate and growing shifts, it has been a gradual process, they hadn't had to change suddenly everything in a second, hence they are supposed to be much more solid and robust than those ones that have maintained a polluting, unsustainable, irresponsible position since this moment and then had to change everything in a very short period of time. Greener enterprises are more vigorous, more reliable, and less risky at the eyes of financial investors that are future oriented when they have to choose where to put their money. Furthermore their intrinsic value is much more greater than the price paid for them, as the very high level of efficiency and savings in materials and capabilities used are guaranteeing that the market value of the entire company is much bigger than the effective money spent for it, and this is another good point for potential shareholders.

So just even looking at this fact, it can be understood how much important it can be for a given enterprise to promote its sustainable development and activities, as in this way it could be able to outpace its rivals and create some value added in the market.

Trying to have a more pragmatic and practical view of the situation to be valued and looking at the effective regression that has been developed, the results are shown in the below image.

Figure 37: Results of linear regression on Food and Beverage industry

```
Call:
lm(formula = TotalFactorProductivity..TFP. ~ GHGEmissions + QualifiedEmployees +
    CapitalProductivity)

Residuals:
    Min      1Q  Median      3Q     Max
-0.8931 -0.3740 -0.1464  0.3528  1.2367

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)        92.636472  29.442062   3.146   0.0040 **
GHGEmissions       -3.361382   1.207577  -2.784   0.0097 **
QualifiedEmployees  0.003649   0.034840   0.105   0.9174
CapitalProductivity 0.809785   0.061441  13.180 2.82e-13 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.6135 on 27 degrees of freedom
  (14 observations deleted due to missingness)
Multiple R-squared:  0.9176,    Adjusted R-squared:  0.9084
F-statistic: 100.2 on 3 and 27 DF,  p-value: 9.502e-15
```

According to what is depicted in the above image, it can be immediately seen that there's a coefficient that is insignificant. *The beta for Qualified Employees, in fact, has a p-value that is close to one, which extremely high, and the standard errors are greater than the value of the coefficient itself.* Furthermore the beta is almost close to zero, which should mean that there's no connection between the variable and Total Factor Productivity, the Y is not dependent at all to this specific *x*. This probably happens because there's a correlation of 60% between Qualified Employees and GHG Emissions, and when two or more factors are connected between each other, there's a problem of multicollinearity within the model that can cause changes in the coefficients and the insignificance of them from a statistical point of view. Normally, multicollinearity should be avoided, the variables inserted in the equation should be distant and unrelated the one with the other, to ensure that the result are the more valid it's possible, while this situation, on the other hand, can produce biased, unrealistic results. The reason why it has been considered in any case, is because it is in some way a "*control variable*". In fact, if it is not inserted in the model, the results become unreasonable, the relationship and the linkage between factors are not captured and the outcomes suggest that part of the trend, some of the characteristics of Total Factor Productivity, are left behind, are not investigated. According to this, it had been thought that, probably, inserting the variable even if it is partially connected with GHG Emissions, could have been more an advantage than a disadvantage. As through Qualified Employees, part of the nuances and specific attribute of Y dependent variable are considered in the model, the outcomes seem to be more plausible and significant, and even the tests suggest that the results are more stable, solid and realistic in this way. So, in this specific case, considering a factor that is correlated with another one within the model has come out to be useful, given the fact that in this way, more complete, detailed and particular information are obtained on the TFP variable, even if the independent factor result to be insignificant from a statistical point of view. The equation is effectively more stable. For what concerns the other two coefficients and the intercept, instead, it is possible to understand that in all cases they are strongly significative, with very high t-values and low standard errors if compared. *The intercept and GHG Emissions's coefficient have a p-value lower than 1% and the beta of Capital Productivity is lower than a thousandth.* There's a very low probability of finding values different from the shown ones. The overall p-value of the whole equation is very close to zero, so the analysis seems to be solid enough. *The coefficient of Capital productivity shows that there's a linkage with TFP equal to 0.81%.* It is a positive relationship, and this makes sense, as when the degree of efficiency and the capabilities of machineries, plants and equipment is increasing it is reasonable than even the overall productivity of the entire factor used is supposed to increase. The reason behind the very

low degree of connection between the two can be related to the fact that Capital Productivity is very strongly connected with TFP, with a percentage almost equal to 93%, which should be a little bit too high to be considered within a regression, as in previous chapter it has been said that when the correlation is too high between the variable Y and a regressor, the latter won't be able to provide any additional, particular information about the dependent factor, as it is too much near its value. Possibly the 0,80% value for the coefficient is representing the part of the variable that is not connected with Total Factor Productivity, the part of Capital productivity that is independent from Y, that captures the particular, tiny, sophisticated characteristic of Capital efficiency that are not considered in TFP. Essentially the very small beta for this specific factor, is valuating and taking into account a specific part of the independent variable that is not connected with Y parameter, and that so, is providing new, valuable, precious and important information. Probably it can represent those particular characteristics of machineries and equipment that are not subjected to particular synergies, linkage or influences by labour or other input factors, it identifies the facets and attributes of capital that are independent from any other element, that can be represented just through capital itself.

Concentrating on GHG Emissions variable, contrarily, it has a negative coefficient in the equation, with a Beta equal to -3,36%. This is realistic and truthful, as it is plausible that if the pollutant emissions increase for some reasons, the productivity decrease of 3,36%, for all the motivations expressed previously. A greater level of emissions can be related to greater level of obsolescence in the machineries, lower level of effectiveness and efficiency in the development of goods and services and worse use of the resources at disposal. All these insights are making it clear to understand that if emissions are increasing, and these can be the causes, the productivity possibly, is going to decrease. And there's a quite high connection between TFP and GHG Emissions variable.

Furthermore, there are many examples of companies and situations in which these intuition and perception have been discovered to be true and actuated. Enterprises have really understood the importance of being sustainable, the very big advantages that can be perceived if they become greener. They want to grow and develop respecting the territory in which they are settled, Lattebusche, for example, put a lot of efforts in trying to guarantee to farmers the possibility to stay in the mountains where they are used to live, and where cattle are bred in optimal conditions, protecting these particular environments and contrasting the phenomenon of abandonment of lands. Moreover they have been able to win 7 awards in the latest five years thanks to their capabilities of reducing consumptions, utilizing renewable sources of energy and investing in the development of new technologies. Many wine companies, too, are revolutionizing their processes

using thinner and lighter bottles, utilizing paper packaging, reducing the dimensions of the value chain to control better all the processes, reusing the heat produced during the use of the plants, recycling water and using LED lights. And the Italian wine market exports all over the world, it's very famous and remunerative, so it can be a huge resource. Andrea Illy, president of the prestigious Italian coffee enterprise, has declared that the future development of the industry will be based on the exploitation of renewable sources of energy, according to him sustainability is a huge and precious engine for growth. He has presented a virtuous plan for its company to transform it into something completely sustainable making the value chain to be completely carbon free in 2033, trying to assemble cultivating lands so that they will be carbon negative, inducting the removal of CO_2 from the ecosystem. Essentially lands are enriched with nutrients and substances that are able to absorb Carbon Dioxide from the atmosphere and farmers can be able, in this way, to obtain carbon receivables that can be sold on the market. They have decided to acquire directly primary resources, fixing precise and rigorous plan in processing of activities to reduce the consumption of water, for example. The buildings on the head quarters are fully sustained through electricity generated with renewable resources, for packaging they use only biological materials and farmers have salaries that are 30% higher than the quoted ones. According to him quality and sustainability are two sides of the same coin.

So even for the food and beverage industry, we can conclude that renewable energies are becoming any time more convenient in the market if compared to fossil fuels and moreover, financial systems are more and more oriented on enterprises that care about the environment, so if companies pollute they will find more difficulties in obtaining lending and borrowing. It is the market that asks for a shift in this direction. It's pretty much important for the sector to move towards sustainability as in this way it will obtain greater advantages in terms of market share, greater quality and higher prices to be settled. In addition, we have seen that even from a mathematical point of view, being more environmentally friendly helps companies in achieving higher levels of productivity and efficiency, making it possible for them to save money, resources, time and capabilities that can be used and involved in other processes. Sustainability is a win-win opportunity.

3.2.3 Agriculture

For what concerns Agriculture industry, four variables have resulted to be the most relevant to be taken into account within the final linear regression, and they are respectively: Sustainability Subsidies for the macro-category of sustainability, Export Level for the degree of competitiveness, Average Salary for the quality of Human Capital and finally, Cost Competitiveness.

Even referring to this sector, it has been considered that Cost Competitiveness has a correlation with Capital Productivity equal to 67%, suggesting that the factor is partially able to individuate and catch part of the trend of the category referred to quality of physical capital. This is something that can be very straightforward if it is analysed properly. It is clear that if the level of productivity of the machineries, of tools, of utensils, of equipment is greater, they are supposed to work better, which means that they are not assumed to damage quite easily, they last in time, the plants are not excessively consuming the resources, wasting a lot of precious materials, but are taking just what is needed, it means that they don't need huge amount of fuel to be ready to work, they don't have to be fed continuously with gasoline and they are fully able to satisfy the request of production, they are able to generate and create what has to be created, staying in line with the demand. The fact is that Cost Competitiveness captures the convenience of labour work, so it tries to compare the value produced by workers with the cost of labour, the salary that have to be provided to employees for the performances and the activities that they ensure. It is a measure of how efficient workers are, as the greater the level for the factor, the more they are able to guarantee a very high percentage of value added compared with the remuneration that they perceive. And this doesn't mean that employees are underpaid, this means that the labour force is working so good, that the costs related to salary are almost unperceived by the enterprise given the very high degree of utility that they are able to produce. So if the salary is high, they should be able to produce huge amount of value added with the minimum effort.

If all these particular observations are guaranteed and respected, if these facts are really happening, the connection between Capital Productivity and Cost Competitiveness is represented by the simple fact that if the tools, the instruments that workers use are efficient and working properly, for sure employees will be able to produce more with the minimum additional endeavour. If the machinery are working with less necessity of repair, on an on-going basis, with low requirement of resources to be used to feed them, as fuels and electricity, the employees will be able to ensure a greater level of quality in the products, a higher quantity of goods and services to be provided and a higher value in general on the market.

So there's effectively a reasonable connection between the two variables and Cost Competitiveness can be able to represent, just a little, the movements and the fluctuations in the category related to quality of capital and resources.

Furthermore, the Export Level variable has a very strong and deep connection with more than one variable related to sustainability. The correlation index between Export Level and Biological Cultures is equal to 99%, while the connection between the parameter and Value Added in the Environment is 91%. This is evidencing that there's a very powerful, compelling foreign demand for goods and product that are deeply sustainable. People from inside and outside of our national boundaries are searching for goods that are respectful of the environment, that are in line with bio-dynamics cycle, with seasons; clients want in their tables food that is healthy, natural and wholesome. According to Coldiretti, an Italian institution that manage and control bureaucracy and regulation for the agricultural industry, two over three Italian citizens prefer to purchase biological cultures and has analysed that consumptions of biological products have increased of 178% just in the last year. In Europe, Italy is the leader country for biological production with almost 79 thousands farms involved in the sector and the whole industry has a value of 5 billions euros. The fact is that this very big production of cultures raised with no pesticides, with natural fertilizers, with no genetically modified organisms, affects strongly even Exports. The Italian Export and the "made in Italy" culture, nowadays worth 2,2 billions euros, our country is the first in Europe for national biological exports and, globally talking, it is second just to the United States. The exports are literally pulling biological activities, the demand for these products is huge and this is boosting very much the production. Value Added in the Environment and Biological Cultures variables can be understood to be pretty similar in this case, as the first one should represent the actions, processes and efforts taken by companies to offer their contribute in enhancing, reinforcing and protecting the environment jointly with production of good and services to be offered in the market. But when talking about agriculture, this factor is pretty in line with Biological activities, as in both cases the aim is to respect the ecosystem, to follow and be part of its cycles, of its seasons, to not damage the source of the goods that are so precious for humans; the objective is to take what we need from the environment, being sure to restore what we have taken, to recreate, re-bring, in different forms maybe, those resources back in the system. Italian goods are so appreciated because of their quality, of their safeness, as they are certified, because of their continuous research for innovation. Even if the sector most of the times is undervalued when talking about sustainable activities because it is though to be extremely

traditional, old-styled and out-dated, it is really evolved. There are a lot of incentives, initiatives and proposal to push towards a more responsible, green and evolved system.

Having defined clearly, all the most important premises to be taken into account specifically for this industry, below are shown the outcomes of the linear regression that have been performed.

Figure 38: Results of linear regression on Agriculture industry

```
Call:
lm(formula = TotalFactorProductivity..TFP. ~ SustainabilitySubsidies +
    ExportLevel + AverageSalary + CostCompetitivity)

Residuals:
     Min       1Q   Median       3Q      Max
-2.98427 -1.01848 -0.04012  0.99801  2.21748

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)            -464.06316   86.13681  -5.388 7.80e-06 ***
SustainabilitySubsidies    5.00705    2.20036   2.276 0.030181 *
ExportLevel               17.20477    3.45243   4.983 2.44e-05 ***
AverageSalary             -1.09086    0.74482  -1.465 0.153432
CostCompetitivity          0.12704    0.03243   3.918 0.000479 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.383 on 30 degrees of freedom
  (10 observations deleted due to missingness)
Multiple R-squared:  0.8891,    Adjusted R-squared:  0.8743
F-statistic: 60.13 on 4 and 30 DF,  p-value: 6.763e-14
```

Given the results from the equation, first of all what is particularly emerging, is that *Average Salary, comes out to be not very significant. It has a p-value equal to 0,15*, defining that there's a probability equal to 15% or less to find out a result that is not in line with the estimation provided by the regression. Moreover *the coefficient has revealed to be negative, with a value equal to -1,09%*, which is something very strange, given that it should mean that if workers are paid more, the productivity decreases. But maybe, given the fact that in any case the results are not dramatically bad, as the T-value is not close to zero and the standard error compared with the coefficient is not very high, there can be some insights to be captured and analysed. Possibly the negative connection between salaries and productivity is to show that they have tended to diverge in the latest years, which doesn't mean that there's a direct relationship of cause and effect between salaries and productivity, guaranteeing that if workers are paid less, productivity increases, but probably it tries to capture the gap that exists between wages and productivity. Some researches, in fact, have shown that even if in many countries productivity have increased in the ultimate years, wages of medium-low income workers

have remained stagnant and haven't grown. This had happened because even if workers, and farmers in this case, are working more productively and efficiently, the fruits of their labour have primarily accrued to those on the top and to corporates, especially in the recent years. And this can be particularly valid for agricultural industry, which is most of the time undervalued, not taken into account and not evaluated properly in policies and governmental decisions. It is considered an old, traditional job, which is not supposed to be able to join possible transformation, evolution and development for the future, not that much, and so, normally, it is forgotten by institutions. In this way the potential substantial growth offered by the industry is not perceived by the principle and major workers, that contribute to the mechanism, in terms of greater wages, but all the advantages are taken by larger corporations and enterprises that are colossus within the market and are able to impose their strength and capabilities. So in some way, it can be said that the coefficient is evidencing a deep and serious problem perceived by the employees in the industry, connected to the fact that frequently the labour force that contributes heavily in the development and evolution of the whole sector is undervalued, is not considered, not taken into account and weighted in a equal, balanced and right way. This suggests that, given the fact that the economy of agriculture has shown to have a huge potential, especially in Italy, where there are plenty of opportunities, products and resources to be exploited responsibly, and has shown to be able to take advantage from this potential, farmers, who are responsible of these improvements and evolutions, should be remunerated and rewarded optimally and equally, and must not suffer from mismatches between productivity and salaries. *For what refers to other coefficients and the intercept they are all deeply consistent, as all the p-values are lower than 5%, and for the α, the Export Level and Cost Competitiveness is even lower than one thousandth. T-values in all cases are substantially high and the standard errors low*. The overall p-value for the general equation is close to zero, so it seems to be very robust. Export Level and Cost Competitiveness have both a positive coefficient, which is reasonable, given the fact that the lower are the costs compared to the value added produced and the greater will be the level of efficiency in companies, as the costs to produce a fixed amount of worthiness are reduced pretty much. And moreover, the greater is the amount, the value of goods sold in general, the more incentives there will be to be more productive, more efficient and able to generate more without additional efforts, so to satisfy the market and reap all the advantages. *It is possible even to notice that, in any case, the coefficient of Export Level is very high if compared to the one of Cost Competitiveness, as the first is equal to 17% while the second just to 0,13%.* This again, evidences the importance of Exports for the agricultural sector development in Italy, as it has been already mentioned previously how much this variable is particularly important for the industry.

Exports in 2019 have increased of 5,3% in Italy pushed by the agricultural development. Foreign demand for Italian agricultural product have reached 44,6 billions euros, and goods produced from this industry are pushing growth substantially, especially through meats, cheeses, milk and wine, even if the latter is more related to food and beverage industry rather than this one. The true, original and valuable "made in Italy" can really make the difference. And moreover, it has been clarified that there's a very strong positive connection between biological products and the degree of consciousness and efforts that farms put on the environment, so the Value Added in the Environment, and Exports. The concept of "biologic" and the interests that companies are putting on the environment is becoming any time more relevant for customers, they are looking for those products generated with respect of the environment, with awareness of the cycles, of bio-dynamics and of resources used to treat them properly. This idea is becoming more and more relevant and mainstream, it is no more a niche concept. Exports of biological goods have increased of 597% since 2008. Italy is an absolute leader in the sector, being first producer of bio citrus fruit, bio producer of grapes, bio producer of oil, cereals and it is the first in the continent for number of companies involved in these activities. So it is clear that exports are a fundamental factor for Italian agricultural development, if they increase of 10%, there will be a positive shift in productivity of 1,7%, very good result. It has been specified that exports are really important to improve the level of efficiency, and so TFP, in the industry; and that, at the very same time, biological cultures and the capabilities of enterprises to add the more value it is possible on the ecosystem are two essential, crucial and fundamental factors to develop a strong, safe and advantageous competitive position in the export activity. Finally, the last parameter to consider is *Sustainability Subsidies, which is affecting productivity with a positive coefficient equal to 5%.* A beta equal to 5% can be particularly important to make evolutions and changes in the industry, this suggests that helps and incentives provided by the government have came out to be particularly useful and relevant, probably because they are used responsibly and efficiently within the industry. Contributes to production in Italy are near to 5 billions euros, not that much compared to money perceived by France (8,2 bn €), Germany (6,7 bn €) and Spain (5,7 bn €), which means that the relationship between subsidies and value produced is low. This strengthen the hypothesis that the resources provided are used particularly efficiently to innovate the industry and improve its preciousness, its intrinsic value. In our country, even if the resources provided are less, they are used so competently, ably and expertly by the industry, that the value produced is much more higher than the one guaranteed by other nations, thanks to the very high level of efficiency ensured in the system. Italy leads the agriculture sector in 17 different types of vegetables products

in Europe and even for what concerns fruits it has a lot of advantages. To evidence the idea of how much the industry is effectively innovating and renewing itself, many examples are reported in the literature. Fomet Company, in Verona, has learned how to reuse and recover wastes using them as fertilizers. On an industrial scale, it retires manure, re-handle it through process of drying and concentration for months to create nutrients and natural plant food. They have understood even how to recover the vegetal part of coffee beans and every material that contains sugars, protein and amino acids that otherwise would have been wasted by other industries, to create useful and nourishing substances for cultures that are re-given back to the ground. Demethra Biotech is an Italian company, settled in Vicenza, which produces in vitro bioactive substances, derived from a Mother Plant and grown in a perfectly sterilized environment, without any external contamination as pesticides or heavy metals, that can be used in cosmetics, food, to colour textiles, in pharmaceutical industry or to feed cattle. They in some way exploit the natural capability of vegetal cells of auto-replicating without any OGM intervention, and at the very same time the soil is fully honoured, fully zeroing ground consumption. Chemicals activities are abolished and water consumption very reduced, but the very incredible thing is that through these processes the final good is completely fito-complex, which means that it has all the natural chemicals component of a vegetal organism that would have taken millennium to be produced in nature. This important research shows possible ways to preserve deeply biodiversity of species providing the possibility of creating huge and infinite quantities of vegetables without depleting natural resources; in this way it can be recreated undergrowth in our mountains. They start from a real seed that germinates in a protected environment, with a certified DNA to avoid adulteration. Moreover the plants in which these activities are performed are fully automatized according to industry 4.0 and has the greatest capacity production of Europe, the value chain is the shortest it can be imagined as is passes directly from cultivation to the final product with the advantage that they don't have to respect seasonality, maintaining a very high quality and pureness. So according to this particular example, it can be imagined that if subsidies and national resources are used in this way, to push Research and Development, to incentivize scientific activities and evolutions, and sustainable, break-through innovative practices and processes the level of productivity and effectiveness in the industry is automatically going to increase very much. And it is even more comprehensible that governmental money are used very efficiently, and are pretty much useful. Nowadays, when thinking about contemporaneity, everything is separated and parcelled, while in agriculture there's more a focus on the entire process, on the full, whole product, they close the process. There's normally a very profound respect of all the phases, of all the resources used, there's the intention of providing

value, love, passion with the good offered. And how this can be done without respecting the Earth that provides you directly what you need?

When talking about sustainability and agriculture, we should know that the concept of "biologic" is not intended to be something new, forward looking and particular, it is most of time a choice dictated by the love and respect that farmers feel for the land, and it has even a social value as it helps population to not abandon and leave some areas and territories, but to learn how to take advantage from them and work with them in a responsible way. It is a very deep, delicate concept much more related to the soul and consciousness than to economy when we are referring to agriculture, but there's a clear and strong relationship between sustainability and the productivity level in the industry, and it can be perceived from many perspectives, both the sentimental and the economical one.

3.2.4 Construction

Finally, the last industry to be taken into account will be Construction. In this latest case, the variables that have been chosen to be the most appropriate and best fitting to define the ultimate final regression are essentially six. This is because there are two possible alternative equations that can be represented to make the evaluations: the first contains Environmental Taxes, Weighted Average Cost of Capital and Qualified Employees, and it takes into account even the sustainability factor, given that the focus of the thesis is to demonstrate that there's effectively a strong and deep relationship between productivity and being sustainable; and a second regression in which there's no parameter to account for sustainability, referring only to Weighted Average Cost of Capital, Capital Productivity and Average Salary. The reason why have been taken into account two different possibilities for the regression, is connected to the fact that, at the first sight, it was essential to try to choose one factor for each macro-category to consider for the development of productivity, which means that had to be selected a parameter for sustainability, a parameter for degree of progress, another one for labour and capital productivity and the last one to represent the level of competitiveness within the industry. The choice had to be made giving priority to the macro-category of sustainability, meaning that, for sure, there should have been a variable connected to it within the regression, as the main objective, the goal of the abstract is to prove from a statistical and mathematical perspective, that exists and holds a linkage between the capability of respecting the environment (Sustainability) and being more efficient, productive and valuable (Total Factor Productivity). On the other hand, not all the other classes should have been

considered, especially if one of the selected factors in the regression is deeply connected with another factor representing another category not evaluated in the equation, as the first can partially represent the group of the second, and there's no necessity of inserting them both. As have been said before, if for example, Capital Productivity is one of the three variables chosen in the final and ultimate equation, and it is strongly related to R&D expenses, with a correlation index equal to 89%, it can be decided to insert only Capital Productivity and leave behind R&D expenses, even if the first is accounting for the quality of physical capital and the second for the degree of progress, as Capital Productivity can be able to partially explain, to represent and endorse even the degree of progress, guaranteeing a free position for another factor, of another class, to be considered. This happens because just three, four or maximum five parameters can be taken into account in the equation, otherwise there are too many regressors compared to the number of observation that are at disposal; and given that the macro-categories are five, one or two of them are not going to be inserted in the model, so has to be found a way to partially take them into account and capture their behaviour, even if just a little bit.

The obstacle that have been discovered in this case is that the only variable connected to sustainability that have passed the filters, the tests of the first two judgements made to reduce the number of regressors, is the one representing Environmental Taxes. The problem with this factor is that it is a little bit biased and tricky. In all the industries that have been analysed and considered in the thesis, from Apparel to Construction, the trend of environmental taxes was always showing an increase, it doesn't matter the trend, the fluctuations of productivity, it was always raising. For all the previous three industry Environmental Taxes have shown to be uncorrelated at all with productivity as they have been going always in the same direction, with increase in productivity have increased even taxes and vice versa. And this should not be right as the more you pay in terms of Environmental Taxes, the more should decrease productivity, for the hypothesis that have been defined reasonably at the beginning, because the more you pay the more you pollute. Only in this latest industry, Environmental Taxes seems to have a plausible linkage with Y dependent variable, and this sound strange. The reason why they seem to be connected is because productivity is decreasing during time, while the independent variable referred to taxes is continuing to increase, as it has done in the previous industries considered. The insights and the intuitions captured from this, are referred to the idea that probably the reason why Environmental Taxes are increasing during time, is because government and nations are starting to become aware and conscious about the real and effective problems caused by climate change, institution have understood that the traditional behaviour may not be sustainable any more, that the activities, as

they have been performed since this moment, have lead to dangerous, unprecedented and consistent consequences and they have discovered that they have to try to do something to stop, or at least limit, the dramatic situations in which they are going through. The factor, probably, is raising its value over time because the country has effectively started to define clearer regulations, more precise norms to be respected, because it has been able to adjust and refine the laws and limits to be taken into account or because it has been capable of developing technologies and mechanisms able to capture in a more efficient and effective way all the different variations in the level of pollution and the enterprises responsible for it. The important fact, is that, given the previous analysis of other sectors, given the particular trend of the parameter, Environmental Taxes seems to be an element that has its particular history that is independent from the one of all the other variables and from the dependent variable productivity, too. It has its own reasons and movements that are not able to provide us any clear or useful information about productivity. And these valuations can be strengthened even by looking at the results of the first regression that have been analysed. In fact, concentrating on the outcomes obtained by the model in which have been considered Environmental Taxes, WACC and Qualified Employees, it can be noticed that the coefficients are strange and unusual.

Figure 39: Results of first linear regression on Construction industry

```
Call:
lm(formula = TotalFactorProductivity..TFP. ~ EnvironmentalTaxes +
    WACC + QualifiedEmployees)

Residuals:
    Min      1Q  Median      3Q     Max
-1.9631 -0.7969  0.1379  0.7684  1.8039

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)       262.8802    25.7509  10.209 9.10e-11 ***
EnvironmentalTaxes  -9.3413     1.3239  -7.056 1.38e-07 ***
WACC                 1.0867     0.3876   2.803  0.00925 **
QualifiedEmployees   0.9176     0.1036   8.853 1.81e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.116 on 27 degrees of freedom
  (14 observations deleted due to missingness)
Multiple R-squared:  0.8164,    Adjusted R-squared:  0.796
F-statistic: 40.02 on 3 and 27 DF,  p-value: 4.481e-10
```

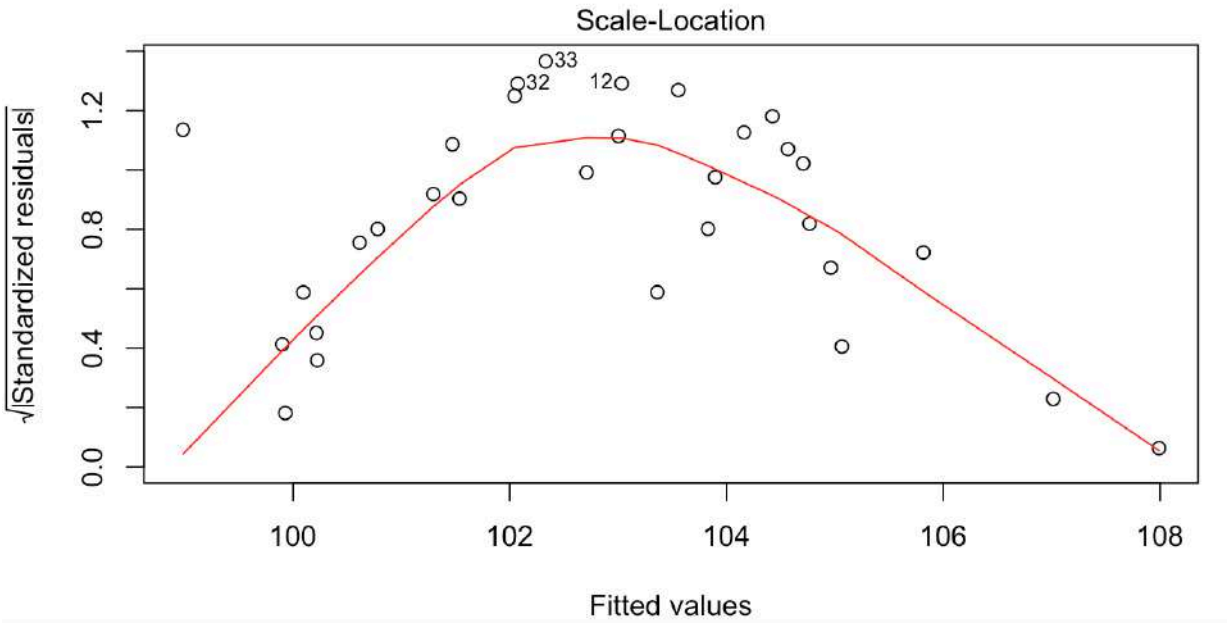
As it can be noticed from the upper image, Weighted Average Cost of Capital has a positive coefficient, and this is something very bizarre, especially considering the solidity and reliability of

the factor, which has no missing value and collects information for every temporal observation. If the perception of risk for shares and debt holders increase during time, and the interests to be paid back to them are increasing, the productivity should not increase, as it will mean that we pay more to receive the very same result, and this is not efficient.

Moreover, even though the coefficient should be wrong, given its positive sign that is not realistic, it has a very high level of significance, as looking at the p-value it is lower than 1%, suggesting that there's a very low possibility of being wrong in the estimates, the standard error is low and the T-value pretty high. Furthermore, if is taken into account *the correlation index given by Total Factor Productivity and Environmental Taxes, it is equal to -0,47%,* which is not that high considering the other figures related to sustainability discovered for the other industries. And looking at the connection between TFP and all the other variables related to sustainability, it can be seen that it is always showing non plausible, strange and weird results according to a probable negative connection between Environmental Taxes and productivity; as it has a positive connection with GHG emissions and Adjusted Waste Generation and a negative linkage with Value Added in the Environment and Sustainability subsidies. This is suggesting that the industry is a highly polluting one, and that in the latest years it had increased its level of pollution and damages in the environment jointly with improvement of productivity. It has probably obsolete, out-dated and old-fashioned structure and processes joined with a traditional and antiquated concept of evolution. So, given these facts, the negative linkage between the Y variable and Environmental Taxes, cannot be thought to be explanatory, truthful and logical. Moreover, if are analysed the graphs to check the statistical significance of the errors[77], it can be seen that the hypothesis of homoscedasticity is not respected at all, identifying a clear trend and behaviour in the variables which is left in the errors and not captured in the regression. When the Scale Location plot is showing results like this one, it means that the effective model is not able to capture and account for all the significant and valuable nuances and characteristics of productivity, and that many of its movements are left on the errors.

[77] The graphical representation to check significance of errors are going to be valuated in the following chapter for all the industries, but given that this particular regression would not be considered, they are mentioned here in this case.

Figure 40: Graphical representation of Scale-Location plot to control homoscedasticity hypothesis respect



According to these evaluations and the unreliability of the data, this hypothesis was discarded and not considered realistic and fruitful.

That's the reason why it has been taken into account a second regression to be valuated, not considering at all Environmental Taxes. This equation valuates WACC, Capital Productivity and Average Salary, and the information revealed by this alternative analysis are much more solid, realistic and plausible than the previous one, even if sustainability is not considered at all. Probably, the reason why sustainability is not that much relevant and significant in this particular industry, is related to the idea that it has already to understand and figure out the potential that can be exploited from sustainability matter. Maybe this sector hasn't already invested pretty much in the category, it hasn't take it into account for its development and evolution and it is a little bit more backward than the others in this sense. Construction industry has to learn that many opportunities and success can be achieved if sustainability become an effective part of the business plan.

Figure 41: Results of linear regression on Construction industry

```
Call:
lm(formula = TotalFactorProductivity..TFP. ~ WACC + CapitalProductivity +
    AverageSalary)

Residuals:
    Min      1Q  Median      3Q     Max
-1.6157 -0.8595 -0.4689  0.8015  2.3605

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)        59.36932    6.66984   8.901 8.64e-10 ***
WACC               -0.07246    0.38479  -0.188    0.852
CapitalProductivity  0.36379    0.03997   9.102 5.33e-10 ***
AverageSalary        1.44896    0.28536   5.078 2.04e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.243 on 29 degrees of freedom
  (12 observations deleted due to missingness)
Multiple R-squared:  0.8391,    Adjusted R-squared:  0.8225
F-statistic: 50.42 on 3 and 29 DF,  p-value: 1.269e-11
```

According to this chart, *the most relevant variables and factors that influence the dependent variable Y are essentially Average Salary and Capital Productivity. They show to have coefficients respectively equal to 1,45% and 0,36%, and they are positively related to productivity*. T-values for both variables, and for the intercept, too, are quite high and the compared standard errors are low, so the valuations are pretty robust. For the intercept, and the coefficients of the last mentioned factors, the p-values are below one thousandth per cent for all of them, so there's a very low, if not inexistent, possibility of discovering values different from the given ones. The main reason behind the low coefficient related to capital productivity, may be connected, as it has been considered for Food and Beverage industry, to the fact that the beta considers just the small fraction and facets of Capital Productivity that is not subjected to any influence by all the other input. It captures just the part of productivity of machineries, plants, buildings and tools that may affect the overall productivity of the industry and that is not affected by movements and fluctuations of other factor, the independent nuance of Capital. *As in reality TFP and Capital Productivity have a correlation index equal to 90%, so TFP is moving almost equally to the variable. The 0,36% takes into account the "almost" part of Capital that is not represented by TFP at all.* On the other hand, *Average Salary variable has a coefficient equal to 1,45%, and this means that if wages are growing of 20%, then productivity in companies is increasing of almost 0,3%.* This means that probably the industry is highly affected by wages provided to workers, and during time the two factors have shown to be very much related to each other. One of the reasons

behind this, may be connected to the fact that this sector in particular is highly depending on people, on human work force to be sustained. *The inputs are mainly provided in terms of labour, in terms of professional capabilities and labourers, there's no automation, there's no machine substituting the tasks performed by employees, so human employees and people are essential and crucial for the survival of this particular industry at the moment.*

Talking about WACC, instead, it comes out to be highly insignificant in the regression, with a p-value equal to 85%, T-values close to zero and very high standard errors. The coefficient is negative, as it should be, but it cannot be considered in the final evaluations. In this case the justification behind the irrelevance of Weighted Average Cost of Capital can be related to the very low level of innovation, improvement and development of the industry. The sector is highly traditional, it is very much based on old, conventional practices, it has not perceived huge, break-through innovation in the latest years, even if it had and has the possibility of exploiting many different opportunities. Essentially enterprises aren't able to realize them. And possibly, this can be the source of the insignificance of Weighted Average Cost of Capital, as the industry isn't already ready to be connected with financial markets, with global fluctuations, with feelings and behaviours of people, with potential future insights about technological and informatics improvement, as they don't use these resources. It is a regional, concentrated activity that focuses much more in the area in which is settled rather than to expand its horizons, the enterprises are not organised in clusters but are normally represented by small entities quite dispersed on the territory. Probably in the future, if the sector decides to evolve, differ from historic practices and come out from the out-dated, standard processes and mechanisms, this variable can come out to be much more impactful and important. Even if this specific industry seems to be less connected to sustainability than all the others, which have been considered since this moment, it has shown in the latest years some efforts in trying to renew and evolve itself in this sense. The fact is that enterprises should be able to understand that competitiveness, sustainability and profitability are not in contrast, but they can work jointly together. If companies working in the sector find out a way to take part to the sustainability run, they can benefit from thousandth billions European euros provided and hypothesized by the Green Deal. First of all enterprises should be able to understand that materials and scraps should be reused and recycled. The 30% of wastes produced through demolition activities are brought to landfills even if concrete and asphalt companies are fully ready, technologically talking, to reuse them in their operations, but they don't have the bravery to do anything as regulation to understand what can be reused and what cannot are complicated and unclear and they don't want to bear huge costs and fines. Another methodology through which

building companies can take part to the development is redeveloping existing buildings in order to reduce CO_2 emissions and making them more energy efficient. There have been many major companies that started to take part to the project guaranteeing to citizens the possibility of projecting, realizing and developing new energy systems in existing structures making them more sustainable, and they have resulted in being pretty much profitable, as revenues have grown of 32% in this specific market from 2018 to 2019, increasing even the client base of 10,5%. Furthermore, these activities can lead to big jumps and improvement in technologies, digitalization and computerization in the sector, which is not that much investing in these performances. Even the reutilization of dismissed areas for construction can be a good solution for the environment, trying to zero soil consumption and fill those empty places created by the abandonment of military, industrial or commercial buildings. For instance, when these areas are not protected with historical-architectural norms, they can be demolished, the area can be reclaimed and replaced with natural parks, forests, lawns re-giving space to nature and having a positive impact on the environment. Italcementi, just to provide a practical example, tries to recover extracting areas, used to take and create cement, through soaking activities, re-creating biodiversity and ecosystems, developing recreational areas or gardens. But again, even for what concerns construction, one of the main reasons why they should foster a shift to a more sustainable development, is because clients are asking for it, to be competitive and to attract international investors it's necessary to be sustainable. Any big financial investor is disposed to attach his image to polluting projects, and countries are adopting any time more restrictive policies. A good solution can be the one found by Edil-Art Decò, a building company, that in order to respect the ecosystem in which it is constructing and to care about social impact of its activities, tries to be not invasive at all and to not waste natural resources. It uses natural materials as wood, cork, stones and lime and they try to separate wastes in the most appropriate way, so that to reuse the materials when its possible.

So, in order to conclude even this subparagraph, it can be understood that even if construction industry has mainly concentrated on other factors than sustainability during time to improve its performances and results, in reality environmental practices can represent a huge and convenient opportunity for the sector to take it into account. The market is deeply asking for it, and there's an infinite set of combination through which sustainability can be implemented in construction, as the examples are showing, and this provides a lot of opportunities to be exploited. There's a big empty space in the market for sustainable construction, and it hasn't been occupied yet, so those first companies that will be able to learn how to consider green economy in their business plans,

will take huge, great profits and benefits from the activities. It is just an opportunity to be captured.

3.3 Tests and evaluations

In order to ensure that every result obtained through the linear regressions is robust, solid, realistic and truthful, some tests have been made. Essentially, every passage evaluated in the previous chapter, every analysis, has been tested with some statistical tools that try to capture the appropriateness and the effectiveness of the coefficients considered. The main instruments that have been taken into account, have been already mentioned in the first chapter and are the Adjusted R^2, the F-test and graphical representation to check statistical assumptions for errors.
Just to recap briefly the meaning and the importance of these indexes, in the interest of evaluating all the different outcomes for the four industries, before of the analysis on the effective solutions there will be a short, small description of the indexes that have been effectively used, to better understand how they are working. The first mentioned, the Adj-R^2, should be able to provide us information about the accuracy of the model, adjusting evaluations according to the number of regressors used. Differently from R^2, it considers the fact that the more variables are inserted within the model, the more information will captured, and so, for sure, the regression will be able to account for more accuracy and changes. But having too many regressors will at the very same time create confusion and difficulties in the interpretation of the results, so this particular index, tries to evaluate the goodness of the model at the net effect of the number of predicting factors used. Normally, the bigger it is, the better should be the model, as with a high index the parameters that have been used are increasingly able to explain the trend, the evolutions of the dependent element, the factors are satisfying and proper to capture all the variations in the Y variable. Clearly, it cannot be too high, otherwise the results wouldn't be realistic and plausible; in fact, it cannot be real an Adj-R^2 equal to 1, as in that case it will mean that the equation is able to make forecasts to explain future trends in factors with a precision of 100%, but the data that we are analysing are stochastic, random information, with no path and no specific network of relationships, they should not be perfectly predictable, or it will mean that they are not representing a real, practical and existent phenomenon. An accuracy of 80%/90% is very good, and can be reasonable, but a higher would for sure not be adaptable to an actual, possible situation, as it's impossible to know *perfectly* how things are supposed to evolve in the future. For the industries considered, and so Apparel, Food and Beverage, Agriculture and Construction, the

Adj-R^2s are respectively the following: *87,08%* for the Apparel industry, *90,84%* for Food and Beverage, *87,43%* for Agriculture and *82,25%* for Construction. They are quite high, suggesting that the model should be sufficiently substantial and stable, and even if sometimes they seem to be too high, recommending that probably there's a little bit of multicollinearity between the variables, the indexes are not suspiciously big considering the very particular evidences that have been analysed, where there are a lot of information, a large amount of variables to be considered and a very short number of temporal data recorded. So given the huge amount of problems faced due to the peculiarity of the analysis considered, the results seem to be good enough.

Considering the F-statistic, on the other hand, the factor is trying to evaluate the possibility of having coefficients different from the one estimated by the regression, and pretty much close to zero. The greater is the value for the F-statistic and the lower is the probability of having in real cases a Beta that is equal to zero, so the bigger the index, and the lower is the possibility of discovering that there's effectively no relationship between the regressors and the dependent variable Y. For the four analysis run in this thesis the results for the F-statistics are: *68,42* with an interval for the degree of freedom that goes from 3 to 27 for Apparel, *100,2* with an interval of 3 and 27 degree of freedom for Food and Beverage, *60,13* value with DF from 4 to 30 for Agriculture industry and for Construction the F-statistic is equal to *50,42* in an interval of 3 and 29 for DF. In all the cases the F-test come out to be positive as the value of the statistic is outside of the Degrees of Freedom's gap, meaning that the null hypothesis, according to which β should have been equal to zero, and no relationship can be investigated between factors and Y, can be fully rejected and the coefficients are all robust and solid. So there's a real and proved linkage between regressors and the dependent variable, given the fact that all the F-values are substantially high and out of the interval defined for the null hypothesis of beta equal to zero.

Another test that have been considered and that is pretty much important is the one related to the analysis of the errors. In fact, even the errors that emerge from a linear regression should respect some criterion so that to make sure that the model is providing us interesting and effective results.

In order to make sure that, statistically talking, the evidence coming out from the equation is truthful and realistic, the assumptions to be respected for the errors are the following: they must have a normal distribution, they should have the same but unknown variance, they should have a mean equal to zero and the errors must be independent the one on the other. According to what have been mentioned in the second chapter, the errors' solidity is checked and analysed through graphs and representation. In particular, will be analysed the Q-Q plot to check the normality, scale-location to control the homoscedasticity, residuals vs. plotted to check the independency of

errors and means equal to zero. In the following lines, will be represented the charts used to control the robustness of errors, taken into account singularly for each industry.

Figure 42: Apparel

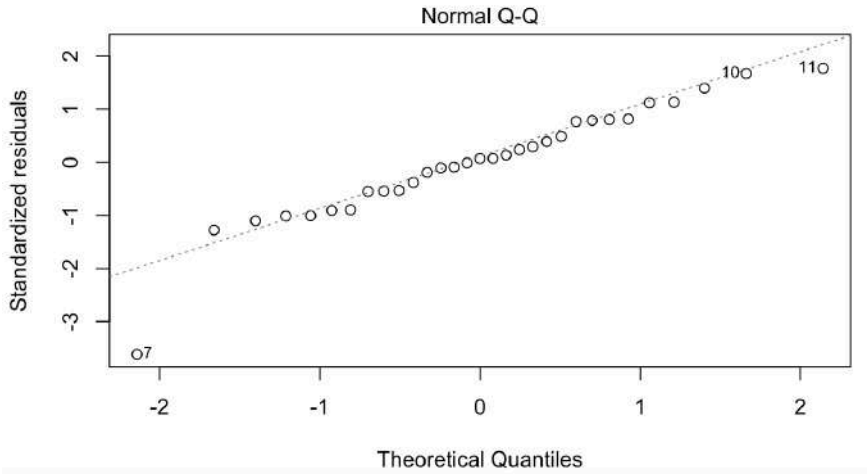


Figure 43: Food and Beverage

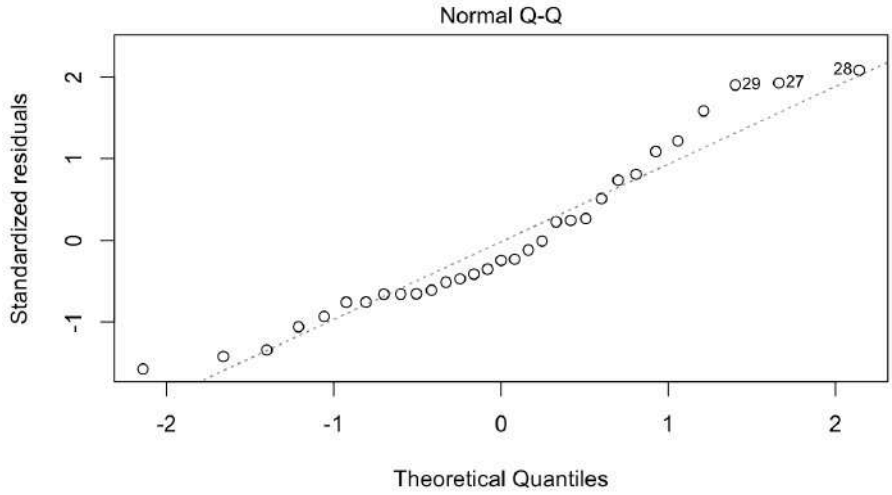


Figure 44: Agriculture

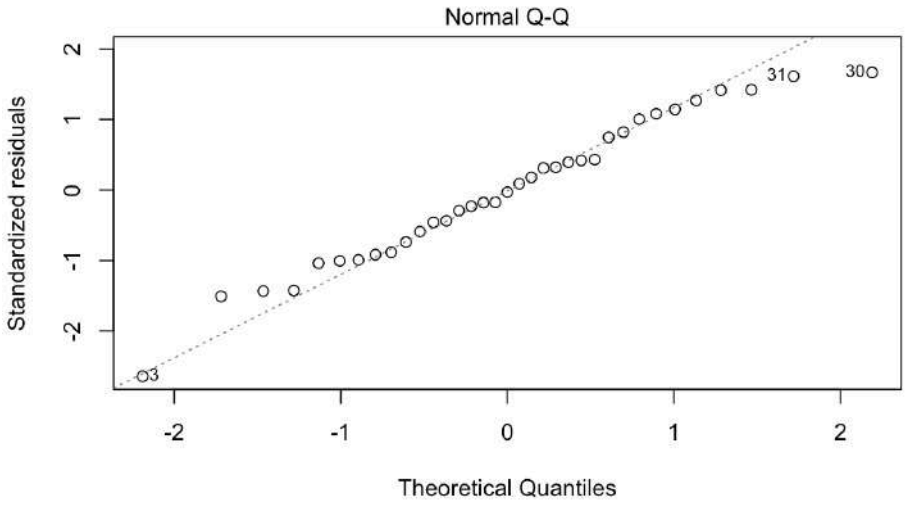
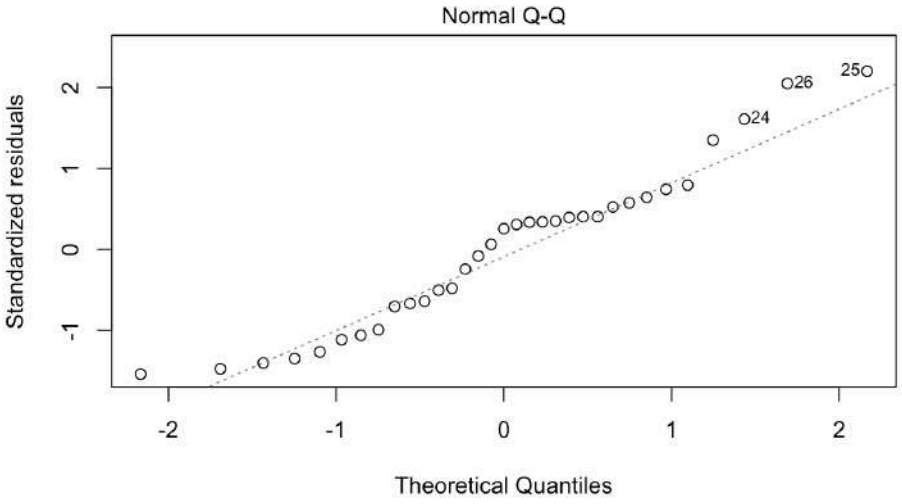


Figure 45: Construction



According to these specific representations it can bee noticed that more or less the normality assumption in the errors is respected, even if the 7th observation can be understood to be an outlier compared to the general trend of the information for Apparel industry. Food and Beverage and Construction industries are appearing to be a little bit less respectful of the assumption as the curvature is not fully respected, and the fluctuations are more frequent and evident, but in any case the movements are not so much pronounced, and in general the distribution is close to the theoretical one. Even if not perfectly, all the industries are providing evidence that their trend is close to a normal one. Given these evaluations, it can be assumed that in all the cases the first assumption can be largely and surely accepted, as the errors left out from the regression are following a normal distribution.

Figure 46: Apparel

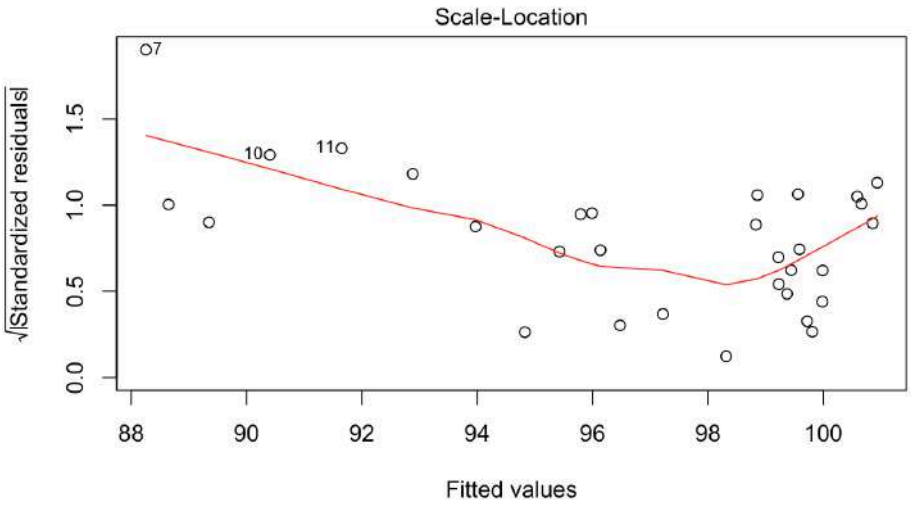


Figure 47: Food and Beverage

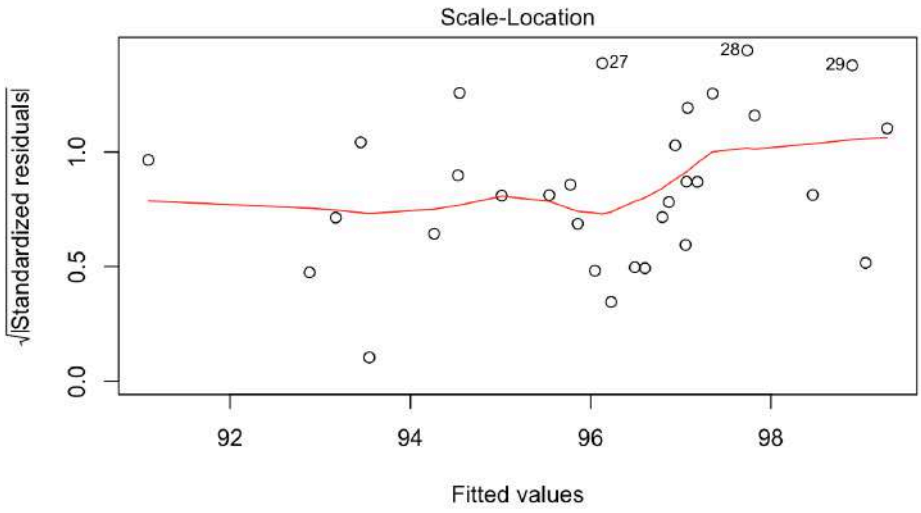


Figure 48: Agriculture

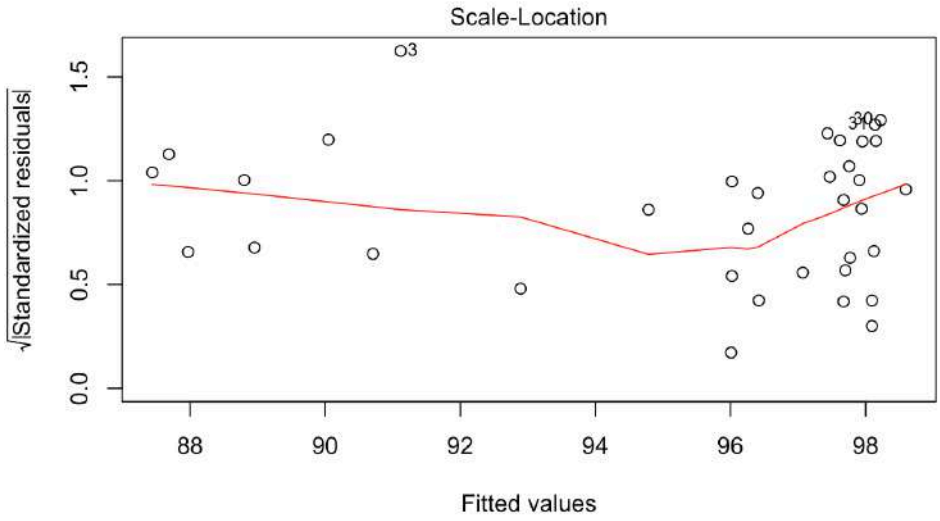
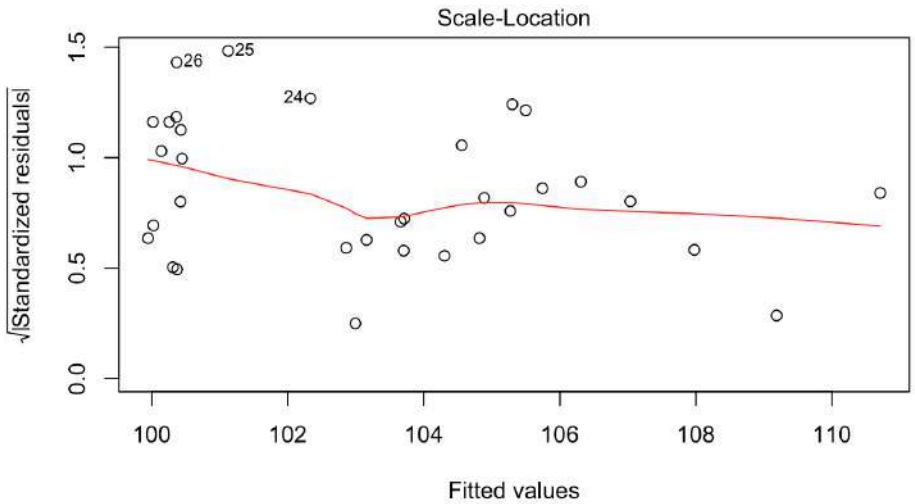


Figure 49: Construction



For what concerns the homoscedasticity assumption, even in this situation the axioms seem to be respected. In all the four situations, the observations are resulting in having the same but unknown variance, as the red line, representing the latter, is stable and more or less straight in all the cases. Some ups and downs can be noticed but they are not that deep, so are assumed to be not very relevant, even if they are not perfect as they should be, especially for the Food and Beverage industry. According this, it's clear that the outcomes obtained are not perfectly in line with the exact result that they should have represented, as the variance should be fully stable in all the cases, but again, given the peculiarity of the dataset that have been used, and the difficulties faced in the management of the information, the result are appearing to be pretty good.

Figure 50: Apparel

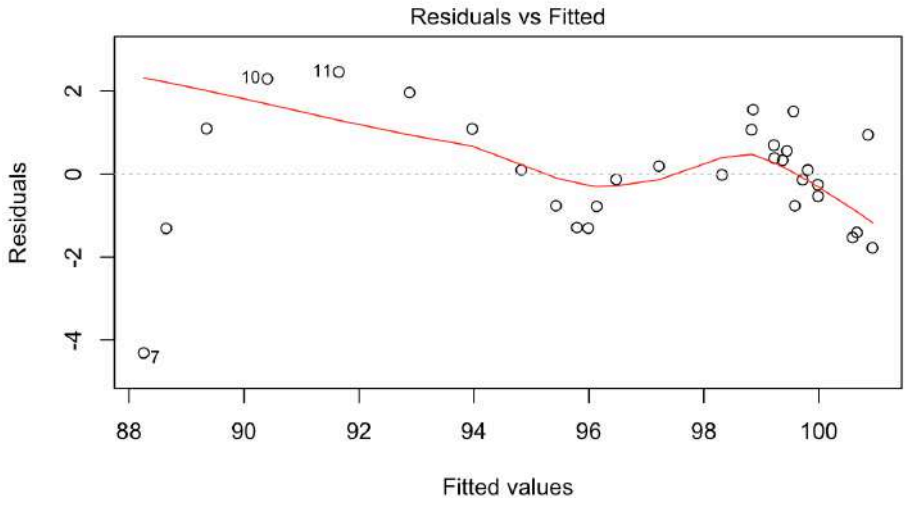


Figure 51: Food and Beverage

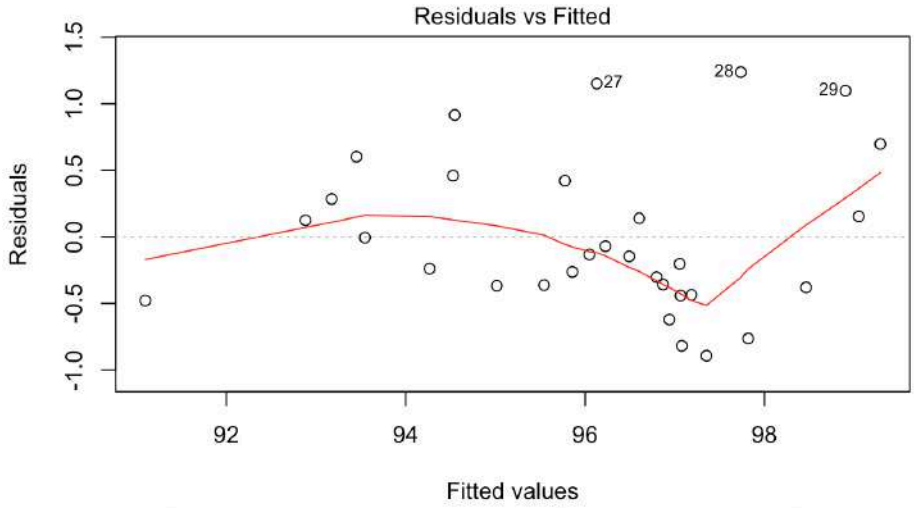


Figure 52: Agriculture

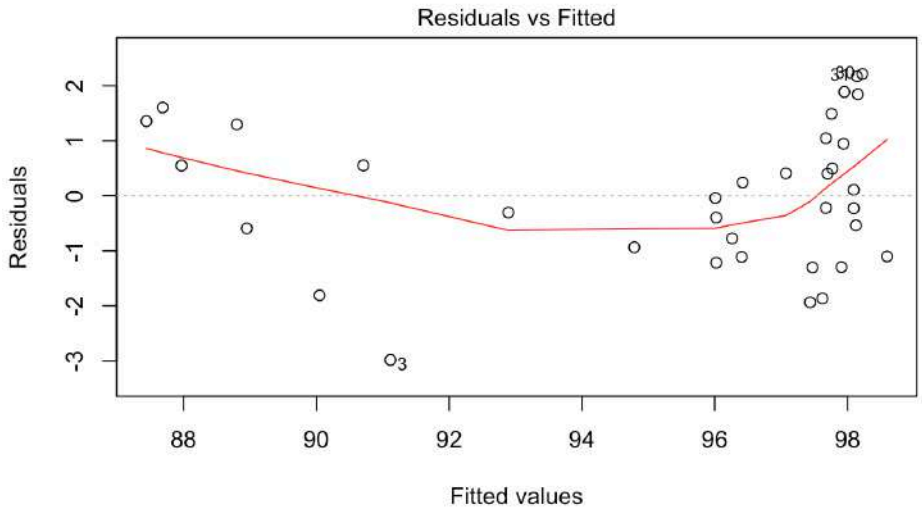
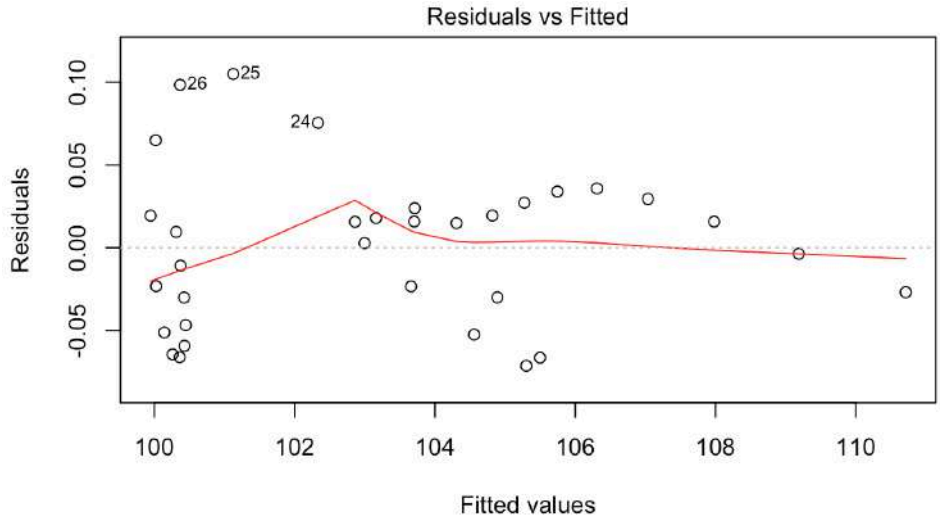


Figure 53: Construction



Finally, the last graphs should be able to demonstrate that the observations are all random and independent the one from the others and that they have, on average, a mean that is equal to zero. So all the dots, representing the singular data, should be spread in the sheet and there should be a red straight line at the level zero.

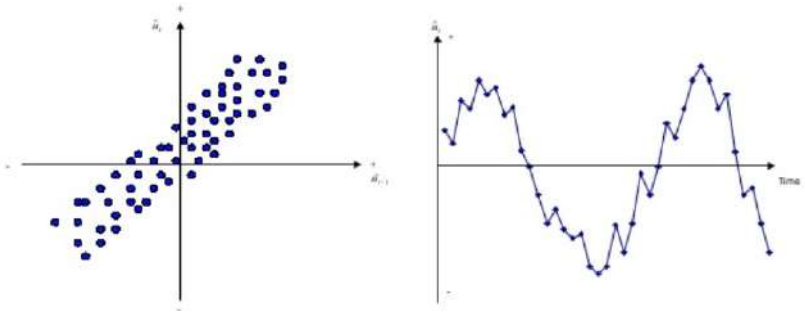
In this particular situation, it is possible to notice that there are some problems to be considered, as more or less in all the industries' analyses there are some pattern left on the errors. In fact, when the regression is not fully able to predict the trends and the fluctuations that can be perceived in the future, when the regressors are not perfectly able to capture all the nuances and specific characteristics of the dependent variable, some movements and paths are left on the errors, and this is what is slightly happening in this case. It can be seen that there are, effectively, some certain behaviours explained by the errors, which are not represented as to be fully stochastic. And this is

also the reason why the mean of the latters is not perfectly equal to zero. Therefore, considering this latest test, it can be said that this is partially violated, even if the are not that much conspicuous and important evidences that the valuations are fully wrong and biased, as the results are just a little distant from the theoretical ones, not extremely incorrect. This peculiar condition can be explained by the fact that in any case the topic is a very new and untouched argument, and so there can be some important additional factors that should be taken into account, which are not valuated in this case. There can be a particular variable able to capture the little part of behaviour in the dependent variable that is not considered here. Or maybe putting, some way, together all the regressors specifying the different macro-categories into one factor per each class, having just four indexes for each industry, instead of choosing those variables that seem to be the most relevant from a set of 19 factors, all the particular variations of Y could have been taken into account, as the single factors for degree of progress, for quality of human and for physical capital, for sustainability and for competitiveness, would have been capable of including and granting the definition of all the small peculiar variables. So for what is related to this last test to check the statistical robustness of the errors, some obstacles and complications have been found, even if the results can be assumed to be good in any case, as the outcome are not so bad, definitely.

The last evaluation that has been considered, is related to the evaluation of ACF (Auto Correlation Function) and PACF (Partial Auto Correlation Function). These tests are performed to check if the results obtained from the linear regression respect White Noise assumptions. It is essentially the frequency that is able to capture the degree of connection between the variables according to the different observations, the level of repetition that has to be maintained to ensure that there's no correlation between the variables, that they are independent and fully autonomous. Even for this analysis, the main aim is to guarantee, that the sample's data are uncorrelated, random, stochastic, with no mean and a limited variance that should be equal and stable for all the variables. These two mentioned functions can be able even to figure out if there's cyclicity, seasonality in the residuals, but the interest, in this case, is mainly put on the capability of the formula to check if there is a type of correlation, connection, between the residuals of the regression. The ACF is able to discover auto-correlation of any series with its lagged value, it defines how well present values are connected with past values, how variables are connected with each other, considering each value with all the others inserted in the formula. PACF, instead, finds correlation between the residuals that remain to consider after the previous ACF analysis, those which haven't been explained by the earlier lags, the partial effects of the regression that haven't been captured by the first test. Essentially, when looking at the graphs, the blue horizontal lines

are representing the confidence interval inside which the valuations should be to make sure that there's no correlation between regressors and temporal data. The y-axis is accounting for the level of correlation, and in the x-axis are represented the residuals, while the vertical lines are identifying the degree of correlation of the residuals with all the others. If the values for the lags in the residuals come out to be inside of the interval fixed by the two horizontal lines, then White-Noise assumption is accepted, there's no autocorrelation in the observations, and they are independent between each other and in time, so the estimations are good and useful. Moreover, another way to check if there's correlation in the observations looking at graphs is analysing the trend of the lines in the representations. If there's a cyclical plot of residuals overtime, which means that, for example, there are some residual lines all in the upper side of the graph, and then many lines downside, and again they raise upside for many residuals, so there's a curvature, a general behaviour that can be noticed, then the errors are positively correlated.

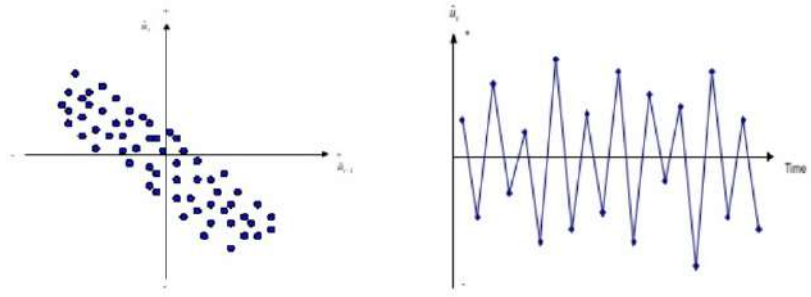
Figure 54 : Positive autocorrelation



Source: "Introductory econometrics for finance" Chris Brooks 2013

If on the other hand, there is an alternating pattern where there's a line up, another down, then up, then down again, with continuous up and down with respect to the x-axis, crossing it more frequently, there's negative correlation in the residuals.

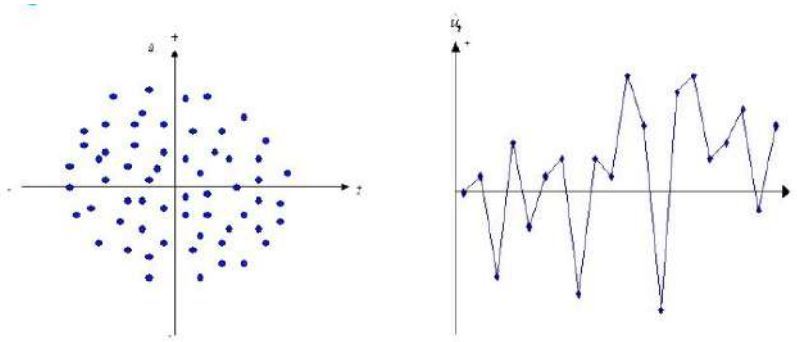
Figure 55: Negative autocorrelation



Source: "Introductory econometrics for finance" Chris Brooks 2013

No correlation is perceived, when there's a kind of mixed behaviour between the first and the second case, when there is no pattern at all in the residuals.

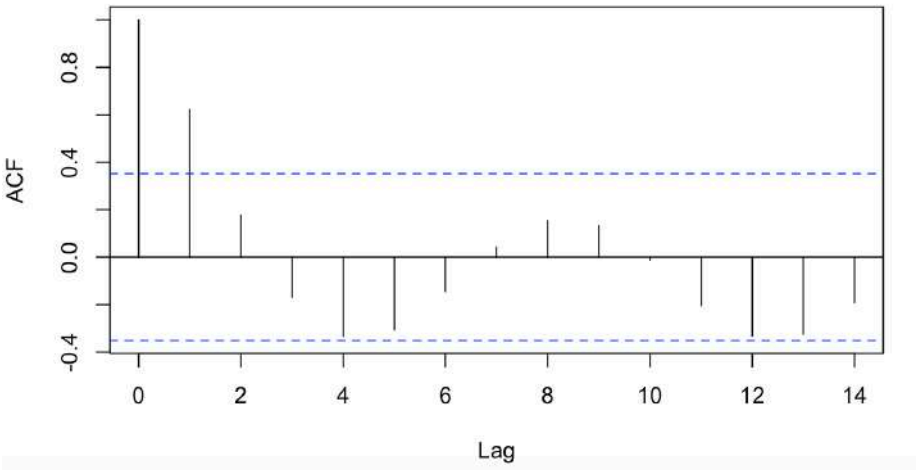
Figure 56: No autocorrelation



Source: "Introductory econometrics for finance" Chris Brooks 2013

In below images, are defined the result obtained from the analysis of Autocorrelation Function and Partial Autocorrelation Function for all industries.

Figure 56: Apparel



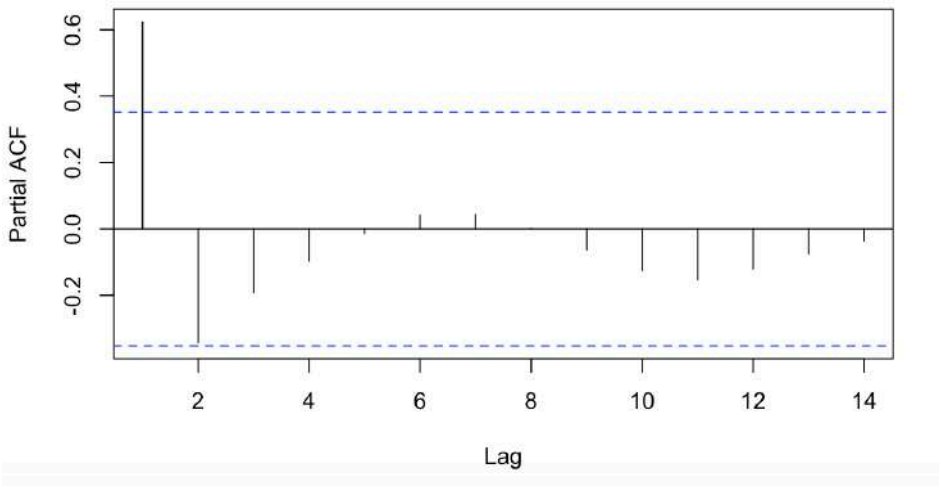
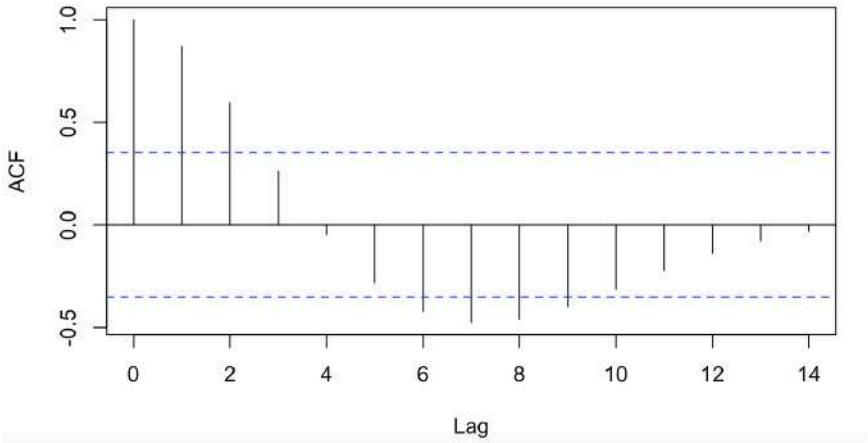


Figure 57: Food and Beverage



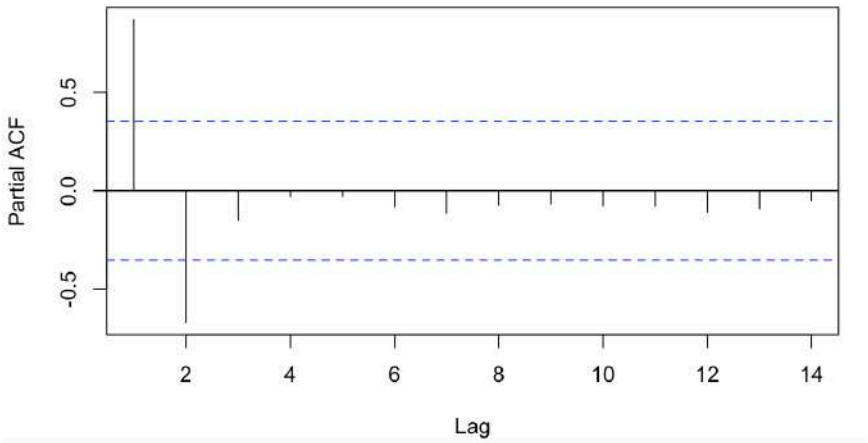


Figure 58: Agriculture

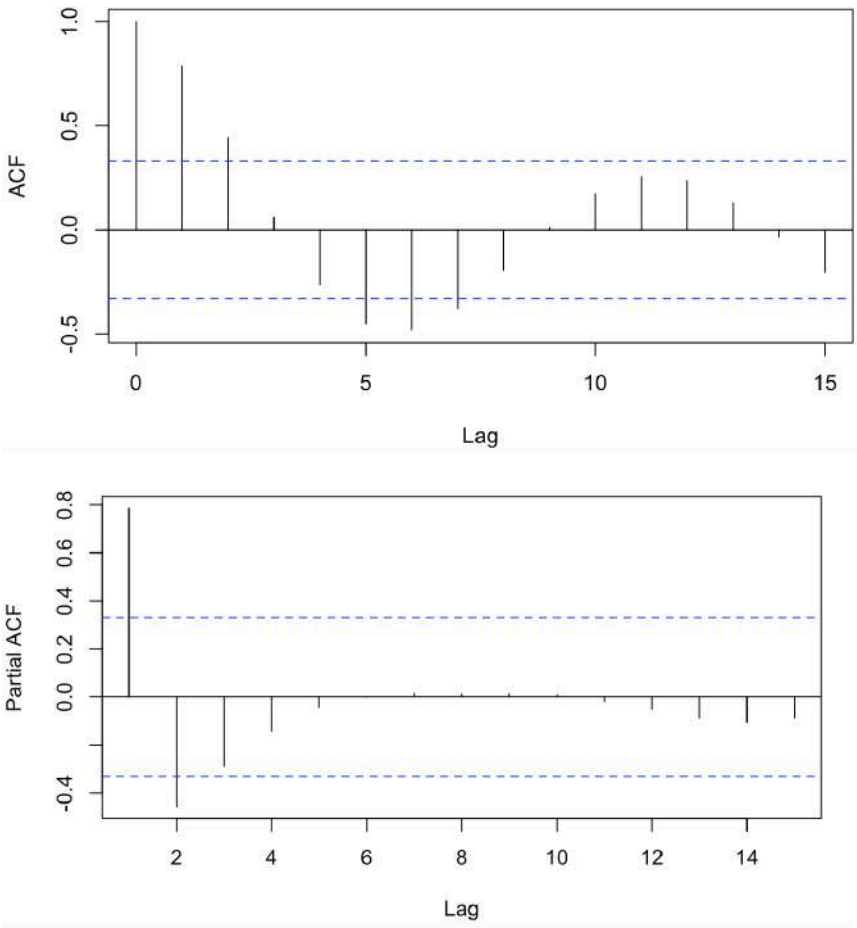
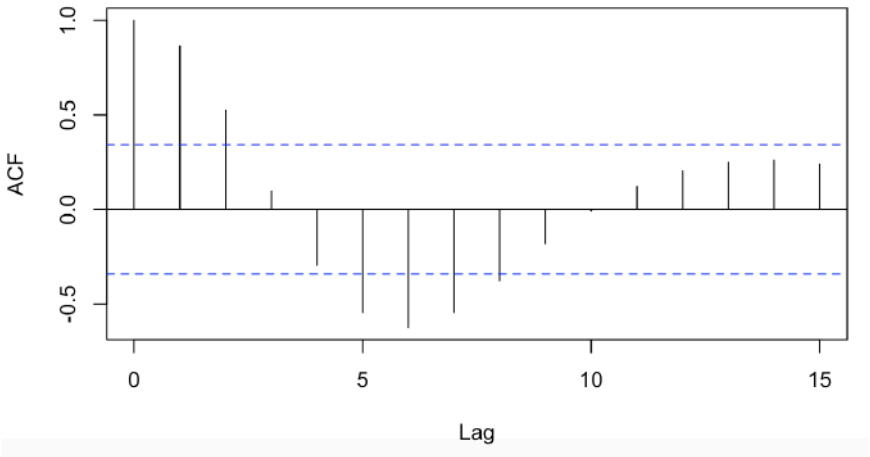
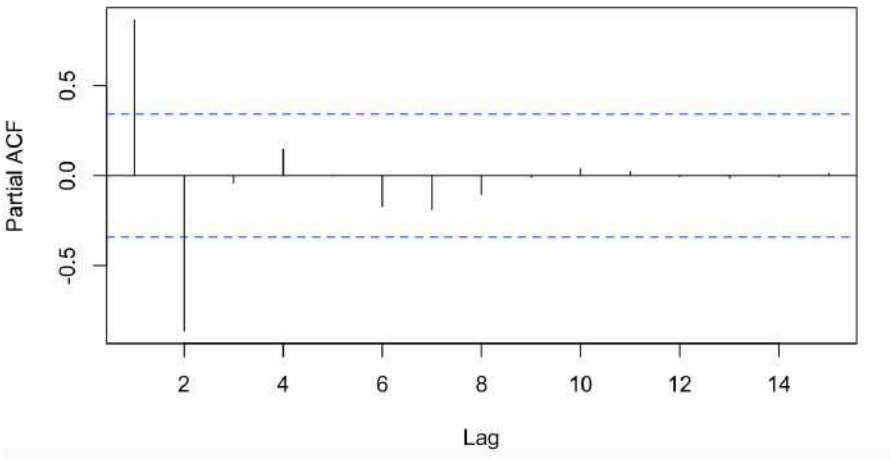


Figure 59: Construction





In all the different analysis performed for Apparel, Food and Beverage, Agriculture and Construction industries, the results show a quite good level of robustness and solidity in the valuations. Even if, for some lags, the estimates for the errors are outside the interval shown to be appropriate to assume no correlation between the observations, the values are not extremely disparate and wrong, the fluctuations are reasonable and realistic. Furthermore, if the pattern of the vertical lines is considered, it can be seen that there's no trend in the representation of correlation between residuals, there's no cyclical pattern at all, and neither there's a continuous and frequent up and down through di x-axis, so there's no positive nor negative correlation, they are not auto-correlated.

Given this, the White-Noise hypothesis is assumed to be respected fully, as the graphs are similar to the one that should have been guaranteed in a theoretical, ideal situation, the errors are not auto-correlated in time, they are almost completely independent and autonomous, and the betas are valuable.

So, in order to conclude all the examinations that have been taken into account, it can be said that given the evaluations considered, and the different analyses that have been run, the estimates, the values for the coefficient are judged to be plausible, pretty much accurate and explanatory. The statistical tests are showing that, from a mathematical point of view, even if some imperfections are left in the model, and the accuracy is not that perfect, the coefficients can be judged to be solid, and have a real, effective meaning in practical situations. It has been already mentioned different times, that the evaluations have been re-handled and managed because of the difficulties related to the amount of observations, which were too short, because of the actuality of the topic, of the lack of uniform, collective variables to be considered for the regression and because of the obstacles found on the choice of appropriate factors to explain the phenomenon. Actually, given the fact that the analyses have been so peculiar, it is a matter of fact and perfectly reasonable that

there can be some discrepancies, some possible limits and mistakes in the analysis, as the evaluations are not so precise as they should be. But for sure, considering all these obstacles, the investigation, the study has been performed in the best way it was possible, and according to this, the tests for the errors are not that bad at all.

4. Conclusion

In nowadays world is essential to take into account the needs and the rhythms of ecosystems, the problem can't be postponed anymore. Environmental sustainability is no more a topic handled and considered only by tree huggers, environmentalists or non-profit organization, it should be considered by every entrepreneur, every enterprise that wants to develop, innovate itself and look at the future opportunities that can be exploited from the market of tomorrow. The world is changing, it's a matter of fact, it's a real condition, it cannot be hidden. It's been years since experts, scientists, climatologists are saying that the consequences will be extremely dramatic if no action is taken, if no shift, no change is promoted in the way in which we operate. Seasons will change, in all regions, especially those near the poles and at lower latitudes, extreme weather events as typhoons, storms, floods and hurricanes will be more frequent and those particularly dangerous and severe catastrophes that we are used to feel once every 50 years are going to happen every 10 years. Many animal species will be extinguished by our irresponsible and foolish behaviours; forests will be reduced dramatically, depleted by human activities in search of ground and resources to sustain their jobs, and this will endanger even more the already terrifying situation, as the world will loose its lungs. The arctic will melt, jointly with permafrost, causing problems to marine currents, in temperatures and weather, and releasing huge quantities of methane, which is toxic for the atmosphere. Many economists, in recent years, have estimated the consequences, from an economical perspective, of these conditions and they are highly negative, more than it can be imagined. Huge losses will be perceived both by enterprises, and countries in general, due to damages in the infrastructure, in water availability, in health disease, due to shifts in temperatures, in seasonal ciclycities. This is the reason why the population, the authorities, the governments and the markets should deeply review the way in which they are organized and in which they work to effectively have a future in tomorrow world; if not because it is ethically correct and right from a behavioural and sensible point of view, because it's convenient, because it's mandatory if they don't want to fail and loose their advantageous position in the economy. It is a transformation that is starting from the bottom, as consumers, clients are already asking for

environmentally friendly products, they are disposed to pay more for something that is sustainable, they are looking for those goods that are in line with a sustainable process. Financial investors are searching for those opportunities that have shown a deep involvement and effort in trying to re-manage and mute their activities and product in order to respect the environment; so if companies want to perceive funds and money to run their businesses they have to worry about their impact on nature. And the fact is that if they effectively are able to change their actions and behaviours in order to become greener, they will have the possibility of exploiting an enormous, huge, unexplored market that haven't already been touched. It would be like they are in practice creating a new slice, a new area in the economy, redeveloping their organizations, with all the consequent advantages related to it that are unimaginable. In order to make all these analyses more concrete and effective, have been performed a statistical evaluation so that to demonstrate that productivity in industries can increase thanks to sustainable activities. The main objective, the final goal of the abstract has been the one to denote that spending resources, time, energy and capital in performing sustainable processes and investments can result in a greater level of efficiency within organization, so that to make sure that it will be convenient even in the relative short term and from an economical perspective to become more environmentally friendly. Through the development of a linear regression it has been proved that sustainability can impact with very high percentages in the development of enterprises and sectors in general. In fact, analysing the four major industries in Italy, represented by Agriculture, Food and Beverage, Construction and Apparel, it has emerged that sustainability, on the majority of the cases, has a relevance more or less equal to 10%, which is a very important and pretty high coefficient. This means that if companies decide to invest in sustainable practices as, for example, adding value in the environment through biological practices in agriculture, or managing the resources more efficiently recycling wasted materials and reusing products instead of throwing them away, or using renewable sources of energy, or reducing the Greenhouse Gases Emissions revisiting and managing properly the machineries and plants for the activities, then the production becomes more efficient, and more valuable. If enterprises spend their energies and time in trying to find solutions that respect the ecosystem, that replenish the resources that they use, if they reorganize their activities so to ensure that what they take from the environment than it's re-given back, guaranteeing a closure in the circle and equilibrium in natural processes, then they will be able to do more with less. Being more productive means that there's the possibility of having greater results with the very some amount of efforts, it is possible to produce more value, with less necessity of capital, time and energies, as the given inputs are used more efficiently, are better and

more appropriately considered. Moreover, a greater value can be extracted from the market in which the goods and services are sold, as normally customers are disposed to invest more money for bigger level of quality in products, and being sustainable is surely a characteristic that improves qualitative perceptions of everything exchanged on the market.

Even if the calculations and the mathematical analyses have been subjected to strong limitations and many obstacles have been faced in developing the process of evaluations, the results obtained are in any case clear and solid, and can effectively provide an incontrovertible evidence that is surely convenient for companies to invest in green economy. Given the fact that is just a matter of time that the whole system converts into something more sustainable, and given that it has to be done pretty fastly considering the speed with which the environment is changing according to negative behaviours and choices of the past, even greater than what thought and estimated by scientists, those enterprises that will be able to move towards this direction will for sure perceive advantages in terms of greater values and returns. And the more they are able to anticipate the others in the shift, the more they will be advantaged by the situation as they will have already developed a better and more efficient learning curve, they will have already redefined and developed their activities and processes so that to exploit these conditions, and reap all the positive advantages from the new economy; while all the others, which have waited until the last moment to follow the environmental needs, will necessitate to completely transform and revisit their businesses from zero, loosing the initial, huge, quantum leap in the benefits and economic value.

The shift is required and asked by the ecosystems, by the markets, through investors and customers, and by the natural evolution and development of processes, reminding that is natural at some point to renew ourselves and find new ways to achieve our objectives. Even thinking about the infective pandemic that has brought to its knees the whole planet, the ecosystem has its role, and its important. Climate change can increase the frequency and the severity of diseases, viruses and spread of bacterium. This is not to say that shifts in global temperatures are the cause of Covid-19, but it's to specify that there's a strong linkage, connection between the environmental component and the human one: whatever happens on a factor, sooner or later will affect even the other; all the movements, crisis, fluctuations, shifts that are affecting the ecosystem will be perceived even by the population and vice versa. Institutions and scientists have said that with a high probability the virus has been transmitted through zoonosis, because of Asian wet markets conditions, as there's a very low level of cleanliness and hygiene in those places, without mentioning the condition in which animals have to suffer. But isn't this one an incorrect and

unbalanced exploitation and treatment of natural resources? Isn't it connected to an irresponsible management of natural resources? Moreover, as it has been said in the thesis, if production basis are not supposed to change and the CO_2 emissions are not cut dramatically in a short time-lapse, the consequences will be hugely devastating, leading to shifts in temperatures, in fact Mediterranean area is supposed to become hyper arid, leading to changes in seasons, bringing extreme weather events much more frequently, jointly with floods and droughts. The problem is that extreme weather conditions have already proved to be coincident with health diseases. In India, studies have shown that cholera has been brought by floods that have plagued cities, contaminating potable water sources with animals scraps and bacterium; recent researches[78] have demonstrated that the Great Plague diffusion was caused by fluctuations in climate conditions that have brought to periodic deaths and reintroduction of rodents populations, as gerbils, traditional vectors of the disease, in the Asian territory, making it necessary for the infection to search other potential hosts where to live, as camels, which at that time have been used to move across the Mediterranean, causing the spread of the destructing disease in all Europe. This is just to say, that if global temperatures are supposed to rise, and in the same way even extreme weather catastrophes, pandemics are assumed to be more recurrent and severe, too. Furthermore, talking about Coronavirus, American researches have demonstrated that where the atmospheric pollution is greater, the virus comes out to be more lethal; in fact, an increase of 1 mg in ppm can lead to an increase in mortality of the virus of 15%. This effect won't be direct and immediate, but will surely exist. If companies take advantage of the current situation, given that is mandatory, and learn how to work in a more sustainable way, through smart working from home, separating and reorganizing line work, they will take positive effects and benefits from the negative condition and they will come out richer from it, having understood that productivity can be maintained even with less energy, less efforts and less pollution. And even employees' exposure to risks of contamination will be lower, just to mention the health benefits that can be obtained. It's complex, difficult and considering the dramatic situation of the country, can seem to be even unrealistic. But imagine if it can turn out to be an opportunity for the future, and Italy can truly understand its worthiness, its capabilities, and demonstrate to the whole world, that is not a traditional, old-styled, unproductive nation.

It is mandatory to find our place inside the equilibrium of nature, has to be found the way to be part of the circle, to be balanced with everything that surround us. We should learn from nature the capability of solving any problem, any contrast with solutions that do not have a negative

[78] "Proceedings of the National Academy of Sciences" of Universities of Oslo and Bern.

impact on all the other factors; every single element in the environment has its specific place, its duties, its mansions and it's perfectly in equilibrium with all the others not damaging them, not depleting the resources, not consuming heavily assets and riches of the ecosystems. Through biomimetism companies, people, countries and institutions should copy nature, follow its teachings, its ideologies, its movements. We should be able to transfer biological processes from natural world to artificial world, as in this way humans can find solutions to the most disparate and articulated problems, *"There's nothing we can invent that nature hasn't already invented"* said Albert Einstein. Since the ages of Leonardo Da Vinci nature has always been inspirational and stimulating for innovation, as the great inventor has derived his ideas on airplanes from birds flying capacities. There's a strong, deep, complex socioeconomic interconnection between nature and anthropic variables, there's an ecological continuum, according to which a cascade effect will affect every single element in the interconnection, it doesn't matter how far they are, or how different they seem to be.

As soon as we will realise how much nature, the ecosystems, the environment, plants, animals and all the other resources that the planet is able to provide us are important, fundamental, essential for our survival, we will also be able to discover how much valuable nature is, and we have to do it now, we have to recognize how much it worth. We don't have to wait until it will be too late, until everything will be destroyed, we have to protect our home. It inspires poets and writers, it provides to businesses the resources to sustain themselves, it keeps us alive, it hosts many species and protect them. It is art, beauty, science, fear, catastrophe and soul.

Earth have helped all the creatures on its surface since the dawn of times, providing them all they need to survive, whenever it was necessary, it is our duty right now, to return the favour.

Tables:

Table 1.1: Apparel dataset

APPAREL								
Year	TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	EnvironmentProtectionExpenses	ValueAddedEnvironment	AdjustedWasteGeneration	RDemployees
2008	84,9293	22,3414	19,3877	16,5407	17,8909	24,2267	23,3803	
2008,25	82,3274	22,2057	19,4144	16,5630	18,0451	24,1872	23,3588	
2008,5	80,1883	22,0759	19,4389	16,5839	18,1799	24,1548	23,3372	
2008,75	78,9744	21,9582	19,4587	16,6021	18,1763	24,1363	23,3155	
2009	79,1484	21,8584	19,4715	16,6164	18,3150	24,1388	23,2936	
2009,25	80,9772	21,7811	19,4767	16,6256	18,2865	24,1663	23,2714	
2009,5	83,9441	21,7247	19,4802	16,6290	18,2206	24,2107	23,2486	
2009,75	87,3369	21,6858	19,4896	16,6261	18,1569	24,2608	23,2245	
2010	90,4431	21,6614	19,5126	16,6164	18,1350	24,3054	23,1986	
2010,25	92,6958	21,6471	19,5537	16,6012	18,1807	24,3359	23,1705	
2010,5	94,1091	21,6340	19,6057	16,5883	18,2638	24,3537	23,1392	
2010,75	94,8429	21,6118	19,6584	16,5875	18,3403	24,3628	23,1040	
2011	95,0568	21,5704	19,7016	16,6085	18,3663	24,3669	23,0641	13,2700
2011,25	94,9225	21,5054	19,7277	16,6568	18,3100	24,3690	23,0197	13,4320
2011,5	94,6606	21,4347	19,7401	16,7211	18,1891	24,3676	22,9752	13,5752
2011,75	94,5035	21,3819	19,7448	16,7862	18,0338	24,3604	22,9363	13,6808
2012	94,6838	21,3707	19,7478	16,8367	17,8740	24,3449	22,9086	13,7300
2012,25	95,3538	21,4152	19,7544	16,8640	17,7354	24,3201	22,8956	13,7228
2012,5	96,3447	21,4925	19,7670	16,8870	17,6263	24,2910	22,8938	13,7344
2012,75	97,4074	21,5702	19,7873	16,9312	17,5504	24,2639	22,8977	13,8588
2013	98,2929	21,6159	19,8169	17,0223	17,5117	24,2453	22,9018	14,1900
2013,25	98,8172	21,6079	19,8556	17,1746	17,5103	24,2396	22,9019	14,7644
2013,5	99,0570	21,5665	19,8949	17,3571	17,5323	24,2437	22,8992	15,3883
2013,75	99,1543	21,5229	19,9244	17,5277	17,5601	24,2524	22,8960	15,8106
2014	99,2508	21,5079	19,9336	17,6442	17,5760	24,2606	22,8950	15,7800
2014,25	99,4499	21,5430	19,9164	17,6745	17,5694	24,2646	22,8979	15,1459
2014,5	99,7007	21,6109	19,8837	17,6273	17,5576	24,2661	22,9038	14,1598
2014,75	99,9139	21,6846	19,8504	17,5217	17,5647	24,2682	22,9114	13,1738
2015	100,0000	21,7372	19,8317	17,3766	17,6149	24,2738	22,9192	12,5400
2015,25	99,9059	21,7488	19,8379	17,2143	17,7209	24,2851	22,9261	12,5084
2015,5	99,7236	21,7282	19,8607	17,0721	17,8500	24,2997	22,9320	12,9212
2015,75	99,5813	21,6908	19,8873	16,9905	17,9578	24,3145	22,9375	13,5184
2016	99,6073	21,6525	19,9046	17,0101	17,9999	24,3263	22,9429	14,0400
2016,25	99,8960	21,6257	19,9027	17,1589	17,9440	24,3325	22,9484	14,2835
2016,5	100,4072	21,6100	19,8842	17,4142	17,8056	24,3339	22,9541	14,2754
2016,75	101,0665	21,6016	19,8546	17,7404	17,6123	24,3322	22,9600	14,0996
2017	101,8000	21,5970	19,8194	18,1020	17,3915	24,3289	22,9660	13,8400

RDexpenses	InnovativeActivities	LabourProductivity	QualifiedEmployees	AverageSalary	CompetenceLevel	CapitalProductivity	Industry4.0	TechAreas	WACC	CostCompetitivity	ChangesInventory
		80,4400		12,7000	7,1000	98,0000			7,8400		-18,0512
		78,9134		13,0873	7,2194	92,2907			8,1821		-21,6251
		77,7944		13,4397	7,3310	87,2151			8,4983		-23,9859
		77,4907		13,7222	7,4271	83,4070			8,7629		-23,9202
		78,4100		13,9000	7,5000	81,5000	29,8000	28,6000	8,9500		-20,2148
		80,7767		13,9543	7,5481	81,8864	30,6762	29,6157	9,0422		-12,2225
		84,0830		13,9310	7,5946	83,9922	31,6819	30,7651	9,0562		-1,5593
		87,6378		13,8922	7,6688	87,0019	32,9467	32,1819	9,0171		9,5927
		90,7500	41,70000	13,9000	7,8000	90,1000	34,6000	34,0000	8,9500		19,0516
		92,8864	41,97749	13,9986	8,0023	92,6012	36,6419	36,2193	8,8779		25,0027
		94,1447	42,38398	14,1612	8,2282	94,3410	38,5543	38,3048	8,8155		27,1008
		94,7807	43,04848	14,3432	8,4151	95,2853	39,6896	39,5879	8,7753		25,3680
19,5352	3,3700	95,0590	44,10000	14,5000	8,5000	95,4000	39,4000	39,4000	8,7700	109,0000	19,8264
19,5357	3,3266	95,1847	45,59635	14,5982	8,4490	94,7324	37,3217	37,3636	8,8047	109,7261	10,8172
19,5364	3,2836	95,3230	47,31056	14,6492	8,3425	93,6563	34,2258	34,2658	8,8544	110,4468	-0,0428
19,5374	3,2413	95,5799	48,94450	14,6756	8,2897	92,6271	31,1670	31,1851	8,8870	111,1566	-10,8181
19,5390	3,2000	96,0700	50,20000	14,7000	8,4000	92,1000	29,2000	29,2000	8,8700	111,8500	-19,5728
19,5410	3,1599	96,8626	50,80744	14,7445	8,7222	92,3973	29,0618	29,0640	8,7827	112,5271	-24,7169
19,5428	3,1198	97,8445	50,61127	14,8294	9,0644	93,3087	30,2175	30,2320	8,6505	113,2097	-26,0430
19,5437	3,0786	98,8566	49,48446	14,9746	9,1744	94,4908	31,8145	31,8340	8,5106	113,9249	-23,6893
19,5427	3,0350	99,7400	47,30000	15,2000	8,8000	95,6000	33,0000	33,0000	8,4000	114,7000	-17,7941
19,5398	2,9885	100,3554	44,12077	15,5098	7,8810	96,3752	33,1546	33,1037	8,3453	115,5444	-8,8092
19,5374	2,9427	100,6416	40,76937	15,8458	7,1249	96,8838	32,5916	32,4936	8,3310	116,3958	1,5591
19,5385	2,9017	100,5570	38,25827	16,1338	7,4314	97,2755	31,8579	31,7617	8,3312	117,1744	11,2910
19,5465	2,8700	100,0600	37,60000	16,3000	9,7000	97,7000	31,5000	31,5000	8,3200	117,8000	18,3666
19,5633	2,8504	99,2166	39,39228	16,2896	14,5789	98,2645	31,8918	32,0928	8,2785	118,2181	21,3554
19,5866	2,8401	98,5229	42,57377	16,1251	21,7109	98,9062	32,7160	33,0935	8,2156	118,4758	21,1840
19,6133	2,8347	98,5828	45,66838	15,8480	30,4875	99,5198	33,4821	33,8474	8,1475	118,6456	19,3685
19,6400	2,8300	100,0000	47,20000	15,5000	40,3000	100,0000	33,7000	33,7000	8,0900	118,8000	17,4249
19,6641	2,8226	102,8758	46,13825	15,1300	50,4331	100,2715	33,0578	32,2545	8,0532	118,9957	16,5424
19,6858	2,8127	105,3017	43,23556	14,8163	59,7438	100,3790	31,9570	30,1450	8,0228	119,2259	16,6035
19,7060	2,8015	104,8668	39,69010	14,6445	66,9827	100,3970	30,9778	28,2629	7,9785	119,4682	17,1638
19,7255	2,7900	99,1600	36,70000	14,7000	70,9000	100,4000	30,7000	27,5000	7,9000	119,7000	17,7792
19,7450	2,7792	86,4924	35,19067	15,0412	70,6448	100,4478	31,5537	28,5155	7,7727	119,9039	18,0955
19,7647	2,7691	68,0628	34,99648	15,6171	66,9612	100,5403	33,3685	31,0392	7,6045	120,0830	18,1198
19,7845	2,7594	45,7917	35,67905	16,3494	60,9920	100,6627	35,8241	34,5682	7,4091	120,2456	17,9494
19,8043	2,7500	21,6000	36,80000	17,1600	53,8800	100,8000	38,6000	38,6000	7,2000	120,4000	17,6818

Table 1.2: Food and Beverage dataset

FOOD AND BEVERAGE							
TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	EnvironmentProtectionExpenses	ValueAddedEnvironment	AdjustedWasteGeneration	RDemployees
86,5667	22,6513	19,8020	16,5407	18,9783	24,7987	23,3803	
85,9142	22,6227	19,8636	16,5630	19,0553	24,9528	23,3588	
85,5171	22,5953	19,9186	16,5839	19,1110	25,0877	23,3372	
85,6309	22,5707	19,9606	16,6021	19,1240	25,1841	23,3155	
86,5112	22,5500	19,9830	16,6164	19,0729	25,2228	23,2936	
88,2912	22,5338	19,9827	16,6256	18,9609	25,1942	23,2714	
90,6155	22,5182	19,9706	16,6290	18,8891	25,1283	23,2486	
93,0065	22,4988	19,9610	16,6261	18,9831	25,0646	23,2245	
94,9866	22,4710	19,9682	16,6164	19,3684	25,0428	23,1986	
96,1954	22,4321	20,0020	16,6012	20,1014	25,0884	23,1705	
96,7415	22,3881	20,0534	16,5883	20,9620	25,1715	23,1392	
96,8509	22,3468	20,1092	16,5875	21,6608	25,2481	23,1040	
96,7495	22,3163	20,1559	16,6085	21,9085	25,2740	23,0641	34,7300
96,6226	22,3021	20,1833	16,6568	21,5170	25,2177	23,0197	34,0118
96,4932	22,3006	20,1946	16,7211	20,7029	25,0969	22,9752	33,2718
96,3436	22,3058	20,1960	16,7862	19,7843	24,9416	22,9363	32,4885
96,1563	22,3117	20,1939	16,8367	19,0790	24,7818	22,9086	31,6400
95,9132	22,3135	20,1942	16,8640	18,8225	24,6432	22,8956	30,7264
95,5942	22,3109	20,2001	16,8870	18,9198	24,5340	22,8938	29,8345
95,1788	22,3048	20,2145	16,9312	19,1932	24,4582	22,8977	29,0729
94,6465	22,2958	20,2404	17,0223	19,4653	24,4194	22,9018	28,5500
94,0256	22,2849	20,2780	17,1746	19,5963	24,4181	22,9019	28,3307
93,5386	22,2738	20,3180	17,3571	19,5983	24,4401	22,8992	28,3050
93,4571	22,2639	20,3486	17,5277	19,5212	24,4678	22,8960	28,3193
94,0523	22,2571	20,3580	17,6442	19,4149	24,4837	22,8950	28,2200
95,4608	22,2540	20,3387	17,6745	19,3210	24,4772	22,8979	27,9102
97,2800	22,2522	20,3016	17,6273	19,2484	24,4653	22,9038	27,5205
98,9722	22,2483	20,2616	17,5217	19,1978	24,4724	22,9114	27,2380
100,0000	22,2390	20,2339	17,3766	19,1695	24,5226	22,9192	27,2500
99,9874	22,2224	20,2295	17,2143	19,1638	24,6287	22,9261	27,6594
99,2047	22,2028	20,2427	17,0721	19,1784	24,7578	22,9320	28,2318
98,0836	22,1863	20,2639	16,9905	19,2106	24,8655	22,9375	28,6483
97,0561	22,1787	20,2832	17,0101	19,2575	24,9076	22,9429	28,5900
96,4599	22,1843	20,2930	17,1589	19,3165	24,8517	22,9484	27,8244
96,2577	22,2010	20,2941	17,4142	19,3844	24,7134	22,9541	26,4636
96,3182	22,2251	20,2893	17,7404	19,4584	24,5200	22,9600	24,7060
96,5100	22,2529	20,2817	18,1020	19,5354	24,2992	22,9660	22,7500

RDexpenses	InnovativeActivities	LabourProductivity	QualifiedEmployees	AverageSalary	CompetenceLevel	CapitalProductivity	Industry4.0	TechAreas	WACC	CostCompetitivity	ChangesInventory
		84,5300		12,7000	7,1000	90,5200			6,1400		19,7792
		84,0960		13,0873	7,2194	89,4739			6,4998		4,3701
		83,9247		13,4397	7,3310	88,6713			6,8177		-8,8017
		84,2785		13,7222	7,4271	88,3555			7,0518		-17,4987
		85,4200	41,20000	13,9000	7,5000	88,7700	29,8000	28,6000	7,1600		-19,4836
		87,4796	41,48513	13,9543	7,5481	90,0541	30,6762	29,6157	7,1182		-13,5371
		90,0585	42,08300	13,9310	7,5946	91,9300	31,6819	30,7651	6,9731		-2,5125
		92,6257	42,88938	13,8921	7,6688	94,0159	32,9467	32,1819	6,7889		9,7189
		94,6500	43,80000	13,9000	7,8000	95,9300	34,6000	34,0000	6,6300		19,2856
		95,7424	44,71062	13,9986	8,0023	97,3630	36,6419	36,2193	6,5418		23,3652
		96,0813	45,51700	14,1612	8,2282	98,2963	38,5543	38,3048	6,4937		23,3301
		95,9870	46,11487	14,3432	8,4151	98,7839	39,6896	39,5879	6,4363		21,6016
20,9302	7,0900	95,7800	46,40000	14,5000	8,5000	98,8800	39,4000	39,4000	6,3200	109,0000	20,6012
20,9164	7,3536	95,7102	46,31926	14,5982	8,4490	98,6499	37,3217	37,3636	6,1226	109,7261	21,9235
20,9031	7,6148	95,7464	46,02401	14,6492	8,3425	98,2048	34,2258	34,2658	5,9308	110,4468	23,8566
20,8907	7,8710	95,7869	45,71676	14,6756	8,2897	97,6674	31,1670	31,1851	5,8586	111,1566	23,8621
20,8797	8,1200	95,7300	45,60000	14,7000	8,4000	97,1600	29,2000	29,2000	6,0200	111,8500	19,4014
20,8700	8,3616	95,5036	45,75454	14,7445	8,7222	96,7651	29,0618	29,0640	6,4798	112,5271	9,1001
20,8596	8,6057	95,1532	45,77445	14,8294	9,0644	96,4043	30,2175	30,2320	7,1067	113,2097	-3,7592
20,8459	8,8644	94,7537	45,13214	14,9746	9,1744	95,9588	31,8145	31,8340	7,7202	113,9249	-14,7300
20,8265	9,1500	94,3800	43,30000	15,2000	8,8000	95,3100	33,0000	33,0000	8,1400	114,7000	-19,3656
20,8007	9,4649	94,1027	40,04540	15,5098	7,8810	94,4198	33,1546	33,1037	8,2374	115,5444	-14,6948
20,7762	9,7725	93,9745	36,31567	15,8458	7,1249	93,5729	32,5916	32,4936	8,0912	116,3958	-3,6474
20,7628	10,0263	94,0442	33,35310	16,1338	7,4314	93,1345	31,8579	31,7617	7,8319	117,1744	9,3717
20,7702	10,1800	94,3600	32,40000	16,3000	9,7000	93,4700	31,5000	31,5000	7,5900	117,8000	19,9574
20,8048	10,2026	94,9853	34,22791	16,2896	14,5789	94,7906	31,8918	32,0928	7,4649	118,2181	24,8014
20,8594	10,1251	96,0424	37,72537	16,1251	21,7109	96,6916	32,7160	33,0935	7,4310	118,4758	24,9825
20,9237	9,9938	97,6683	41,31014	15,8480	30,4875	98,6143	33,4821	33,8474	7,4316	118,6456	22,6762
20,9870	9,8550	100,0000	43,40000	15,5000	40,3000	100,0000	33,7000	33,7000	7,4100	118,8000	20,0580
21,0413	9,7455	102,8160	42,87888	15,1300	50,4331	100,4401	33,0578	32,2545	7,3242	118,9957	18,8426
21,0871	9,6628	104,4597	40,49535	14,8163	59,7438	100,1268	31,9570	30,1450	7,1911	119,2259	18,9010
21,1274	9,5950	102,9161	37,46415	14,6445	66,9827	99,4027	30,9778	28,2629	7,0425	119,4682	19,6436
21,1651	9,5300	96,1700	35,00000	14,7000	70,9000	98,6100	30,7000	27,5000	6,9100	119,7000	20,4805
21,2026	9,4581	82,8429	34,04094	15,0412	70,6448	98,0228	31,5537	28,5155	6,8181	119,9039	20,9408
21,2403	9,3793	64,1026	34,41822	15,6171	66,9612	97,6411	33,3685	31,0392	6,7621	120,0830	21,0295
21,2782	9,2958	41,7535	35,68638	16,3494	60,9920	97,3963	35,8241	34,5682	6,7301	120,2456	20,8706
21,3162	9,2100	17,6000	37,40000	17,1600	53,8800	97,2200	38,6000	38,6000	6,7100	120,4000	20,5877

Table 1.3: Agriculture dataset

AGRICULTURE						
TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	BiologicalCultures	RenewableEnergies	ValueAddedEnvironment
87,9484	23,0762	19,8341	18,0369			23,1179
88,0375	23,0771	19,8616	18,0820			23,1036
88,1321	23,0766	19,8858	18,1237			23,0940
88,2378	23,0735	19,9035	18,1584			23,0936
88,3602	23,0664	19,9113	18,1828			23,1072
88,5198	23,0547	19,9081	18,1945			23,1374
88,7984	23,0405	19,9007	18,1955			23,1797
89,2926	23,0265	19,8980	18,1889			23,2276
90,0993	23,0154	19,9091	18,1777			23,2748
91,2592	23,0093	19,9404	18,1662			23,3160
92,5894	23,0068	19,9896	18,1632			23,3504
93,8509	23,0057	20,0516	18,1787			23,3786
94,8048	23,0038	20,1218	18,2227			23,4010
95,2935	22,9997	20,1951	18,3012			23,4184
95,4843	22,9939	20,2660	18,4049			23,4327
95,6261	22,9879	20,3288	18,5204			23,4461
95,9675	22,9830	20,3780	18,6343			23,4608
96,6620	22,9800	20,4097	18,7353			23,4783
97,4812	22,9787	20,4282	18,8190			23,4967
98,1018	22,9782	20,4396	18,8831			23,5134
98,2001	22,9778	20,4501	18,9251	5,9741	2,0644	23,5257
97,5870	22,9770	20,4645	18,9433	6,2659	2,2076	23,5319
96,6107	22,9762	20,4814	18,9395	6,5576	2,3510	23,5340
95,7535	22,9760	20,4983	18,9159	6,8494	2,4945	23,5348
95,4979	22,9772	20,5125	18,8749	7,1412	2,6380	23,5372
96,1681	22,9802	20,5221	18,8183	7,4330	2,7815	23,5436
97,4540	22,9846	20,5276	18,7442	7,7248	2,9250	23,5545
98,8875	22,9896	20,5301	18,6503	8,0165	3,0683	23,5698
100,0000	22,9947	20,5309	18,5340	8,3083	3,2116	23,5894
100,4386	22,9992	20,5318	18,3963	8,6001	3,3547	23,6130
100,3110	23,0028	20,5382	18,2516	8,8919	3,4978	23,6392
99,8403	23,0049	20,5558	18,1178	9,1836	3,6413	23,6664
99,2496	23,0052	20,5909	18,0127	9,4754	3,7852	23,6930
98,7204	23,0034	20,6473	17,9494	9,7672	3,9297	23,7177
98,2685	22,9999	20,7211	17,9210	10,0590	4,0748	23,7407
97,8682	22,9953	20,8067	17,9159	10,3508	4,2203	23,7627
97,4936	22,9901	20,8981	17,9225	10,6425	4,3659	23,7840

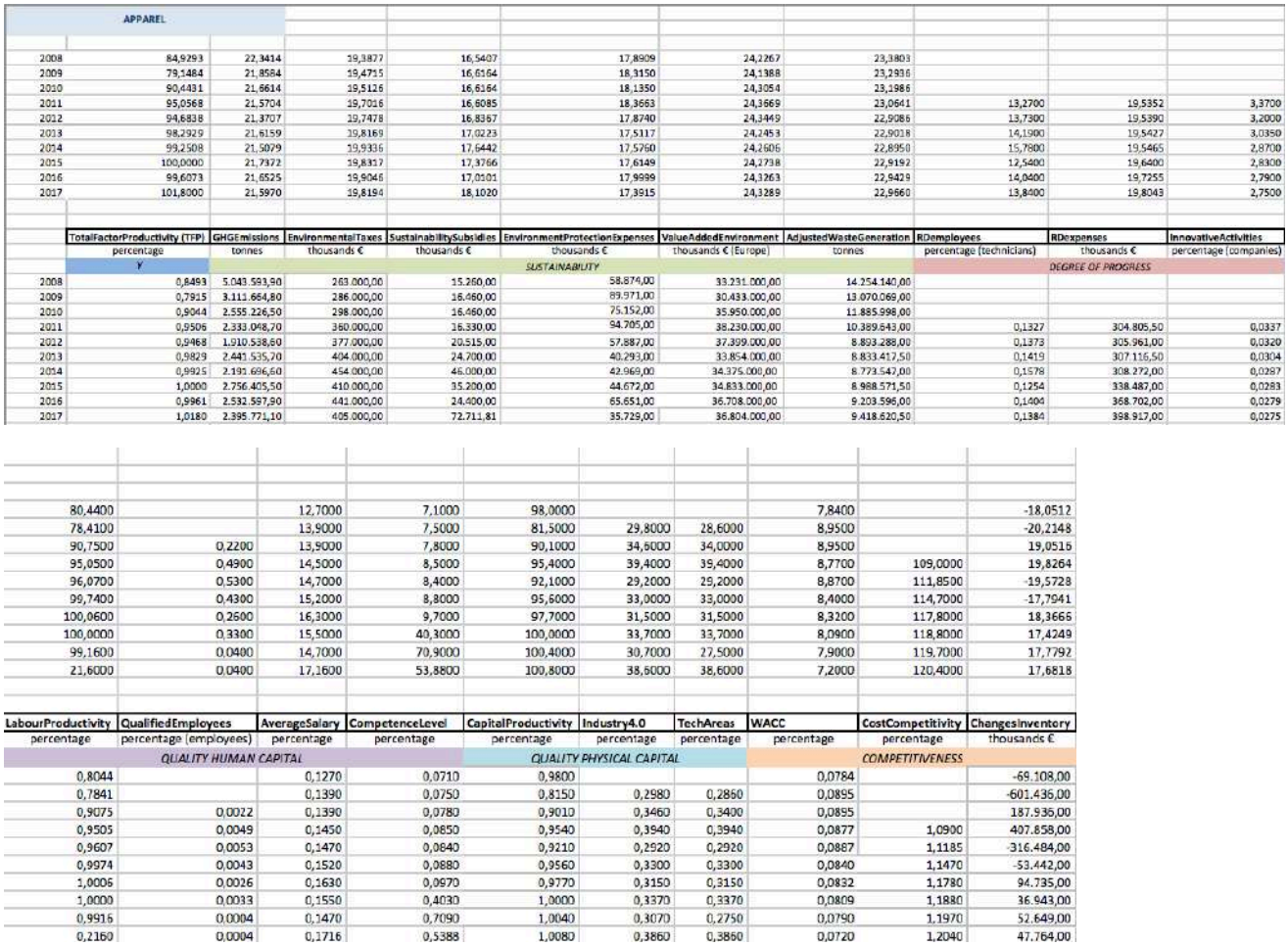
AdjustedWasteGeneration	RDemployees	LabourProductivity	AverageSalary	CompetenceLevel	CapitalProductivity	WACC	CostCompetitivity	ExportLevel
18,5647		90,4700	6,1000	3,2000	84,8300	7,7000	100,2000	26,6341
18,5541		90,6213	6,2543	3,2101	84,7992	7,7290	103,9551	26,5511
18,5421		90,7671	6,3970	3,2161	84,7967	7,7384	107,1481	26,4778
18,5274		90,9018	6,5161	3,2141	84,8509	7,7086	109,2171	26,4239
18,5085		91,0200	6,6000	3,2000	84,9900	7,6200	109,6000	26,3991
18,4853		91,1396	6,6393	3,1723	85,2408	7,4616	108,1422	26,4093
18,4633		91,3726	6,6341	3,1392	85,6237	7,2561	106,3182	26,4455
18,4489		91,8542	6,5869	3,1115	86,1572	7,0352	106,0102	26,4948
18,4489		92,7200	6,5000	3,1000	86,8600	6,8300	109,1000	26,5444
18,4677		94,0374	6,3805	3,1086	87,7206	6,6595	116,6560	26,5840
18,5019		95,6027	6,2540	3,1145	88,6061	6,4921	126,4916	26,6136
18,5458		97,1441	6,1504	3,0882	89,3536	6,2836	135,6063	26,6357
18,5939	52,7500	98,3900	6,1000	3,0000	89,8000	5,9900	141,0000	26,6526
18,6407	50,3542	99,1520	6,1307	2,8495	89,8528	5,5966	140,6760	26,6664
18,6808	47,9167	99,5754	6,2624	2,7526	89,7018	5,2068	136,6530	26,6774
18,7092	45,3958	99,8885	6,5129	2,8545	89,6074	4,9536	131,9535	26,6853
18,7206	42,7500	100,3200	6,9000	3,3000	89,8300	4,9700	129,6000	26,6899
18,7117	39,9791	101,0049	7,4200	4,1215	90,5344	5,3291	131,6790	26,6913
18,6867	37,2500	101,7046	7,9837	4,8999	91,5030	5,8646	136,5338	26,6907
18,6512	34,7708	102,0870	8,4806	5,1034	92,4226	6,3502	141,5717	26,6898
18,6113	32,7500	101,8200	8,8000	4,2000	92,9800	6,5600	144,2000	26,6900
18,5722	31,3572	100,7178	8,8643	2,0520	92,9828	6,3413	142,5986	26,6926
18,5370	30,6072	99,1799	8,7276	0,0977	92,7213	5,8363	138,0369	26,6975
18,5083	30,4761	97,7520	8,4772	0,1696	92,6067	5,2606	132,5567	26,7041
18,4886	30,9400	96,9800	8,2000	4,1000	93,0500	4,8300	128,2000	26,7119
18,4794	31,9106	97,2320	7,9666	13,2142	94,3275	4,7024	126,5142	26,7205
18,4781	33,0425	98,1658	7,7807	26,8091	96,1767	4,8041	127,0688	26,7296
18,4811	33,9255	99,2617	7,6295	43,6745	98,1999	5,0038	128,9390	26,7391
18,4846	34,1500	100,0000	7,5000	62,6000	100,0000	5,1700	131,2000	26,7488
18,4858	33,4331	99,9958	7,3772	82,1630	101,2618	5,2032	133,0932	26,7585
18,4849	32,0005	99,4043	7,2371	100,0907	101,9995	5,1322	134,5256	26,7679
18,4828	30,2051	98,5157	7,0534	113,8981	102,3101	5,0175	135,5701	26,7767
18,4806	28,4000	97,6200	6,8000	121,1000	102,2900	4,9200	136,3000	26,7845
18,4789	26,8648	96,9473	6,4590	120,0043	102,0297	4,8869	136,7863	26,7911
18,4778	25,5869	96,4869	6,0460	112,0906	101,5939	4,9122	137,0915	26,7969
18,4771	24,4806	96,1681	5,5850	99,6316	101,0412	4,9764	137,2759	26,8020
18,4765	23,4600	95,9200	5,1000	84,9000	100,4300	5,0600	137,4000	26,8068

Table 1.4: Construction dataset

CONSTRUCTION							
TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	ValueAddedEnvironment	AdjustedWasteGeneration	RDemployees	RDexpenses
119,2983	22,4879	20,6399	14,5763	24,6321	23,8618		
116,9186	22,4788	20,7458	14,5704	24,6164	23,8434		
114,6292	22,4684	20,8388	14,5668	24,6032	23,8246		
112,5205	22,4555	20,9062	14,5680	24,5949	23,8051		
110,6830	22,4387	20,9351	14,5763	24,5941	23,7843		
109,1834	22,4180	20,9195	14,5928	24,6027	23,7624		
107,9945	22,3990	20,8803	14,6129	24,6199	23,7402		
107,0652	22,3883	20,8452	14,6305	24,6446	23,7191		
106,3447	22,3926	20,8419	14,6397	24,6755	23,7004		
105,7787	22,4156	20,8900	14,6380	24,7108	23,6850		
105,2998	22,4483	20,9762	14,6367	24,7467	23,6717		
104,8370	22,4790	21,0794	14,6508	24,7785	23,6590		
104,3196	22,4956	21,1782	14,6951	24,8018	23,6452	18,4500	19,8926
103,7190	22,4899	21,2546	14,7622	24,8133	23,6294	18,7401	19,8615
103,1762	22,4685	21,3038	14,7552	24,8150	23,6130	19,0672	19,8308
102,8747	22,4414	21,3243	14,5551	24,8103	23,5981	19,4682	19,8011
102,9978	22,4189	21,3144	14,0426	24,8025	23,5868	19,9800	19,7728
103,6355	22,4086	21,2753	13,1773	24,7943	23,5804	20,6026	19,7457
104,5048	22,4080	21,2188	12,2326	24,7866	23,5776	21,1883	19,7165
105,2291	22,4120	21,1595	11,5605	24,7796	23,5763	21,5523	19,6815
105,4321	22,4157	21,1119	11,5129	24,7738	23,5745	21,5100	19,6367
104,8580	22,4150	21,0871	12,3093	24,7697	23,5707	20,9906	19,5814
103,7340	22,4110	21,0816	13,6382	24,7692	23,5661	20,3795	19,5270
102,4081	22,4058	21,0886	15,0558	24,7746	23,5626	20,1762	19,4881
101,2281	22,4014	21,1010	16,1181	24,7882	23,5620	20,8800	19,4791
100,4649	22,3993	21,1133	16,5182	24,8108	23,5656	22,8078	19,5098
100,0817	22,3980	21,1245	16,4974	24,8384	23,5724	25,5460	19,5699
99,9647	22,3950	21,1353	16,4339	24,8656	23,5810	28,4988	19,6444
100,0000	22,3883	21,1459	16,7059	24,8870	23,5897	31,0700	19,7183
100,0891	22,3762	21,1569	17,5742	24,8989	23,5975	32,7908	19,7796
100,1947	22,3608	21,1683	18,8295	24,9050	23,6043	33,7013	19,8294
100,2952	22,3448	21,1804	20,1448	24,9104	23,6106	33,9686	19,8719
100,3687	22,3310	21,1933	21,1933	24,9204	23,6167	33,7600	19,9112
100,3990	22,3216	21,2069	21,7272	24,9391	23,6231	33,2276	19,9507
100,3928	22,3158	21,2212	21,8159	24,9653	23,6296	32,4637	19,9910
100,3621	22,3126	21,2360	21,6076	24,9965	23,6363	31,5455	20,0317
100,3192	22,3106	21,2509	21,2509	25,0301	23,6430	30,5500	20,0728

InnovativeActivities	LabourProductivity	QualifiedEmployees	AverageSalary	CompetenceLevel	CapitalProductivity	Industry4.0	TechAreas	WACC	CostCompetitivity	ChangesInventory
	117,0000		4,3000	3,1000	127,4200			6,9900		23,7556
	114,5928		4,2390	3,1015	125,1881			7,6590		23,8092
	112,2885		4,2024	3,1124	122,9900			8,2544		23,7920
	110,1899		4,2146	3,1421	120,8594			8,7026		23,6331
	108,4000	31,80000	4,3000	3,2000	118,8300	23,1000	21,7000	8,9300		23,2618
	106,9922	31,83903	4,4680	3,2908	116,9400	24,2398	23,0031	8,8899		22,6814
	105,9221	31,54460	4,6678	3,4004	115,2451	25,4837	24,4149	8,6431		22,1920
	105,1159	31,02788	4,8337	3,5098	113,8051	26,9357	26,0443	8,2772		22,1680
	104,5000	30,40000	4,9000	3,6000	112,6800	28,7000	28,0000	7,8800		22,9834
	104,0058	29,77212	4,8266	3,6555	111,8836	30,7765	30,2820	7,5299		24,6728
	103,5858	29,25540	4,6764	3,6735	111,2447	32,7489	32,4552	7,2683		25,9110
	103,1979	28,96097	4,5380	3,6548	110,5459	34,0969	33,9759	7,1276		25,0330
18,1200	102,8000	29,00000	4,5000	3,6000	109,5700	34,3000	34,3000	7,1400	92,6000	20,3737
17,7850	102,3863	29,44748	4,6241	3,5248	108,1789	33,0589	33,1127	7,3216	93,6280	11,0132
17,4510	102,0972	30,23381	4,8641	3,5055	106,5524	30,9582	31,0141	7,6237	94,9962	-0,9878
17,1190	102,1095	31,25323	5,1471	3,6334	104,9497	28,8034	28,8335	7,9814	96,5914	-12,8236
16,7900	102,6000	32,40000	5,4000	4,0000	103,6300	27,4000	27,4000	8,3300	98,3000	-21,6884
16,4639	103,6443	33,54577	5,5615	4,6079	102,7716	27,3221	27,3064	8,6138	100,0086	-25,5608
16,1369	104,9129	34,47187	5,6171	5,1046	102,2294	28,2182	28,2007	8,8145	101,6038	-25,5563
15,8039	105,9751	34,93704	5,5641	5,0490	101,7775	29,5051	29,4947	8,9229	102,9720	-23,5750
15,4600	106,4000	34,70000	5,4000	4,0000	101,1900	30,6000	30,6000	8,9300	104,0000	-21,5167
15,1042	105,8943	33,62411	5,1317	1,8625	100,3182	31,0666	31,0758	8,8406	104,6236	-20,8557
14,7514	104,7136	31,99120	4,8051	-0,0739	99,3225	31,0566	31,0705	8,7147	104,9762	-21,3634
14,4204	103,2512	30,18768	4,4760	-0,1733	98,4406	30,8682	30,8800	8,6265	105,2407	-22,3857
14,1300	101,9000	28,60000	4,2000	3,2000	97,9100	30,8000	30,8000	8,6500	105,6000	-23,2683
13,8929	100,9677	27,53589	4,0197	11,2282	97,9051	31,0629	31,0420	8,8308	106,1799	-23,5141
13,6964	100,4201	26,98834	3,9250	23,2785	98,3468	31,5181	31,4797	9,1016	106,8789	-23,2538
13,5217	100,1375	26,87161	3,8928	38,2646	99,0926	31,9392	31,9026	9,3666	107,5385	-22,7755
13,3500	100,0000	27,10000	3,9000	55,1000	100,0000	32,1000	32,1000	9,5300	108,0000	-22,3670
13,1664	99,9067	27,57293	3,9194	72,5077	100,9410	31,8708	31,8562	9,5199	108,1535	-22,2458
12,9719	99,8309	28,13045	3,9075	88,4475	101,8453	31,5087	30,9355	9,3589	108,0830	-22,3479
12,7714	99,7646	28,59775	3,8169	100,6885	102,6569	31,3672	29,0971	9,0935	107,9210	-22,5388
12,5700	99,7000	28,80000	3,6000	107,0000	103,3200	31,8000	26,1000	8,7700	107,8000	-22,6841
12,3715	99,6306	28,60987	3,2245	105,8629	103,7964	33,0631	21,8020	8,4277	107,8232	-22,6793
12,1760	99,5564	28,08985	2,7187	98,6054	104,1195	35,0221	16,4544	8,0766	107,9765	-22,5395
11,9825	99,4790	27,34991	2,1261	87,2678	104,3403	37,4451	10,4071	7,7198	108,2166	-22,3096
11,7900	99,4000	26,50000	1,4900	73,8900	104,5100	40,1000	4,0100	7,3600	108,5000	-22,0347

Table 2.1: Apparel natural logarithm transformation



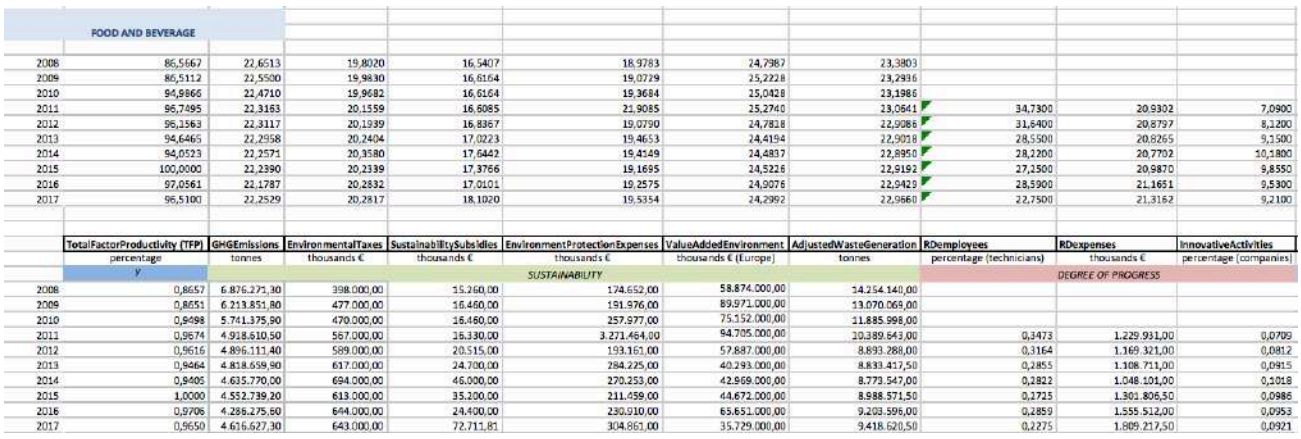
APPAREL											
2008	84,9293	22,3414	19,3877	16,5407	17,8909	24,2267	23,3803				
2009	79,1484	21,8584	19,4715	16,6164	18,3150	24,1388	23,2936				
2010	90,4431	21,6614	19,5126	16,6164	18,1350	24,3054	23,1986				
2011	95,0568	21,5704	19,7016	16,6085	18,3663	24,3669	23,0641	13,2700	19,5352	3,3700	
2012	94,6838	21,3707	19,7478	16,8367	17,8740	24,3449	22,9086	13,7300	19,5390	3,2000	
2013	98,2929	21,6159	19,8169	17,0223	17,5117	24,2453	22,9018	14,1900	19,5427	3,0350	
2014	99,2508	21,5079	19,9336	17,6442	17,5760	24,2606	22,8950	15,7800	19,5465	2,8700	
2015	100,0000	21,7372	19,8317	17,3766	17,6149	24,2738	22,9192	12,5400	19,6400	2,8300	
2016	99,6073	21,6525	19,9046	17,0101	17,9999	24,3263	22,9429	14,0400	19,7255	2,7900	
2017	101,8000	21,5970	19,8194	18,1020	17,3915	24,3289	22,9660	13,8400	19,8043	2,7500	

	TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	EnvironmentProtectionExpenses	ValueAddedEnvironment	AdjustedWasteGeneration	RDemployees	RDexpenses	InnovativeActivities
	percentage	tonnes	thousands €	thousands €	thousands €	thousands € (Europe)	tonnes	percentage (technicians)	thousands €	percentage (companies)
	Y	SUSTAINABILITY						DEGREE OF PROGRESS		
2008	0,8493	5.043.593,90	263.000,00	15.260,00	58.874,00	33.231.000,00	14.254.140,00			
2009	0,7915	3.111.664,80	286.000,00	16.460,00	89.971,00	30.433.000,00	13.070.069,00			
2010	0,9044	2.555.226,50	298.000,00	16.460,00	75.152,00	35.950.000,00	11.885.998,00			
2011	0,9506	2.333.048,70	360.000,00	16.330,00	94.705,00	38.230.000,00	10.389.643,00	0,1327	304.805,50	0,0337
2012	0,9468	1.910.538,60	377.000,00	20.515,00	57.887,00	37.399.000,00	8.893.288,00	0,1373	305.961,00	0,0320
2013	0,9829	2.441.535,70	404.000,00	24.700,00	40.293,00	33.854.000,00	8.833.417,50	0,1419	307.116,50	0,0304
2014	0,9925	2.191.696,60	454.000,00	46.000,00	42.969,00	34.375.000,00	8.773.547,00	0,1578	308.272,00	0,0287
2015	1,0000	2.756.405,50	410.000,00	35.200,00	44.672,00	34.833.000,00	8.988.571,50	0,1254	338.487,00	0,0283
2016	0,9961	2.532.597,90	441.000,00	24.400,00	65.651,00	36.708.000,00	9.203.596,00	0,1404	368.702,00	0,0279
2017	1,0180	2.395.771,10	405.000,00	72.711,81	35.729,00	36.804.000,00	9.418.620,50	0,1384	398.917,00	0,0275

80,4400		12,7000	7,1000	98,0000			7,8400		-18,0512
78,4100		13,9000	7,5000	81,5000	29,8000	28,6000	8,9500		-20,2148
90,7500	0,2200	13,9000	7,8000	90,1000	34,6000	34,0000	8,9500		19,0516
95,0500	0,4900	14,5000	8,5000	95,4000	39,4000	39,4000	8,7700	109,0000	19,8264
96,0700	0,5300	14,7000	8,4000	92,1000	29,2000	29,2000	8,8700	111,8500	-19,5728
99,7400	0,4300	15,2000	8,8000	95,6000	33,0000	33,0000	8,4000	114,7000	-17,7941
100,0600	0,2500	16,3000	9,7000	97,7000	31,5000	31,5000	8,3200	117,8000	18,3665
100,0000	0,3300	15,5000	40,3000	100,0000	33,7000	33,7000	8,0900	118,8000	17,4249
99,1600	0,0400	14,7000	70,9000	100,4000	30,7000	27,5000	7,9000	119,7000	17,7792
21,6000	0,0400	17,1600	53,8800	100,8000	38,6000	38,6000	7,2000	120,4000	17,6818

LabourProductivity	QualifiedEmployees	AverageSalary	CompetenceLevel	CapitalProductivity	Industry4.0	TechAreas	WACC	CostCompetitivity	ChangesInventory
percentage	percentage (employees)	percentage	percentage	percentage	percentage	percentage	percentage	percentage	thousands €
	QUALITY HUMAN CAPITAL			QUALITY PHYSICAL CAPITAL			COMPETITIVENESS		
0,8044		0,1270	0,0710	0,9800			0,0784		-69.108,00
0,7841		0,1390	0,0750	0,8150	0,2980	0,2860	0,0895		-601.436,00
0,9075	0,0022	0,1390	0,0780	0,9010	0,3460	0,3400	0,0895		187.936,00
0,9505	0,0049	0,1450	0,0850	0,9540	0,3940	0,3940	0,0877	1,0900	407.858,00
0,9607	0,0053	0,1470	0,0840	0,9210	0,2920	0,2920	0,0887	1,1185	-316.484,00
0,9974	0,0043	0,1520	0,0880	0,9560	0,3300	0,3300	0,0840	1,1470	-53.442,00
1,0006	0,0026	0,1630	0,0970	0,9770	0,3150	0,3150	0,0832	1,1780	94.735,00
1,0000	0,0033	0,1550	0,4030	1,0000	0,3370	0,3370	0,0809	1,1880	36.943,00
0,9916	0,0004	0,1470	0,7090	1,0040	0,3070	0,2750	0,0790	1,1970	52.649,00
0,2160	0,0004	0,1716	0,5388	1,0080	0,3860	0,3860	0,0720	1,2040	47.764,00

Table 2.2: Food and Beverage natural logarithm transformation



FOOD AND BEVERAGE										
2008	86,5667	22,6513	19,8020	16,5407	18,9783	24,7987	23,3803			
2009	86,5112	22,5500	19,9830	16,6164	19,0729	25,2228	23,2936			
2010	94,9866	22,4710	19,9682	16,6164	19,3684	25,0428	23,1986			
2011	96,7495	22,3163	20,1559	16,6085	21,9085	25,2740	23,0641	34,7300	20,9302	7,0900
2012	96,1563	22,3117	20,1939	16,8367	19,0790	24,7818	22,9086	31,6400	20,8797	8,1200
2013	94,6465	22,2958	20,2404	17,0223	19,4653	24,4194	22,9018	28,5500	20,8265	9,1500
2014	94,0523	22,2571	20,3580	17,6442	19,4149	24,4837	22,8950	28,2200	20,7702	10,1800
2015	100,0000	22,2390	20,2339	17,3766	19,1695	24,5226	22,9192	27,2500	20,9870	9,8550
2016	97,0561	22,1787	20,2832	17,0101	19,2575	24,9076	22,9429	28,5900	21,1651	9,5300
2017	96,5100	22,2529	20,2817	18,1020	19,5354	24,2992	22,9660	22,7500	21,3162	9,2100

	TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	EnvironmentProtectionExpenses	ValueAddedEnvironment	AdjustedWasteGeneration	RDemployees	RDexpenses	InnovativeActivities
	percentage	tonnes	thousands €	thousands €	thousands €	thousands € (Europe)	tonnes	percentage (technicians)	thousands €	percentage (companies)
	Y	SUSTAINABILITY						DEGREE OF PROGRESS		
2008	0,8657	6.876.271,30	398.000,00	15.260,00	174.652,00	58.874.000,00	14.254.140,00			
2009	0,8651	6.213.851,80	477.000,00	16.460,00	191.976,00	89.971.000,00	13.070.069,00			
2010	0,9498	5.741.375,90	470.000,00	16.460,00	257.977,00	75.152.000,00	11.885.998,00			
2011	0,9674	4.918.610,50	567.000,00	16.330,00	3.271.464,00	94.705.000,00	10.389.643,00	0,3473	1.229.931,00	0,0709
2012	0,9616	4.896.111,40	589.000,00	20.515,00	193.161,00	57.887.000,00	8.893.288,00	0,3164	1.169.321,00	0,0812
2013	0,9464	4.818.659,90	617.000,00	24.700,00	284.225,00	40.293.000,00	8.833.417,50	0,2855	1.108.711,00	0,0915
2014	0,9405	4.635.770,00	694.000,00	46.000,00	270.253,00	42.969.000,00	8.773.547,00	0,2822	1.048.101,00	0,1018
2015	1,0000	4.552.739,20	613.000,00	35.200,00	211.459,00	44.672.000,00	8.988.571,50	0,2725	1.301.806,50	0,0986
2016	0,9706	4.286.275,60	644.000,00	24.400,00	230.910,00	65.651.000,00	9.203.596,00	0,2859	1.555.512,00	0,0953
2017	0,9650	4.616.627,30	643.000,00	72.711,81	304.861,00	35.729.000,00	9.418.620,50	0,2275	1.809.217,50	0,0921

84,5300		12,7000	7,1000	90,5200			6,1400		19,7792
85,4200	0,1640	13,9000	7,5000	88,7700	29,8000	28,6000	7,1600		-19,4836
94,6500	0,3600	13,9000	7,8000	95,9300	34,6000	34,0000	6,6300		19,2856
95,7800	0,5900	14,5000	8,5000	98,8800	39,4000	39,4000	6,3200	109,0000	20,6012
95,7300	0,5800	14,7000	8,4000	97,1600	29,2000	29,2000	6,0200	111,8500	19,4014
94,3800	0,5800	15,2000	8,8000	95,3100	33,0000	33,0000	8,1400	114,7000	-19,3656
94,3600	0,3000	16,3000	9,7000	93,4700	31,5000	31,5000	7,5900	117,8000	19,9574
100,0000	0,3500	15,5000	40,3000	100,0000	33,7000	33,7000	7,4100	118,8000	20,0580
96,1700	0,0600	14,7000	70,9000	98,6100	30,7000	27,5000	6,9100	119,7000	20,4805
17,6000	0,0600	17,1600	53,8800	97,2200	38,6000	38,6000	6,7100	120,4000	20,5877

LabourProductivity	QualifiedEmployees	AverageSalary	CompetenceLevel	CapitalProductivity	Industry4.0	TechAreas	WACC	CostCompetitivity	ChangesInventory
percentage	percentage (employees)	percentage	percentage	percentage	percentage	percentage	percentage	percentage	thousands €
	QUALITY HUMAN CAPITAL			*QUALITY PHYSICAL CAPITAL*				*COMPETITIVENESS*	
0,8453		0,1270	0,0710	0,9052			0,0614		389.044,00
0,8542	0,0016	0,1390	0,0750	0,8877	0,2980	0,2860	0,0716		-289.470,00
0,9465	0,0036	0,1390	0,0780	0,9593	0,3460	0,3400	0,0663		237.482,00
0,9578	0,0059	0,1450	0,0850	0,9888	0,3940	0,3940	0,0632	1,0900	885.111,00
0,9573	0,0058	0,1470	0,0840	0,9716	0,2920	0,2920	0,0602	1,1185	266.625,00
0,9438	0,0058	0,1520	0,0880	0,9531	0,3300	0,3300	0,0814	1,1470	-257.264,00
0,9436	0,0030	0,1630	0,0970	0,9347	0,3150	0,3150	0,0759	1,1780	464.938,00
1,0000	0,0035	0,1550	0,4030	1,0000	0,3370	0,3370	0,0741	1,1880	514.142,00
0,9617	0,0006	0,1470	0,7090	0,9861	0,3070	0,2750	0,0691	1,1970	784.420,00
0,1760	0,0006	0,1716	0,5388	0,9722	0,3860	0,3860	0,0671	1,2040	873.224,00

Table 2.3: Agriculture natural logarithm transformation

	AGRICULTURE							
2008	87,9484	23,0762	19,8341	18,0369			23,1179	18,5647
2009	88,3602	23,0664	19,9113	18,1828			23,1072	18,5085
2010	90,0993	23,0154	19,9091	18,1777			23,2748	18,4489
2011	94,8048	23,0038	20,1218	18,2227			23,4010	18,5939
2012	95,9675	22,9830	20,3780	18,6343			23,4608	18,7206
2013	98,2001	22,9778	20,4501	18,9251	5,9741	2,0644	23,5257	18,6113
2014	95,4979	22,9772	20,5125	18,8749	7,1412	2,6380	23,5372	18,4886
2015	100,0000	22,9947	20,5309	18,5340	8,3083	3,2116	23,5894	18,4846
2016	99,2496	23,0052	20,5909	18,0127	9,4754	3,7852	23,6930	18,4806
2017	97,4936	22,9901	20,8981	17,9215	10,6425	4,3659	23,7840	18,4765

	TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	BiologicalColtures	RenewableEnergies	ValueAddedEnvironment	AdjustedWasteGeneration
	percentage	tonnes	thousands €	thousands €	percentage	percentage	thousands € (Europe)	tonnes
	Y				*SUSTAINABILITY*			
2008	0,8794	10.516.838,30	411.000,00	68.130,00			10.964.000,00	115.492,00
2009	0,8836	10.413.956,10	444.000,00	78.830,00			10.847.000,00	109.176,00
2010	0,9009	9.896.490,70	443.000,00	78.430,00			12.827.000,00	102.860,00
2011	0,9480	9.782.179,30	548.000,00	82.040,00			14.552.000,00	118.916,00
2012	0,9597	9.580.189,10	708.000,00	123.820,00			15.449.000,00	134.972,00
2013	0,9820	9.530.713,20	761.000,00	165.600,00	0,0597409	0,0206439	16.485.000,00	121.001,00
2014	0,9549	9.525.573,20	810.000,00	157.500,00	0,0714120	0,0263799	16.675.000,00	107.030,00
2015	1,0000	9.693.120,30	825.000,00	112.000,00	0,0830831	0,0321158	17.569.000,00	106.601,50
2016	0,9924	9.795.741,30	876.000,00	66.500,00	0,0947543	0,0378518	19.487.000,00	106.173,00
2017	0,9749	9.648.484,50	1.191.000,00	60.764,67	0,1064254	0,0436588	21.343.000,00	105.744,50

	90,47	6,10	3,20	84,83	7,70	100,20	26,63
	91,02	6,60	3,20	84,99	7,62	109,60	26,40
	92,72	6,50	3,10	86,86	6,83	109,10	26,54
52,75	98,39	6,10	3,00	89,80	5,99	141,00	26,65
42,75	100,32	6,90	3,30	89,83	4,97	129,60	26,69
32,75	101,82	8,80	4,20	92,98	6,56	144,20	26,69
30,94	96,98	8,20	4,10	93,05	4,83	128,20	26,71
34,15	100,00	7,50	62,60	100,00	5,17	131,20	26,75
28,40	97,62	6,80	121,10	102,29	4,92	136,30	26,78
23,46	95,92	5,10	84,90	100,43	5,06	137,40	26,81

RDemployees	LabourProductivity	AverageSalary	CompetenceLevel	CapitalProducti	WACC	CostCompetitivity	ExportLevel
percentage (technicians)	percentage	percentage	percentage	percentage	percentage	percentage	thousands €
DEGREE OF PROGRESS	QUALITY HUMAN CAPITAL			ITY PHYSICAL CA	COMPETITIVENESS		
	0,9047	0,0610	0,0320	0,8483	0,0770	1,0020	369.015.556,09
	0,9102	0,0660	0,0320	0,8499	0,0762	1,0960	291.733.117,42
	0,9272	0,0650	0,0310	0,8686	0,0683	1,0910	337.346.283,20
0,5275	0,9839	0,0610	0,0300	0,8980	0,0599	1,4100	375.903.831,85
0,4275	1,0032	0,0690	0,0330	0,8983	0,0497	1,2960	390.182.091,87
0,3275	1,0182	0,0880	0,0420	0,9298	0,0656	1,4420	390.232.593,09
0,3094	0,9698	0,0820	0,0410	0,9305	0,0483	1,2820	398.870.413,89
0,3415	1,0000	0,0750	0,6260	1,0000	0,0517	1,3120	413.881.348,78
0,2840	0,9762	0,0680	1,2110	1,0229	0,0492	1,3630	428.892.283,66
0,2346	0,9592	0,0510	0,8490	1,0043	0,0506	1,3740	438.559.496,19

Table 2.4: Construction natural logarithm transformation

CONSTRUCTION									
2008	119,2983	22,4879	20,6399	14,5763	24,6321	23,8618			
2009	110,6830	22,4387	20,9351	14,5763	24,5941	23,7843			
2010	106,3447	22,3926	20,8419	14,6397	24,6755	23,7004			
2011	104,3196	22,4956	21,1782	14,6951	24,8018	23,6452	18,4500	19,8926	18,1200
2012	102,9578	22,4189	21,3144	14,0426	24,8025	23,5868	19,9800	19,7728	16,7900
2013	105,4321	22,4157	21,1119	11,5129	24,7738	23,5745	21,5100	19,6367	15,4600
2014	101,2281	22,4014	21,1010	16,1181	24,7882	23,5620	20,8800	19,4791	14,1300
2015	100,0000	22,3883	21,1459	16,7059	24,8870	23,5897	31,0700	19,7183	13,3500
2016	100,3687	22,3310	21,1933	21,1933	24,9204	23,6167	33,7600	19,9112	12,5700
2017	100,3192	22,3106	21,2509	21,2509	25,0301	23,6430	30,5500	20,0728	11,7900

	TotalFactorProductivity (TFP)	GHGEmissions	EnvironmentalTaxes	SustainabilitySubsidies	ValueAddedEnvironment	AdjustedWasteGeneration	RDemployees	RDexpenses	InnovativeActivities
	percentage	tonnes	thousands €	thousands €	thousands € (Europe)	tonnes	percentage (technicians)	thousands €	percentage (companies)
	Y	SUSTAINABILITY					DEGREE OF PROGRESS		
2008	1,1930	5.839.224,30	920.000,00	2.140,00	46.839.000,00	23.069.542,00			
2009	1,1070	5.558.817,60	1.236.000,00	2.140,00	47.984.000,00	21.350.572,00			
2010	1,0630	5.308.692,50	1.126.000,00	2.280,00	52.050.000,00	19.631.602,00			
2011	1,0430	5.884.724,50	1.576.000,00	2.410,00	59.058.000,00	18.577.119,00	0,1845	435.763,50	0,1812
2012	1,0300	5.449.905,30	1.806.000,00	1.255,00	59.099.000,00	17.522.636,00	0,1998	386.570,00	0,1679
2013	1,0540	5.432.512,40	1.475.000,00	100,00	57.426.000,00	17.308.456,00	0,2151	337.376,50	0,1546
2014	1,0120	5.355.566,80	1.459.000,00	10.000,00	58.260.000,00	17.094.276,00	0,2088	288.183,00	0,1413
2015	1,0000	5.285.686,30	1.526.000,00	18.000,00	64.311.000,00	17.575.001,50	0,3107	366.051,00	0,1335
2016	1,0040	4.991.615,50	1.600.000,00	1.600.000,00	66.497.000,00	18.055.727,00	0,3376	443.919,00	0,1257
2017	1,0030	4.890.778,20	1.695.000,00	1.695.000,00	74.205.000,00	18.536.452,50	0,3055	521.787,00	0,1179

117,0000		4,3000	3,1000	127,4200			6,9900		23,7556
108,4000	0,0600	4,3000	3,2000	118,8300	23,1000	21,7000	8,9300		23,2618
104,5000	0,0300	4,9000	3,6000	112,6800	28,7000	28,0000	7,8800		22,9834
102,8000	0,0600	4,5000	3,6000	109,5700	34,3000	34,3000	7,1400	92,6000	20,3737
102,6000	0,0800	5,4000	4,0000	103,6300	27,4000	27,4000	8,3300	98,3000	-21,6884
106,4000	0,0900	5,4000	4,0000	101,1900	30,6000	30,6000	8,9300	104,0000	-21,5167
101,9000	0,0500	4,2000	3,2000	97,9100	30,8000	30,8000	8,6500	105,6000	-23,2683
100,0000	0,0500	3,9000	55,1000	100,0000	32,1000	32,1000	9,5300	108,0000	-22,3670
99,7000	0,0100	3,6000	107,0000	103,3200	31,8000	26,1000	8,7700	107,8000	-22,6841
99,4000	0,0100	1,4900	73,8900	104,5100	40,1000	4,0100	7,3600	108,5000	-22,0347

LabourProductivity	QualifiedEmployees	AverageSalary	CompetenceLe	CapitalProductivity	Industry4.0	TechAreas	WACC	CostCompetitivity	ChangesInventory
percentage	ercentage (employee	percentage	percentage	percentage	percentage	percentage	percentage	percentage	thousands €
	QUALITY HUMAN CAPITAL			QUALITY PHYSICAL CAPITAL			COMPETITIVENESS		
1,1700		0,0430	0,0310	1,2742			0,0699		20.745.519,00
1,0840	0,0006	0,0430	0,0320	1,1883	0,2310	0,2170	0,0893		12.661.290,00
1,0450	0,0003	0,0490	0,0360	1,1268	0,2870	0,2800	0,0788		9.584.541,00
1,0280	0,0006	0,0450	0,0360	1,0957	0,3430	0,3430	0,0714	0,9260	705.009,00
1,0260	0,0008	0,0540	0,0400	1,0363	0,2740	0,2740	0,0833	0,9830	-2.625.116,00
1,0640	0,0009	0,0540	0,0400	1,0119	0,3060	0,3060	0,0893	1,0400	-2.210.945,00
1,0190	0,0005	0,0420	0,0320	0,9791	0,3080	0,3080	0,0865	1,0560	-12.744.040,00
1,0000	0,0005	0,0390	0,5510	1,0000	0,3210	0,3210	0,0953	1,0800	-5.174.417,00
0,9970	0,0001	0,0360	1,0700	1,0332	0,3180	0,2610	0,0877	1,0780	-7.105.501,00
0,9940	0,0001	0,0149	0,7389	1,0451	0,4010	0,0401	0,0736	1,0850	-3.711.646,00

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