TecnoCampus
Escola Superior
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Computers Usage and Labour Market: a Parallelism with Artificial Intelligence

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1. Abstract

Abstract – This study will focus on the effects that technology, concretely computers, have on employment levels and wages of employees depending the sector of activity they work on and which kind of tasks they develop. EUKlems data will be analysed to extract these conclusions to contrast it with the theoretical background that exists on this topic of computers' usage and the consequences on labour market such as (Murnane, Autor and Levy, 2003) who have published some articles of studying this issue. As Artificial Intelligence is based on actual software and electronic devices, it is possible to forecast how artificial intelligence will affect labour market wages and employment levels of different sectors of the economy on developed economies.

Personal motivation – As a future manager it is very important to know what the future will bring to us. This research it is not only important from a scientific and social point of view. As I've always believed, "knowing what is behind us and how has shaped our present, is essential to go forward and improve everything we have around us". That's the personal motivation behind this study, and that is the reason why I've started to study IT Engineering. Technology will change everything, and if we know what has already changed in our environment, it will be easier for us to adapt in the future.

2. Introduction

Technology or new knowledge has been the cause of most of the steps that humanity has done towards an easier life, pulling forward the limits of our capacities. These new scenarios have created new jobs, destroyed old ones and changed the wages levels of entire industries.

Changes became more relevant since the First Industrial Revolution. Steam-powered machines began the shift from agricultural-based economies to more industrial activities. Characterised by the rise of capitalism as economic system and the accumulation of capital in the hands of a few, this period saw the creation of new jobs in factories, transportation and construction activities, but it also saw the precarisation of living standards, the loss of craftsmen jobs and the increase in worked hours.

The Second Industrial revolution, followed the path marked by the First. The most important difference between both was the demand for jobs. During the Second Revolution economies increased the demand for high skilled jobs and knowledge, specially engineers, and also increased the number of low-skilled jobs that could not be automatized. However, living-standards started to improve.

Nowadays the world is still facing the Third Industrial Revolution. Thanks to the evolution of the internet, electronic devices and software have changed our way of communication, interaction, and how we work. Computers and software are developing faster than ever, and this will change everything around us more than we can imagine.

So, my question is: is it possible to observe this change through wages and employment rates in different developed countries?

Studies from different authors (Spitz-Oener, 2006; Goos and Manning, 2007; Murnane, Willett and Levy, 2016) have proved that low-skills and routine jobs have experienced a decrease in the labour market, following a salary decreased caused by the use of computers at work. They also found that problem-solving skills, *expert thinking* and other more intellectual skills have raised, and so also their salaries. Therefore, these results prove that it may be possible to study how technology impacts job market.

However, some others authors (Oosterbeek, 1997; Borghans, Weel and Grip, 2000;

Borghans and ter Weel, 2004) have found that computers usage at work have no effect on wages. They argue that computers may have had a positive effect on wages during the start of the 70s and 80s, but this effect disappeared. Their result is that: it is not the fact of using computers the cause of higher wages, it is the kind of tasks they develop that has a positive or negative effect on it (Pabilonia and Zoghi, 2005; Borghans and ter Weel, 2011; Liu, Tsou and Hammitt, 2016).

Even those authors, who argue that computers have no direct impact on wages' levels, end up on the skills fact that moves the labour market and wages up and down. Nevertheless, it is obvious that, even though supposing computers have no direct impact on wages, they have shaped the skills required for labour forces, so our main objective of study is still possible under both views.

So, even though the world is still living the third industrial revolution, the fourth has started to show its signs of life. This future industrial revolution will be based on artificial intelligence[1], big data and deep learning, and a revolution on genetic and biotechnology.

[1] Understood as: any device/software that perceives its environment and takes actions to improve the chance to achieve goals, or also that is able to mimic problem solving abilities.

3. Theoretical backgrounds

There is a lot of research done on the ambit of labour market regarding the implementation of new technologies and how the fact of having knowledge about it can improve employees' wages.

My main paper of reference is from Frank Levy (Levy, 2010) *"How technology changes demand for Human Skills"*. On this article Levy, based on data from OECD's PIAACs, argues that there are some skills, such as expert thinking and complex communication, that can increase salaries. And those skills are the ones which have experienced a major increase in labour market according to US occupations.

Another article from Levy, "*The Skill Content of Recent Technological change: an Empirical Exploration"* (Murnane, Autor and Levy, 2003) showcases the fact that: technology has changed the skills demanded by labour market, routine-based jobs have experienced a decrease in salaries, and high cognitive tasks have aroused. Levy has some more articles focused on these facts (Levy and Murnane, 2007; Murnane, Willett and Levy, 2016).

Technology has affected labour market since its first introduction. Our recent history can be divided into three industrial revolutions. Each one had some technology behind it that changed the entire world: the first one was powered by steam, the second by electricity and steel, the third one was based on electronic devices.

During all these periods technology destroyed a large number of jobs, but also created new jobs once unimaginable.

Thanks to the power of steam machines, the First Industrial Revolution changed the world as never seen before; historian Ian Morris explained it on his book about patterns in human history (Morris, 2010). It started the shifted from agricultural activities to industry activities. The demand for jobs in cities grew incredibly fast, and the accumulation of capital of the owners of the industries began. This fact caused a shifted in living standards. There are two views of the First Industrial Revolution consequences' according to as Stephen Broadberry (Broadberry, 2017): the pessimistic which defends that workers worked more days for the same real wage; and the optimistic, that argues that real wages

raised up, and that this fact, along with improvements on education and trade, had a positive impact on living standards for workers in Britain.

The Second Industrial Revolution followed the automation of factories started with the First Industrial Revolution. The introduction of electricity, steel, oil and gas created a demand for high-skilled jobs, such as engineers, to design and create new infrastructures, machines and devices. Low skill jobs' demand also increased due to the fact that, with the help of machines, they were able to do the work once done by moderate-skilled workers (Chin, Juhn and Thompson, 2006).

Even though this technology created concentration, unpleasant and dangerous jobs and living standards, at the end of the Second Revolution, retribution levels were clearly affected positively by these new technologies, worked-hours started to decline, and health related parameters (life expectancy, mortality, etc.) improved during this economic cycle (Strotz and Mokyr, 1999).

The Third Industrial Revolution started when electronic devices, computers, became widespread in corporations and businesses, and is nowadays still taking place. Computers started to reshape how institutions worked from the late sixties and spread to the main public since the eighties.

Even though these changes are known by almost everyone, it seems that most institutions and governments do not understand the deep change that is happening right now. Papers from different institutions: from banks from the USA, as the Federal Reserve Bank of San Francisco (Chen *et al.*, 2011), the Federal Reserve Bank of Richmond (Hornstein and Lubik, 2010) to the International Monetary Fund (Estevão and Tsounta, 2011); have remained silent about technology affecting employment levels.

In the article "*Explaining Job polarization: Routine-Biased Technological Change and Offshoring*" (Goos, Manning and Salomons, 2014) these authors conclude that industries where computers are able to substitute routine tasks, computers are adopted quickly, and if jobs can be offshored they will be. Therefore, on developed countries these increase the gap between well paid and not-so-well paid workers. Industries hire high skills workers and low skills remain mostly unchanged (Michaels, Natraj and Reenen, 2014), as Nobel Prize-winning Paul Samuelson also proved (Samuelson, 2004). It is not an error saying that low skilled workers' wages are not affected by this fact because these workers

have shifted from industry jobs to services jobs. On his papers, David Autor (Autor and Dorn, 2013) studies how routine-based workers' have shifted towards service industry, where there are a lot of low-skilled jobs that are demanded and where offshoring is practically impossible.

Daron Acemoglu and David Author have also found out that: weekly wages have decreased for workers who only have a high-school degree, those with some college studies have stagnated, while those with college degrees have increased their weekly retribution (Acemoglu and Autor, 2011). This change into more analytical and interactive tasks has also been observed on articles about gender discrimination and how technology has impacted feminine labour market (Black and Spitz-Oener, 2010).

All these conclusions follow the same patron that Nobel Prize winner, Robert Solow, showed on his studies about economic growth and resources. He realised that technology created more value without the need of increasing resources such as labour, capital, etc. (Brynjolfsson and Mcafee, 2011).

There also authors who have not find a correlation between computers usage and increase on wages. They argue that computers usage cannot have more impact than using a pencil ("*Pencil paradox*" from (Pischke and DiNardo, 2016)), this affirmation has also been denied arguing that this "pencil effect" disappeared in the late nineties (Spitz-Oener, 2008), and that the fact of using computers have caused a shift towards analytical and interactive tasks (Levy, 2010). However, the important fact is that most of these authors end up justifying that it is not the fact of using a computers, it is the way workers use the computer for, and that it is their level of skills or education or the tasks they perform that provokes an increase on salaries (Pabilonia and Zoghi, 2005; Borghans and ter Weel, 2011).

3. Hypothesis

The Third Industrial Revolution is still ongoing, we are experiencing how computers and technology are changing our everyday life. Papers and studies since the late 80's have proved these differences are visible in labours markets, where employment rates and wages levels are experiencing changes across industrialised economies.

These economies present changes on wages levels and employment rates depending on tasks.

- Those jobs that can be substituted by technology have showed stagnate employment levels since 1995 or have lost part of their jobs.
- Wages levels on the other hand have increased on those sectors surrounded by technology (Murnane, Autor and Levy, 2003) while low-skill jobs have remained practically untouched on remuneration levels.

The analysis of some sectors of activities from developed economies should result in the same conclusions as found by authors such as (Goos, Manning and Salomons, 2014; Murnane, Willett and Levy, 2016). As this process is still ongoing we propose to extend it on the introduction of Artificial Intelligence (AI), so to the beginning of the Fourth Industrial Revolution. Which basically will accelerate and prolong in time the changes initiated by the introduction of ICT technologies observed thus far.

4. Methodology

This study will use different articles, studies and scientific papers in general to see what has been accomplished by nowadays research, which hypothesis and conclusions they have reached and how these results effect the main hypothesis of this study.

Once the theoretical part is done the following data base will be used to examine how computer usage have affected salaries and employment rates. These data will be used on both, a descriptive analysis and a regression analysis to approve or deny the main hypothesis of this study.

- EUKlems database gives information of all 28 countries of the European Union and the United States, realised with the help of more than 15 organisations across the EU and with the support of various statistical offices and the OECD. The time period is from 1995 to 2015 for most countries and industries. The data has been adjusted to the new ESA 2010 (European System of National Accounts), and also uses the Structure Earnings Survey (SES) and European Labour Force Survey (LFS).

  The main goal of EUKlems database is to offer a way to analyse and study the relationship between skills, formation, technological progress and innovation with productivity and other outputs.

4.1 Descriptive Analysis

Microsoft Excel® has been used to elaborate all the graphs to be able to analyse the sectors of the economy of the different developed countries. The type of graph selected has two y axis so that it is possible to see ICT investment on the right y axis, and the level of employment or wages on the left y axis. The x axis shows the years of the data, going from 1995 to 2015 in most cases. This way is it possible to see how ICT levels may have impacted on labour market's variables.

4.2 Regression Analysis

Stata®, a statistical software, has been used to calculate a regression analysis of the EUKlems database to confirm or deny the conclusions found during the descriptive analysis.

Due to time and resources availability, the regression analyses have focused on the whole economy of the country, without dividing it into sectors of activities as it was done in the descriptive analysis. It would be possible to examine sector per sector in future releases if this project is followed, as data files are divided into sectors of activities.

The dependant quantitative variables, are employment levels and salaries. Those can be explained by the following quantitative variables. On employment side:

- ICT Investment (t-1): investments in computers do not affect immediately employment levels. For example, a business has to take sure all computers and machinery work correctly before they can fire someone, because if something fails they have a problem. That is the reason why this variable should have negative values.
- Value added (t): productivity of labour. It is logical to think that, if productivity grows, it means that employers can hire more people because they receive more output per input.
- Rents (t): profits returned to capitalists or investors. If profits are destined to capital owners instead of new investments, employment will not grow or even decrease.

It is important to note that the dependent variable "salaries" is not studied in a qualitative way, but a quantitative. Salaries are not analysed by their quality, that is if workers receive more per year than last year; they are analysed by the quantity: if the economy on its global remunerates more or less to employees. There are the independents variables:

- ICT Investment (t-1): last year's investment may have a negative impact on salaries. This fact is related on how ICT investment may impact jobs. If we suppose that ICT investment reduces the number of jobs, it is normal to think that as jobs are reduced, less is paid on the total of the economy, and that is the reason why salaries can be affected negatively by last year's investment.
- ICT investment (t): investment that is taking place at the moment has an impact positively on wages, because if new machinery/software is used, employees must learn, at least at first, how to use them. So, they improve their skills and receive better salaries.
- Value added (t): once that productivity is improved, and employees realise that things are going well to the company, they ask for better salaries. So, value added

should have a positive impact on wages.

- Rents(t): if more retribution is given to the investors or owners of the capital, the company is less able to improve working conditions because a part of the profits are gone and cannot be distributed to the employees or reinvested into the company.
- Employment(t): If employment increases salaries should increase also, because if more people works on the sector, it should increase also the total amount paid.

Various combination of variables were tried, the following formulas are the best that were found. Its quality depends a bit on the country, but they result in a realistic view of the economy of the country.

$$Employment = z * Cons + \alpha * ICT\ Investment\ (t-1) + \beta * Valueadded(t) + \gamma * Rents(t) + e$$

$$Salaries = z * Const + \delta * ICT\ Investment\ (t-1) + \eta * ICT\ INvestment\ (t) + \rho * Valueadded(t) + \vartheta * Rents(t) + \xi * Employment(t) + e$$

5. Descriptive analysis: sectors' comparisons

Five different sectors: manufacturing, accommodation & food services, wholesale & retail, finance & insurance and information & communication; of a total of eight different countries: Spain, Germany, UK, USA, Sweden, France, Italy and Denmark; have been analysed to observe trends in ICT investment related to wages and employment rates.

ICT investment data has as reference 2010 level's, and is defined by OECD as:

> *"The acquisition of equipment and computer software that is used in production for more than one year. ICT has three components: information technology equipment (computers and related hardware); communications equipment; and software. Software includes acquisition of pre-packaged software, customized software and software developed in-house. This indicator is measured as a percentage of total non-residential gross fixed capital formation."*
>
> Source: OECD webpage: https://data.oecd.org/ict/ict-investment.html

Employment data is given on absolute values (number of people employed on a concrete sector or activity). This descriptive analysis will work with relative values to be able to see how employment rates have evolved. All employment data is divided by the number of people working on all sectors and activities, and multiplied by one hundred, so that the percentage of people working on a sector/activity given the number of total employees is revealed.

Wages levels are provided also by the total amount of national current units that it is paid in a sector or activity. With these numbers it is possible to get some misunderstandings, due to the fact of working with absolute numbers, for example: it is not the same to pay one million n.c.u. for a thousand employees than for one million. To obtain comparative data, the quantity paid to employees has been divided by the number of people who works on that sector or activity, to obtain the annual average wage in n.c.u.

5.1 Manufacturing: Employment and ICT Investment

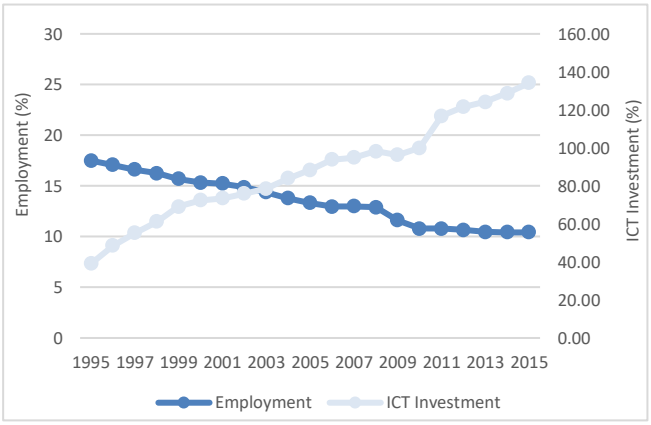

Figure 1 Manufacturing: Employment & ICT Investment. Denmark

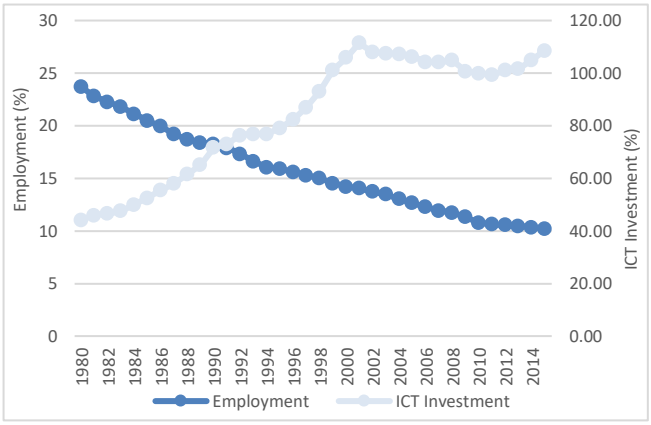

Figure 1 Manufacturing: Employment & ICT Investment. France

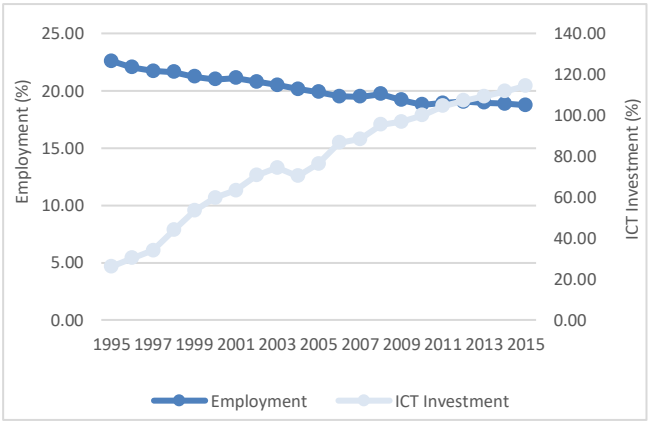

Figure 3 Manufacturing. Employment & ICT Investment. Germany

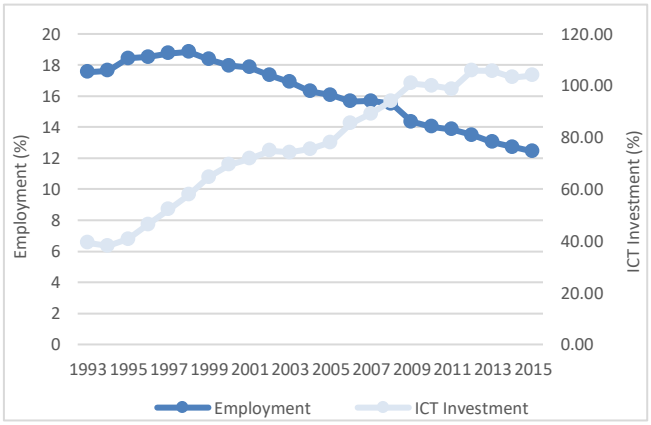

Figure 4 Manufacturing. Employment & ICT Investment. Sweden

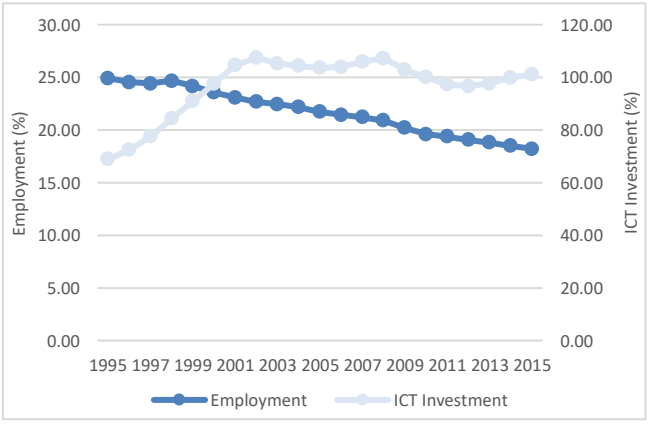

Figure 5 Manufacturing. Employment & ICT Investment. Italy

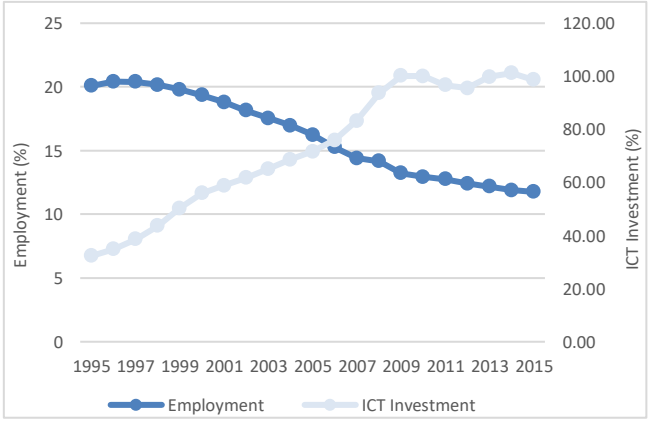

Figure 6 Manufacturing. Employment & ICT Investment. Spain

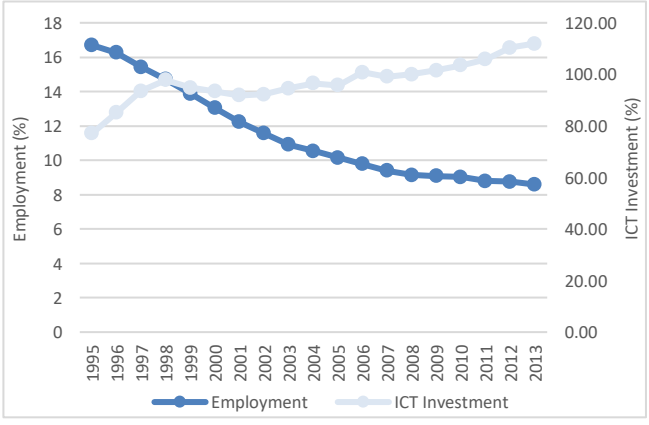

Figure 7 Manufacturing. Employment & ICT Investment. UK

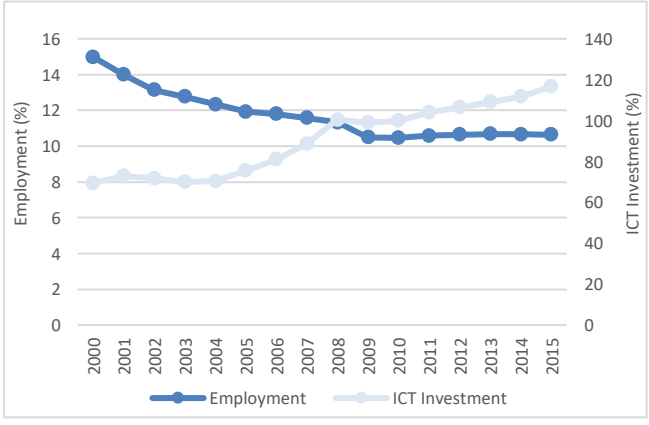

Figure 8 Manufacturing. Employment & ICT Investment. USA

Manufacturing sector includes activities such as: food processing, wood and paper products, chemical and rubber activities, production of electrical and machinery equipment, etc. Therefore, it could be said that this sector represents the secondary sector of any economy: industry.

All of eight countries show a decreased on the number of people employed on the sector of manufacturing. Most countries have experienced a loss of half of their jobs in manufacturing activities from the early nineties to nowadays. The 2007 financial and economic crisis did not had any important effect on this sector, as the global tendency on industrialized countries was to decreased the number of people employed and off-shore all the tasks that can be offshored (Goos, Manning and Salomons, 2014).

On the other hand, ICT investment has aroused. This investment does show some effect of the financial crisis in some countries (Spain, Italy, Sweden) but the trend is to invest constantly on this sector. So, it seems there is a negative correlation between ICT investment and people working on the secondary sector of the economy.

It is worth saying that the only three countries that show a bit slower decrease on employment are: Germany, USA and Italy. Countries that are known for their high-tech industry: the USA (not for their manufacturing processes but for their design and innovations), and Italy and Germany have a broad sector of assembling cars.

5.2 Manufacturing: Average wages and ICT Investment

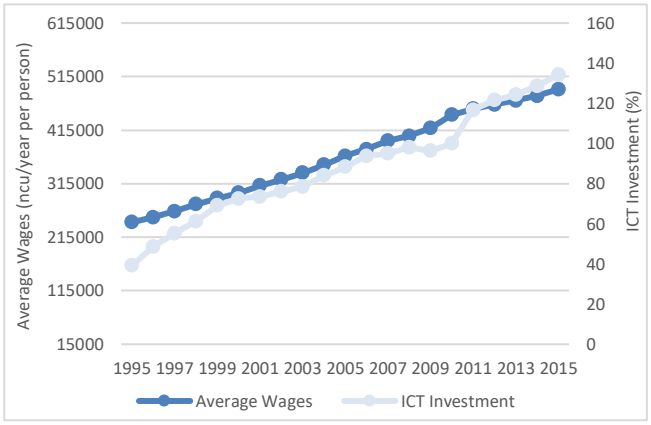

Figure 9 Manufacturing. Average Wages & ICT Investment. Denmark

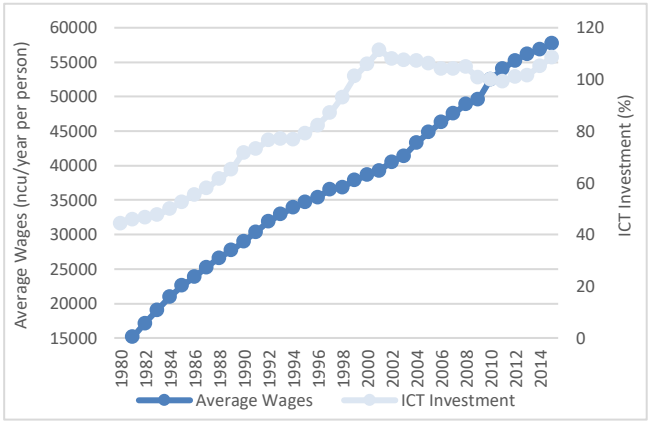

Figure 10 Manufacturing. Average Wages & ICT Investment. France

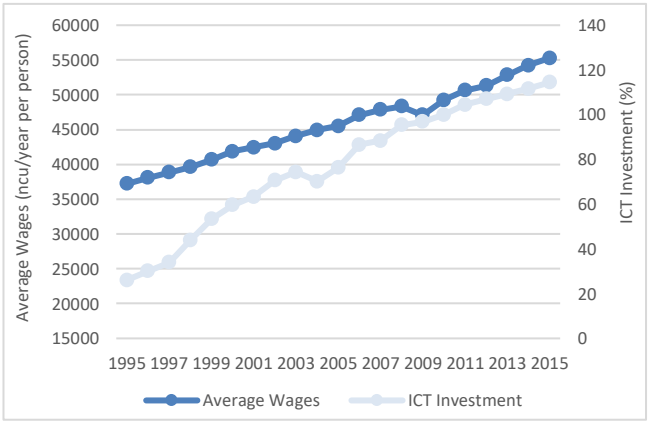

Figure 11 Manufacturing. Average Wages & ICT Investment. Germany

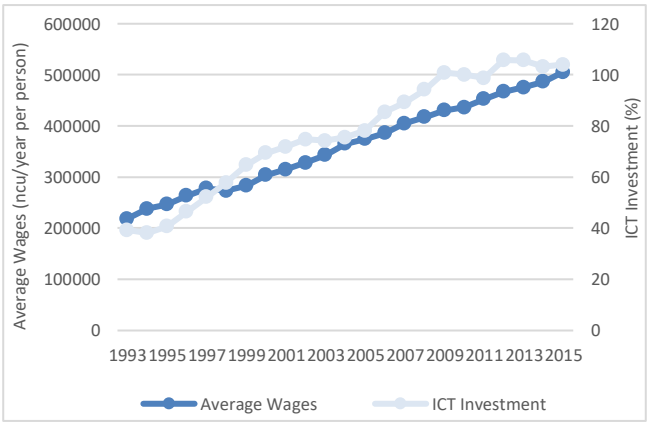

Figure 12 Manufacturing. Average Wages & ICT Investment. Sweden

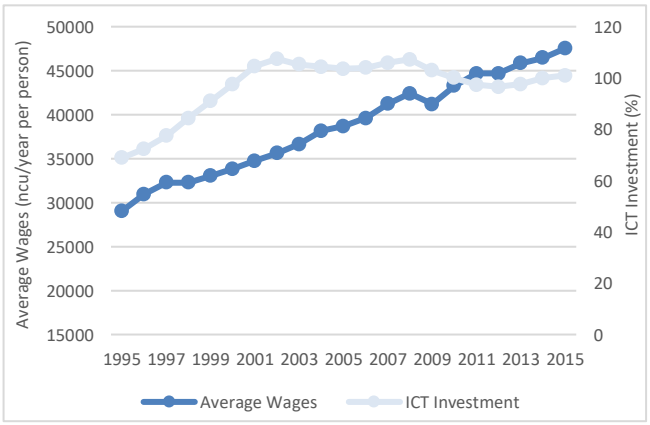

Figure 13 Manufacturing. Average Wages & ICT Investment. Italy

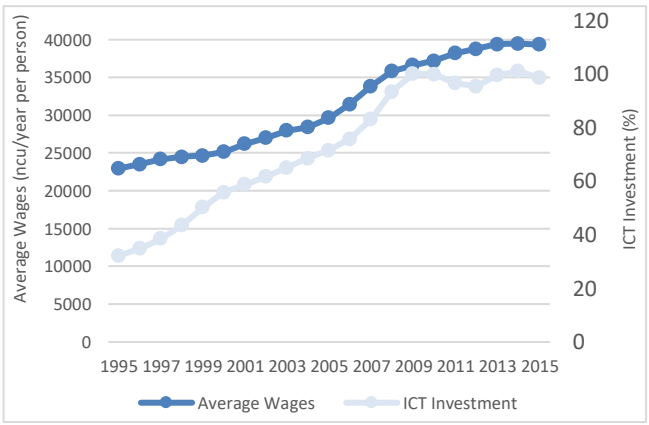

Figure 14 Manufacturing. Average Wages & ICT Investment. Spain

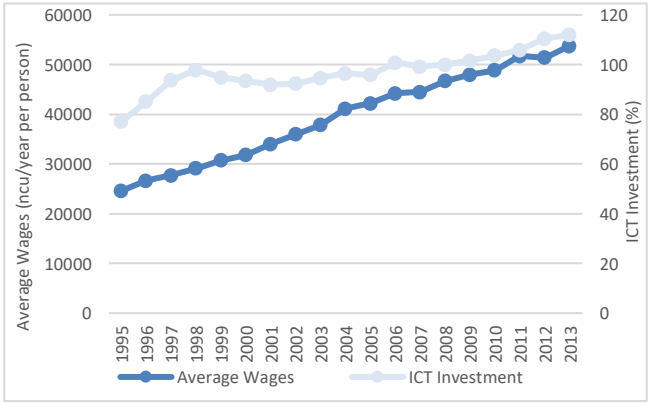

Figure 15 Manufacturing. Average Wages & ICT Investment. UK

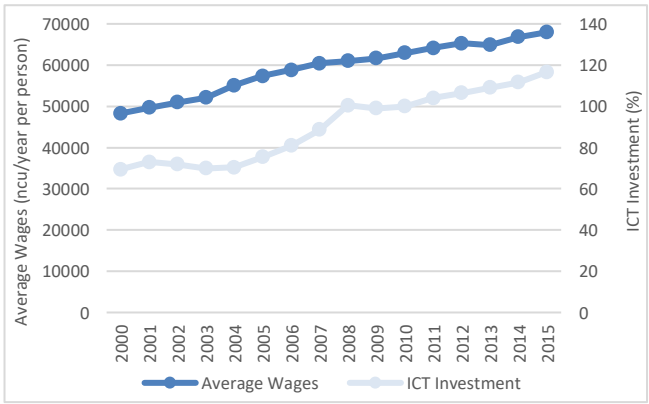

Figure 16 Manufacturing. Average Wages & ICT Investment. USA

In spite of the fact that labour market has lost almost half of the jobs on the secondary sectors, average wages have doubled, or almost doubled, their own value on the best scenarios (UK, Denmark, France, Sweden, Spain), and on other scenarios averages wages have increased by 50% their value (in countries such as Germany, USA and Italy).

This data shows that high-tech countries, where it is more difficult to substitute workers for computers or to automatize processes with the help of machines, have experienced a much lower increased on retribution. While those countries with highly substitutable tasks have fired those low-skill workers and those jobs that have remained on the sector present higher salaries due to their requirement of high-skill and non-routine tasks (Falck, Heimisch and Wiederhold, 2016).

Also, it is worth noting that this sector can be highly offshored, moving entire production lines to more affordable countries such as China or India is not difficult nowadays. In conclusion, it is more easy to move those activities that can be done at a much lower cost and that need almost no knowledge (Goos, Manning and Salomons, 2014).

5.3 Wholesale and Retail: Employment and ICT Investment

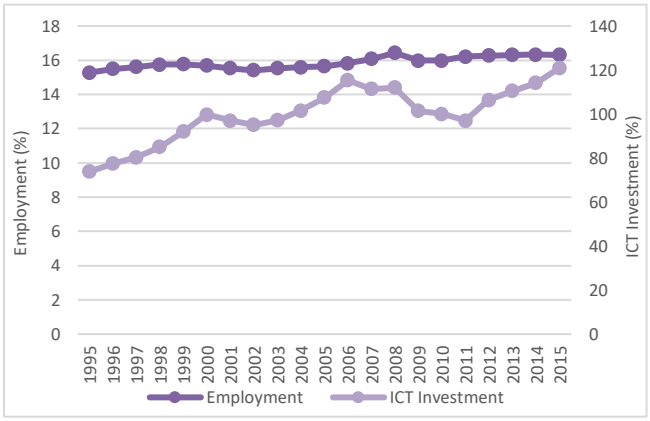

Figure 17 Wholesale & Retail. Employment & ICT Investment. Denmark

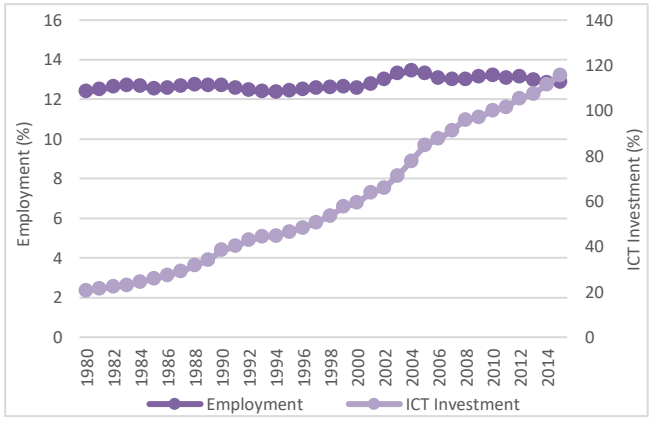

Figure 18 Wholesale & Retail. Employment & ICT Investment. France

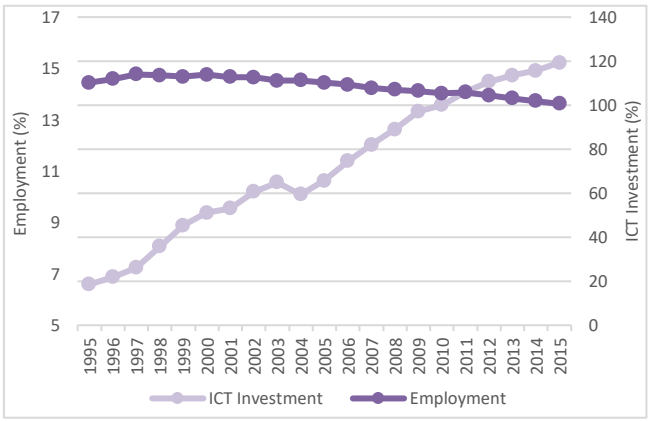

Figure 19 Wholesale & Retail. Employment & ICT Investment. Germany

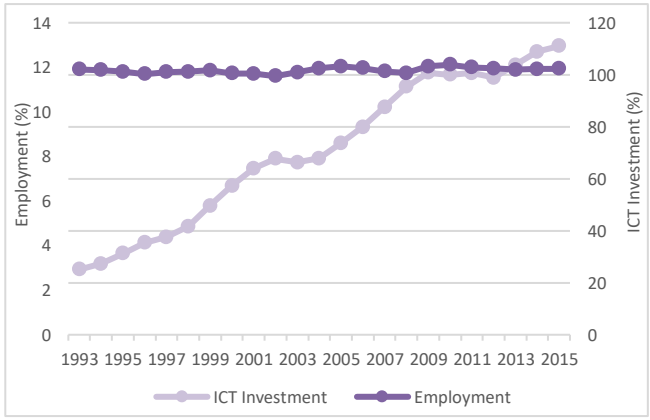

Figure 20 Wholesale & Retail. Employment & ICT Investment. Sweden

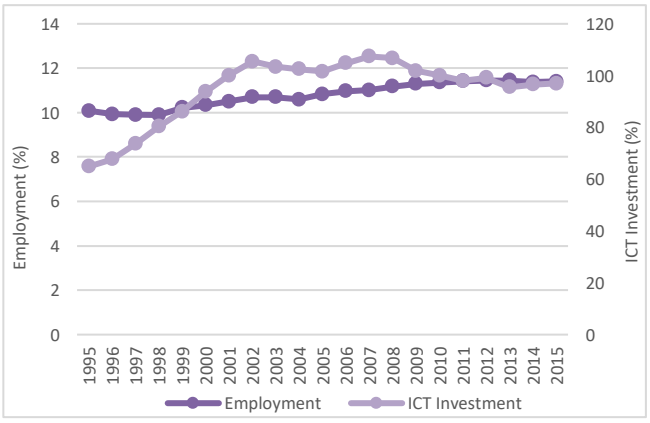

Figure 21 Wholesale & Retail. Employment & ICT Investment. Italy

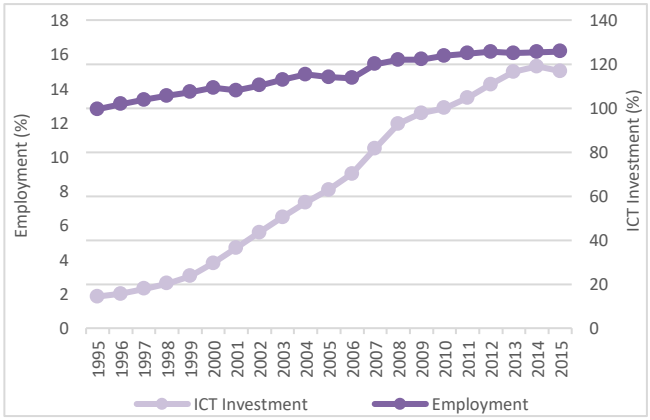

Figure 22 Wholesale & Retail. Employment & ICT Investment. Spain

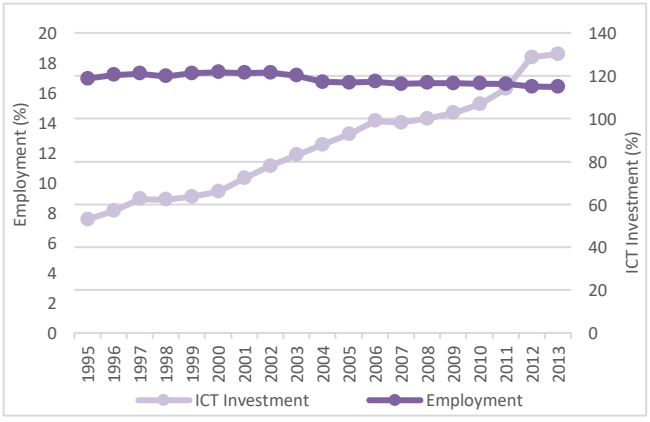

Figure 23 Wholesale & Retail. Employment & ICT Investment. UK

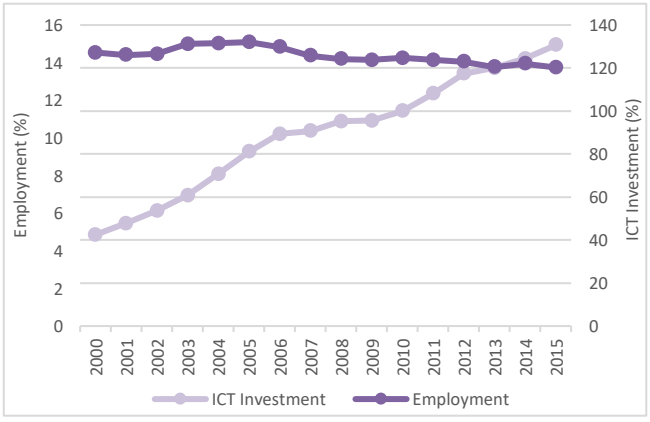

Figure 24 Wholesale & Retail. Employment & ICT Investment. USA

Wholesale and retail sector is defined by OECD data as those activities that have, as main focus, some type of commercial relationship, either it is between companies at a large scale or between shops and customers; such as commercial centres and distributors, with the exception of those transactions that involve motorcycles, cars, and also their repair services.

ICT investment has grown a lot since the early nineties in most countries, except Denmark and Italy, where it has been steady or with almost no growth.

Wholesale and retail, as accommodation and food services activities, have become one of the main sources of economic growth over the last years. Even though this fact, economic growth has not been transformed into a growing necessity of workers in the labour market. Employment has not increased; it has even decreased on some countries. This fact could be caused by the globalization of internet connections, and the creation of enormous virtual shopping centres and online shopping, which increased around 14% in 2017 according to the European E-commerce Report 2017.

The evidence that online shopping is increasing very fast, 77% of business with more than 10 employees have a webpage; and that more than 80% of the population of countries such as UK, Germany and Denmark buy online, support the idea of the shift from physical retails to online ones.

As a consequence of these facts, is it clear that ICT investment has not caused an employment increase due to the fact that this investment substitutes the need of creation of physical stores with employees, and all can be done through one location, such as a logistic centre.

5.4 Wholesale and Retail. Average Wages and ICT Investment

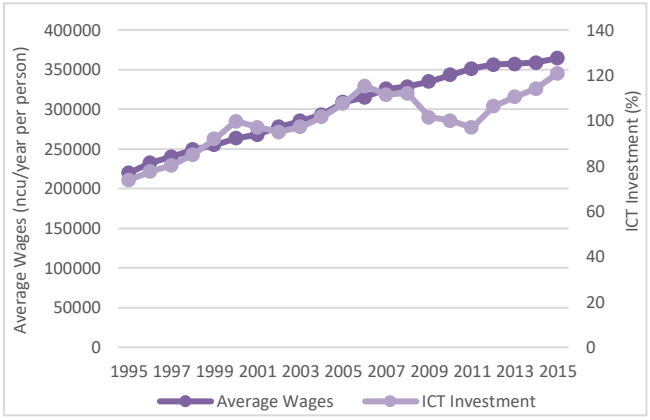

Figure 25 Wholesale & Retail. Average Wages & ICT Investment. Denmark

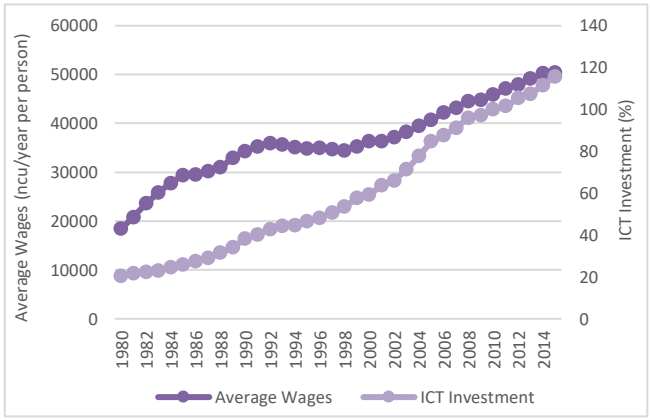

Figure 26 Wholesale & Retail. Average Wages & ICT Investment. France

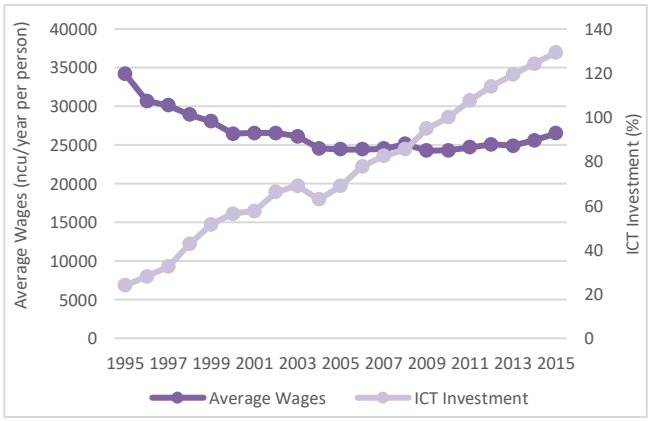

Figure 27 Wholesale & Retail. Average Wages & ICT Investment. Germany

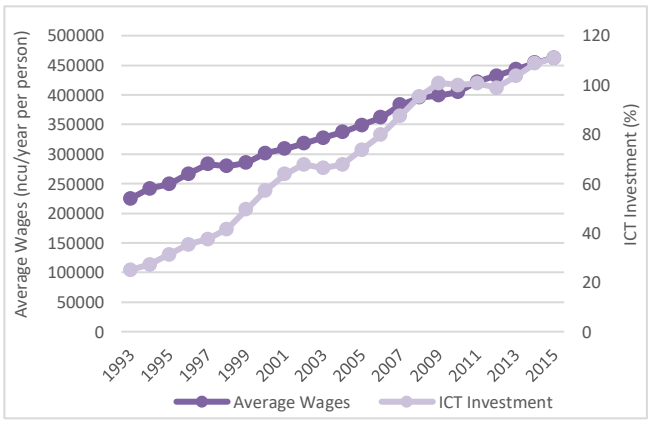

Figure 28 Wholesale & Retail. Average Wages & ICT Investment. Sweden

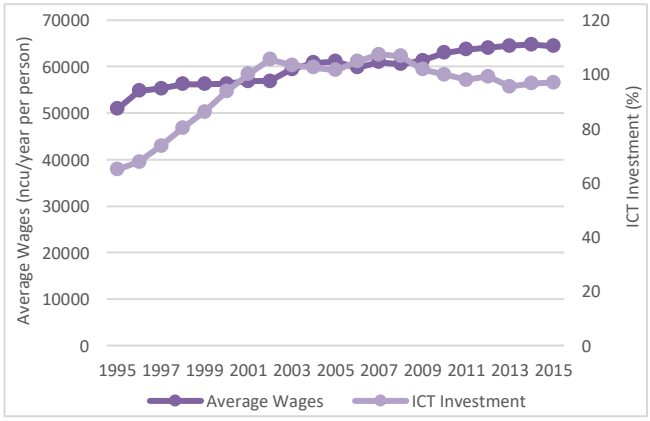

Figure 29 Wholesale & Retail. Average Wages & ICT Investment. Italy

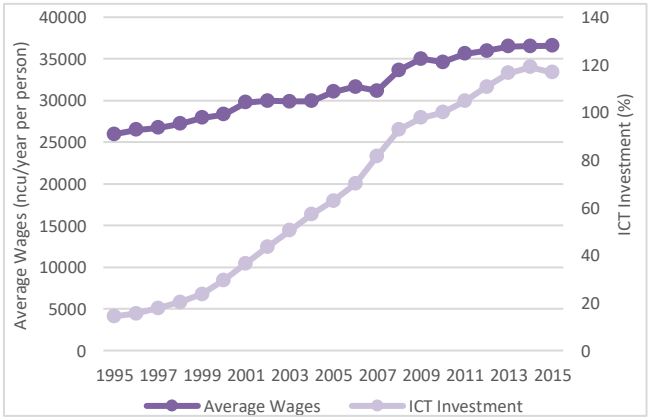

Figure 30 Wholesale & Retail. Average Wages & ICT Investment. Spain

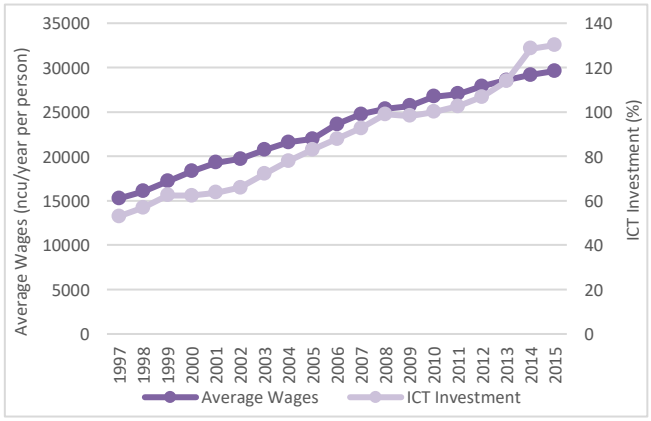

Figure 31 Wholesale & Retail. Average Wages & ICT Investment. UK

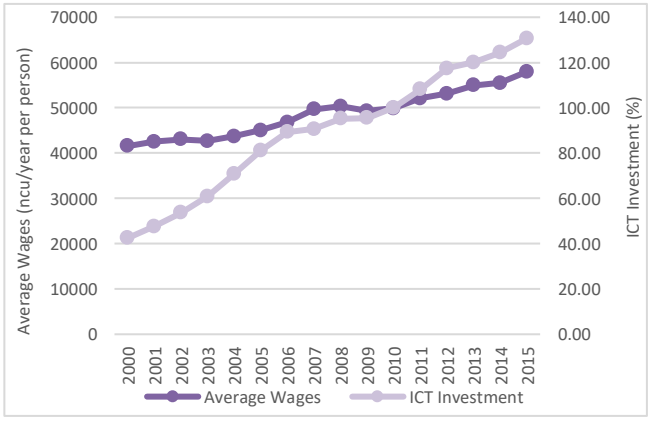

Figure 32 Wholesale & Retail. Average Wages & ICT Investment. USA

Wholesale and retail wages do have a positive trend, but in comparison with, for example, manufacturing salaries, this trend is different depending on the country that is observed. It is not possible to spot a clear positive trend. There are countries such as Germany, France, Italy and Spain, where remuneration' growth is very steady since the late nineties. However, if all countries are observed, once ICT investment increases heavily, average retribution start slowing down their increases.

Due to differences observed in some countries' average remuneration on wholesale and retail, this data must be observed and compared with other activities of the economy. Through this observation it will be possible to determine how average wages have increased in comparison with other sectors of the economy of the same country, therefore, be possible to catch a trend in this sector. For example: if in Sweden wholesale's averages salaries have doubled themselves, but all other wages' sectors have multiplied themselves for three, it is clear that ICT investment has caused this gap between it and manufacturing for example.

5.5 Accommodation and food services. Employment and ICT investment

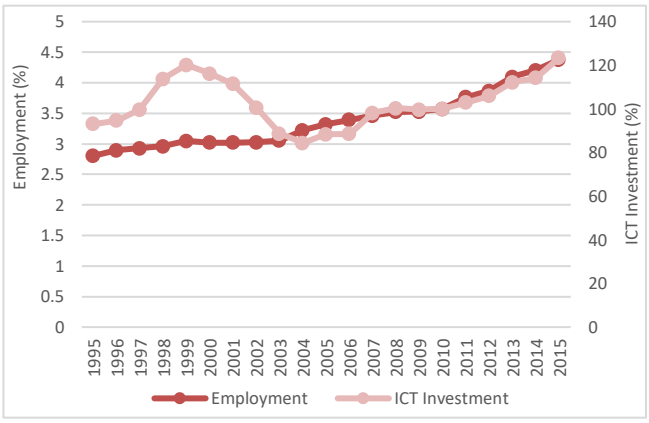

Figure 33 Accommodation & Food Serv. Employment & ICT Investment. Denmark

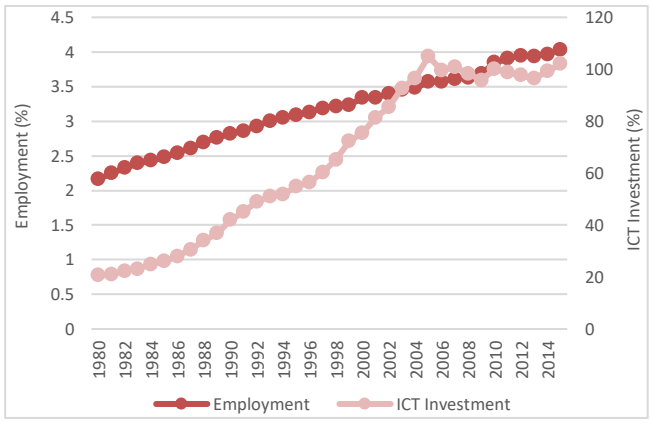

Figure 34 Accommodation & Food Serv. Employment & ICT Investment. France

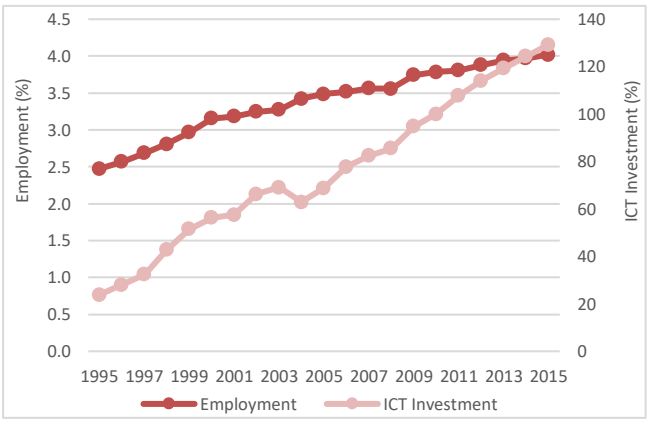

Figure 35 Accommodation & Food Serv. Employment & ICT Investment. Germany

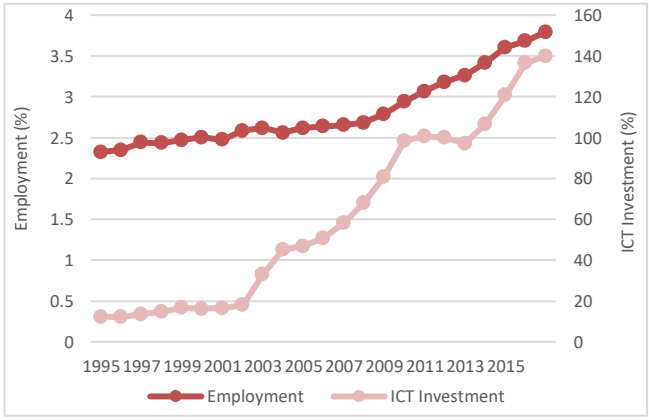

Figure 36 Accommodation & Food Serv. Employment & ICT Investment. Sweden

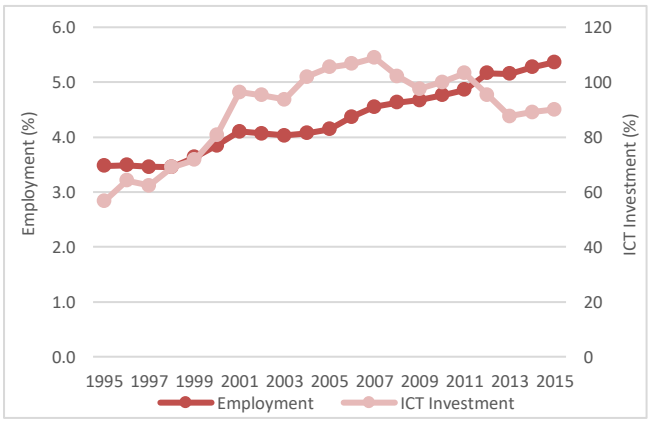

Figure 37 Accommodation & Food Serv. Employment & ICT Investment. Italy

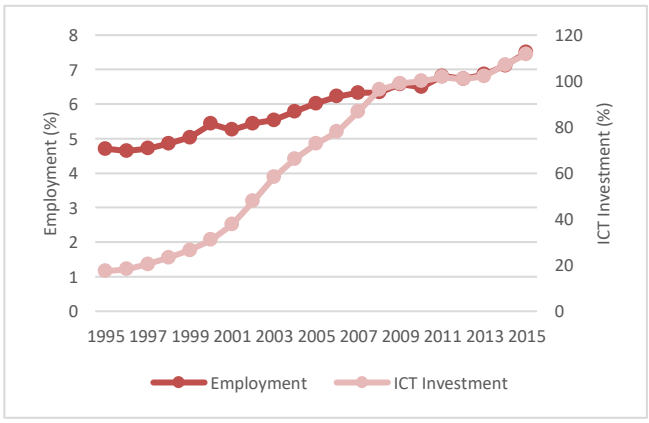

Figure 38 Accommodation & Food Serv. Employment & ICT Investment. Spain

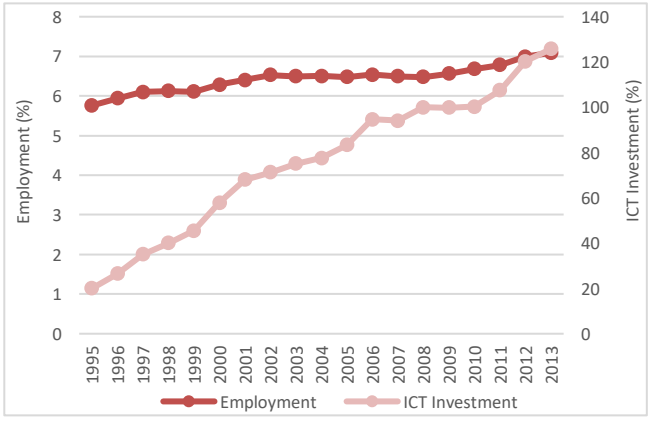

Figure 39 Accommodation & Food Serv. Employment & ICT Investment. UK

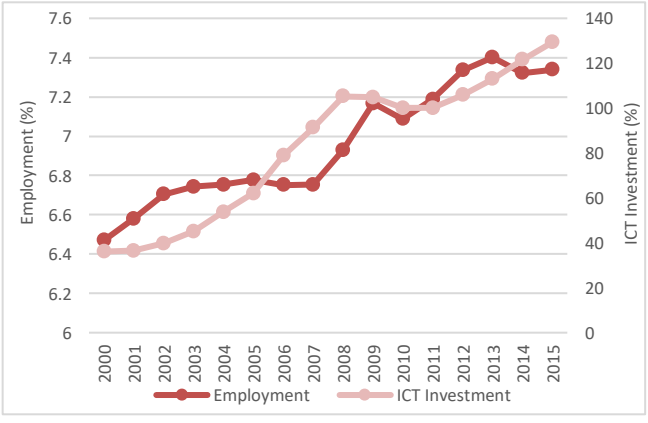

Figure 40 Accommodation & Food Serv. Employment & ICT Investment. USA

Accommodation and food services is another part of the tertiary sector. It is defined by those activities that involve tourism: hotels, hostels, campings, restaurants, bars, pubs, and other tourism establishments that serve drinks and food which are prepared to be eaten at the moment that is bought and requires no post preparation.

On these activities it is clear that employment has aroused, doubling the quantity of people employed, from around two percent of the population to employ around four percent of the population. On the scenarios where these activities employed around four percent of the population, the employment has increased fifty percent.

As the "European Parliamentary Research Service" report about tourism indicated (Juul, 2015) tourism is the third most important activity on European economies, that is the reason why employment has been following a positive trend during the last decades. But this does not explain why, for example, manufacturing activities have lost ten percent of the employment, and tourism, the third most important economic activity has only increased around two percent on employment.

This peculiar fact could be explained by ICT Investment, which has grown extremely quickly since the late nineties on most countries, going from almost no investment to being one of the most invested activities. The expansion of internet services paved the way to more centralized ways to book accommodation, erasing a great quantity of travel agencies. Also, some services at hotels can be managed more effectively thanks to apps or services that use data to analyse how people work and what would be the best to save money or resources.

Also, it is important to note that these activities are mostly seasonal, and only are on their maximum levels during holidays (summer or winter for some activities).

5.6 Accommodation and food services. Average wages and ICT Investment

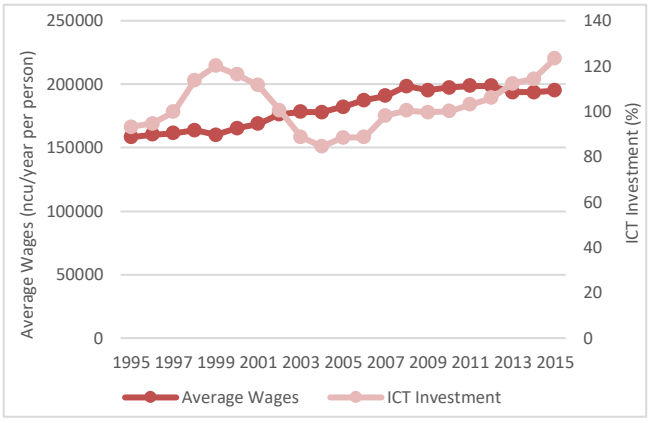

Figure 41 Accommodation & Food Serv. Average Wages & ICT Inv. Denmark

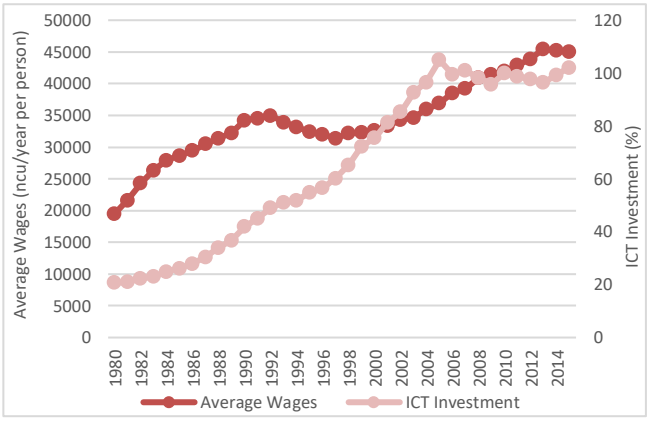

Figure 42 Accommodation & Food Serv. Average Wages & ICT Inv. Denmark

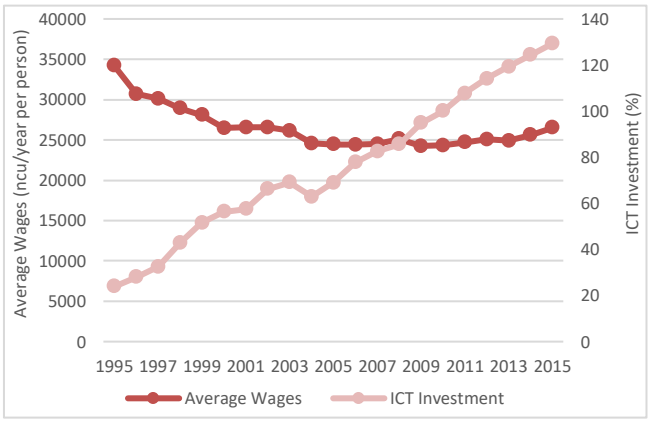

Figure 43 Accommodation & Food Serv. Average Wages & ICT Inv. Germany

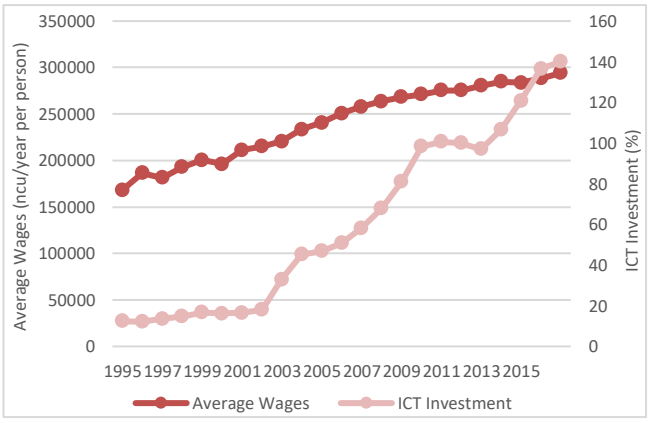

Figure 44 Accommodation & Food Serv. Average Wages & ICT Inv. Sweden

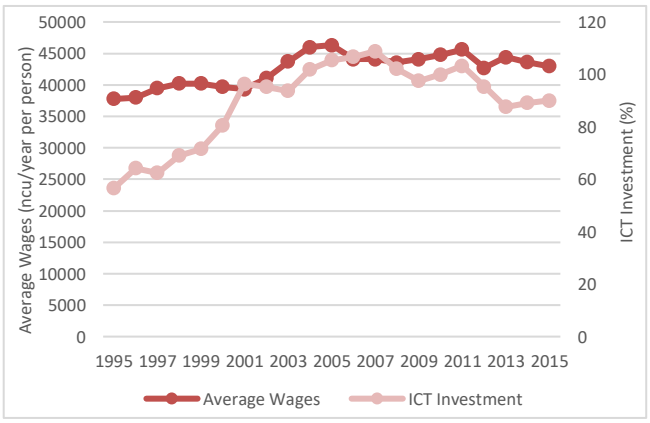

Figure 45 Accommodation & Food Serv. Average Wages & ICT Inv. Italy

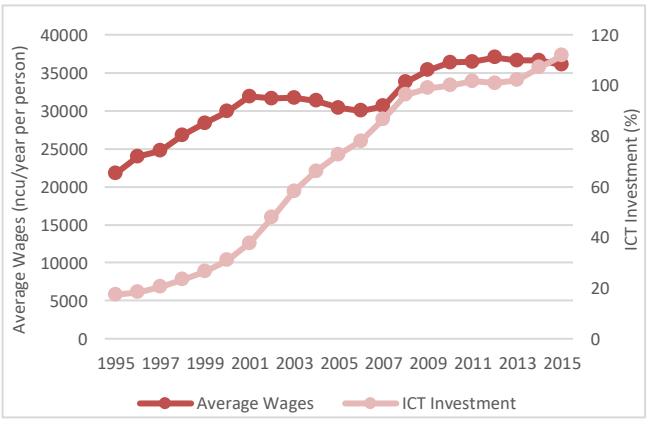

Figure 46 Accommodation & Food Serv. Average Wages & ICT Inv. Spain

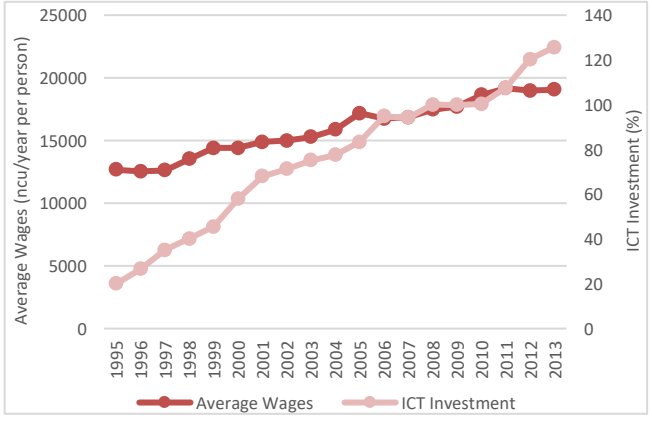

Figure 47 Accommodation & Food Serv. Average Wages & ICT Inv. UK

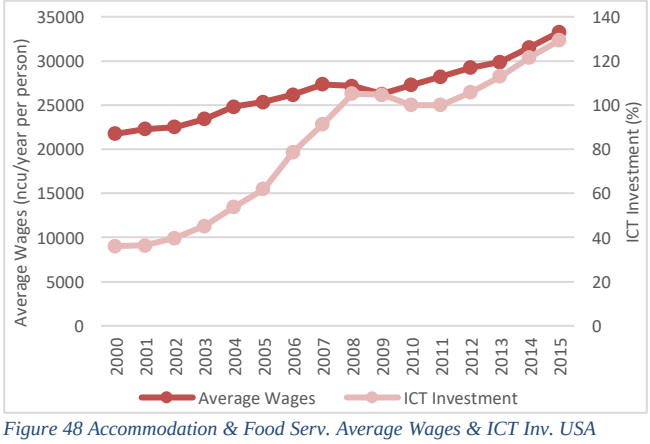

Figure 48 Accommodation & Food Serv. Average Wages & ICT Inv. USA

Accommodations and food service activities do not show a clear tendency on all countries. Three countries show almost zero growth or negative growth on salaries, while three others show clear periods where wages did decrease, only two countries show a clear positive trend.

A fact that can be observed is that when ICT investment increases a lot, salaries tend to slow down and keep steady during that period, and when ICT investment decreases, wages tend to increase. These moments are shown in, for example, Spain between the 2001 and 2007 (*Figure 46*), in Denmark between 1999 and 2005 (*Figure 41*), and in UK between 2009 and 2013 (*Figure 47*).

This fact could be the result of the patrons that these businesses show when they have to invest money. As found by this study focused on Slovenian hotels (Mihaliča, Praničević and Arnerić, 2015), businesses on accommodation sector tend to wait until they decide to invest in some new technology, which is studied to analyse their benefits and their costs.

Therefore, it could be that ICT investment in this sector does not mean an increases in salaries; when businesses invest in ICT, employees have no increase in their retribution, while when there is no investment, employees tend to earn more money. So, profits from these activities are canalised into investment or wages, but it does not seem that ICT investment creates better salaries on employees.

5.7 Information and communication. Employment and ICT Investment

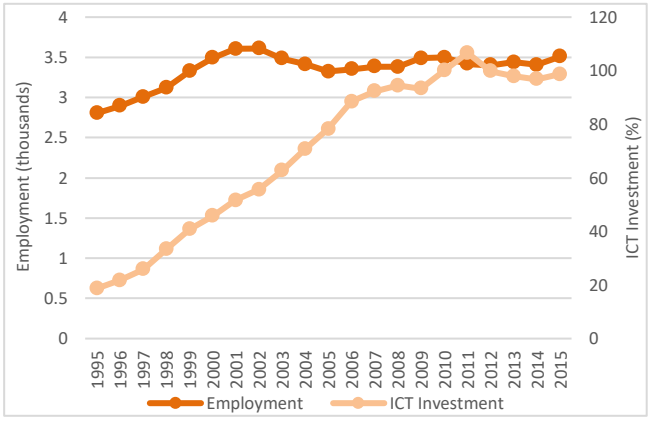

Figure 49 Information & communication. Employment & ICT Inv. Denmark

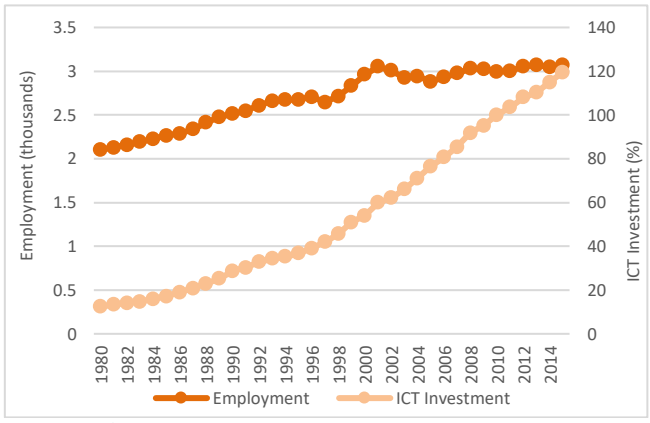

Figure 50 Information & communication. Employment & ICT Inv. France

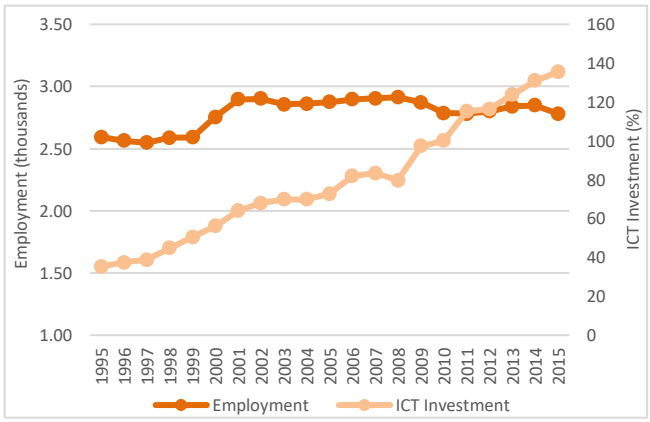

Figure 51 Information & communication. Employment & ICT Inv. Germany

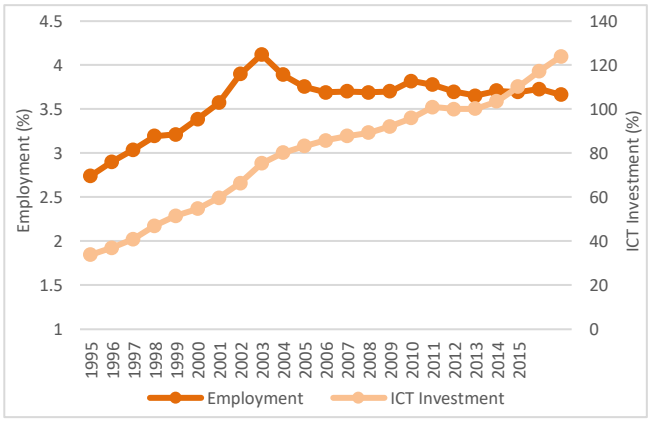

Figure 52 Information & communication. Employment & ICT Inv. Sweden

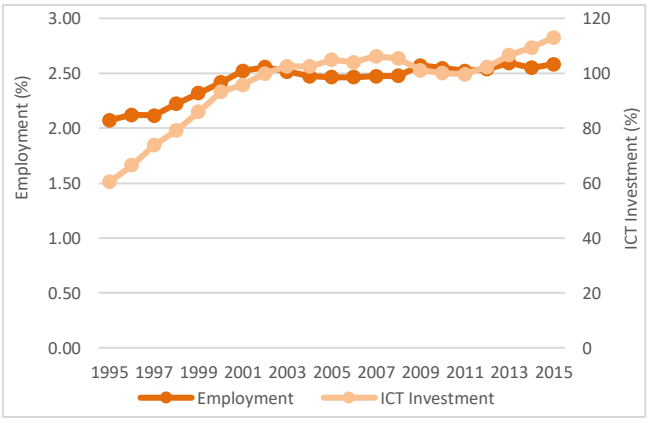

Figure 53 Information & communication. Employment & ICT Inv. Italy

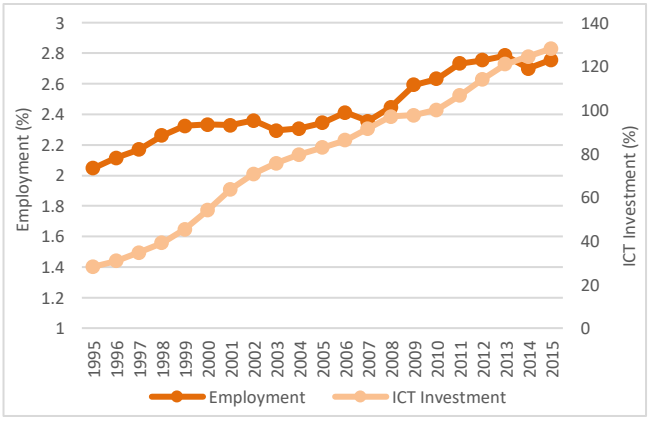

Figure 54 Information & communication. Employment & ICT Inv. Spain

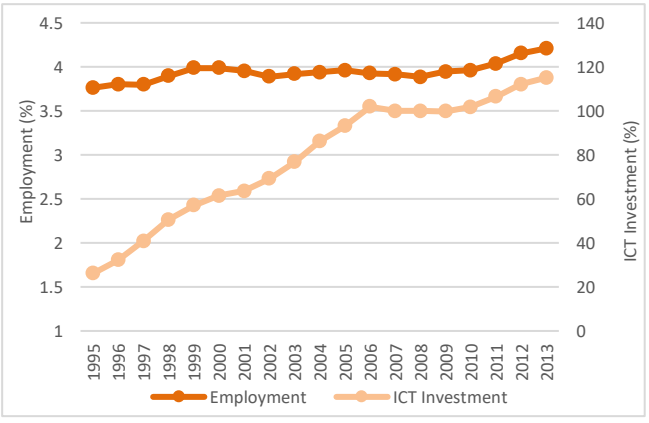

Figure 55 Information & communication. Employment & ICT Inv. UK

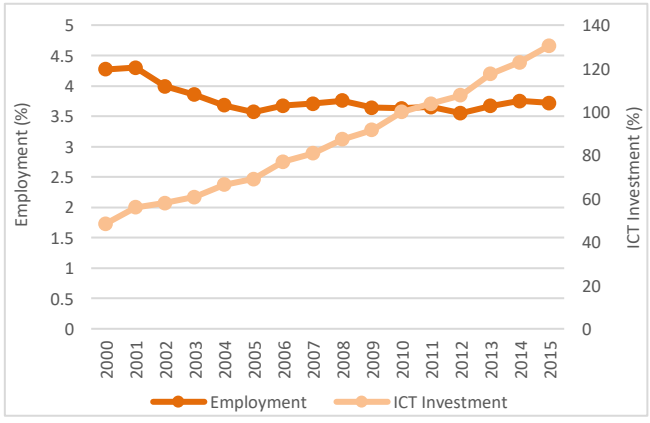

Figure 56 Information & communication. Employment & ICT Inv. USA

Information and communication activities are defined by:

> *"The production and distribution of information and cultural products, the provision of the means to transmit or distribute these products as well as data or communications, information technology activities, and the processing of data and other information service activities"*

Source: Eurostat. Statics Explained

These activities include publishing, programming, consultancy, broadcasting, data processing, hosting, recording…

As it can be seen, employment has, in the best scenarios, aroused around fifty percent from the mid-nineties to 2015. But it has mostly been steady around two and three percent of the total working population of every country.

On the other hand, ICT investment at the contrary has increased a lot, almost an exponential growth. These activities are grounded on technology, so it is normal that investment presents high levels of expenditures. Spend on new technologies and devices is necessary to maintain their competiveness, and also explains that more people is not employed as a consequence of this investment, because new processes and new machinery and technologies allow to do the same or more advanced technics with the same number of people.

5.8 Information and communication. Average wages and ICT investment

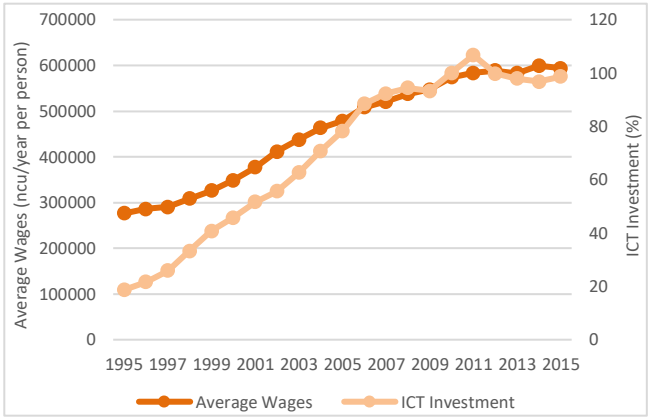

Figure 57 Information & communication. Average wages & ICT Inv. Denmark

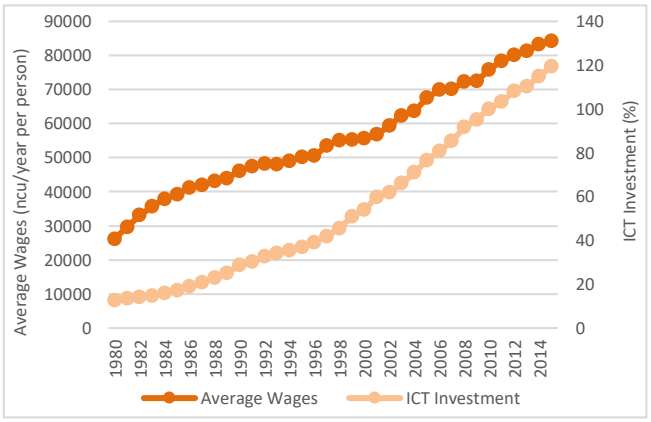

Figure 58 Information & communication. Average wages & ICT Inv. France

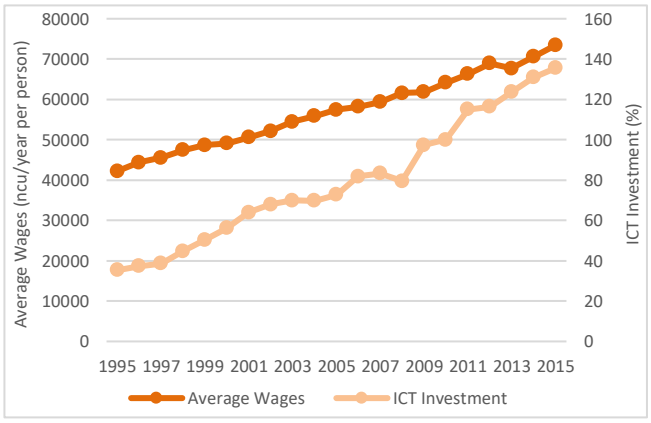

Figure 59 Information & communication. Average wages & ICT Inv. Germany

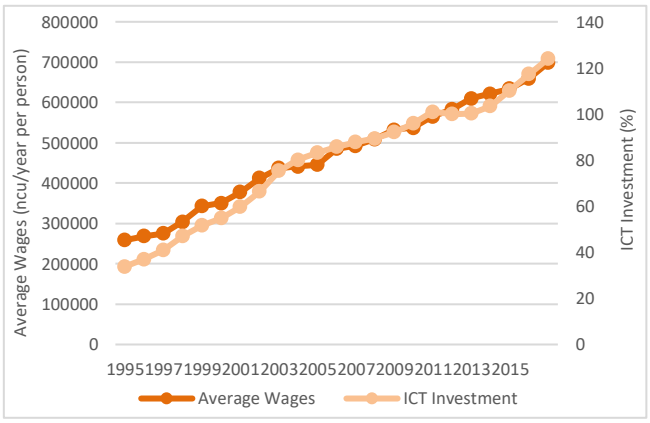

Figure 60 Information & communication. Average wages & ICT Inv. Sweden

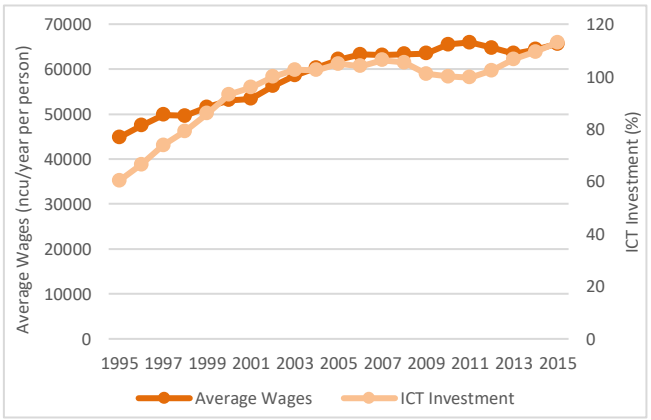

Figure 61 Information & communication. Average wages & ICT Inv. Italy

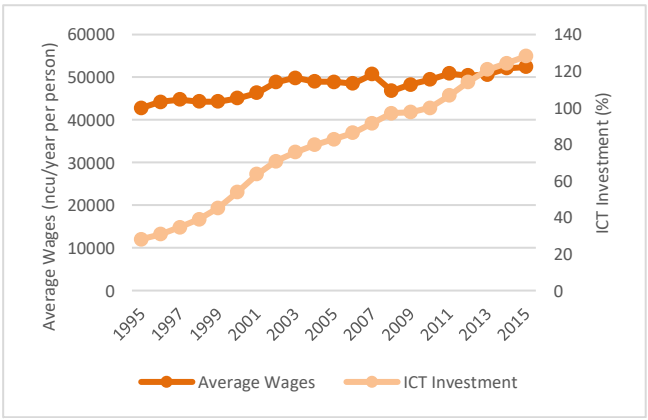

Figure 62 Information & communication. Average wages & ICT Inv. Spain

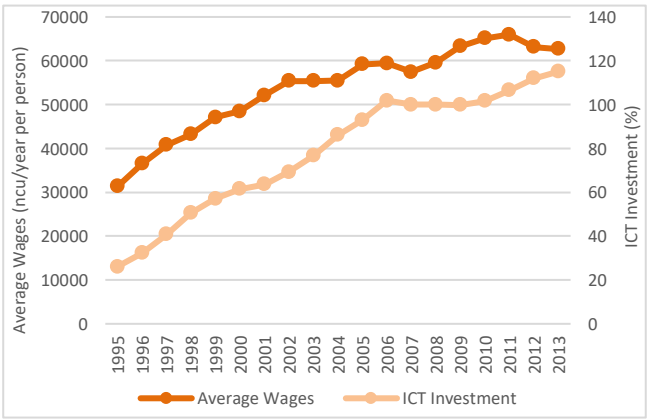

Figure 63 Information & communication. Average wages & ICT Inv. UK

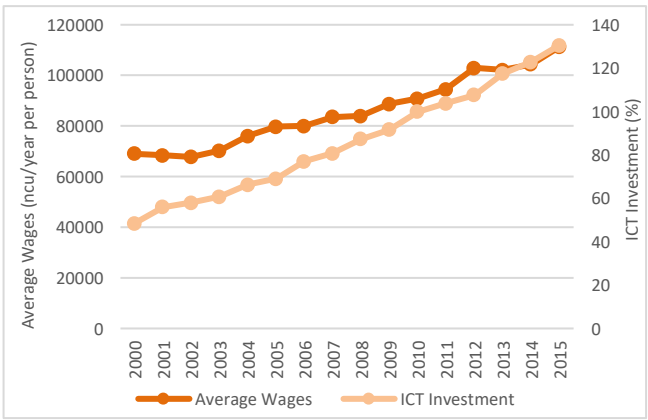

Figure 64 Information & communication. Average wages & ICT Inv. USA

Even though employment rates have been steady, average wages have doubled themselves on all countries (except Spain and Italy). Averages salaries have followed the positive trend as ICT investment has, as salaries do follow the pattern shown by information and communication technologies expenditures'.

If some processes can be automatized, allowing people to explore and dedicate their time to more complex functions, it is supposed that employees should have better salaries that reflect this more complex and high-skilled work.

It is also important, as with other sectors, to look at the global image of how much is people paid on these activities in comparison with other sectors. Only through this analysis it will be possible to see at a glance how this sector evolving compared to other activities.

5.9 Finance and insurance. Employment and ICT investment

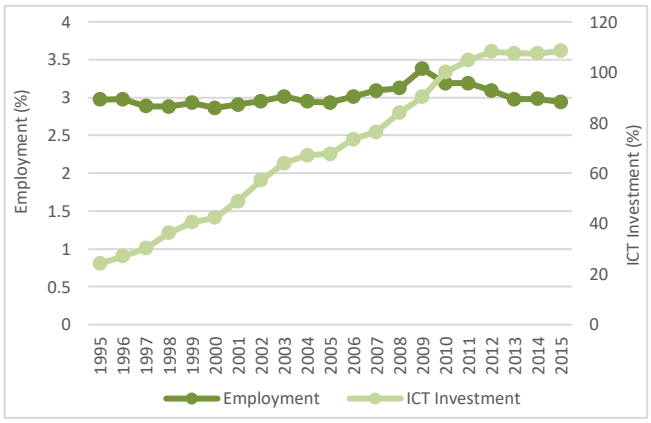

Figure 65 Finance and insurance. Employment & ICT Investment. Denmark

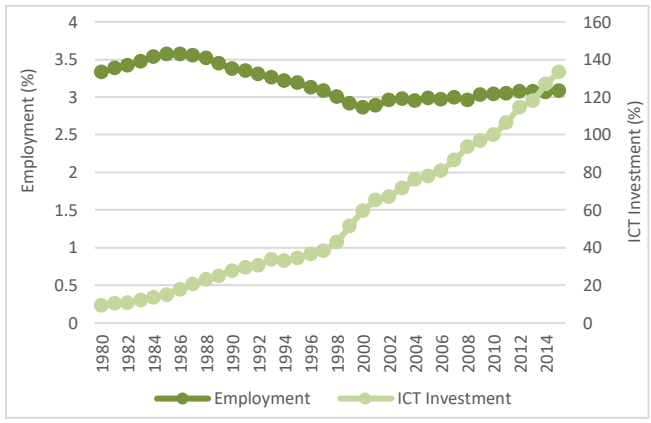

Figure 66 Finance and insurance. Employment & ICT Investment. France

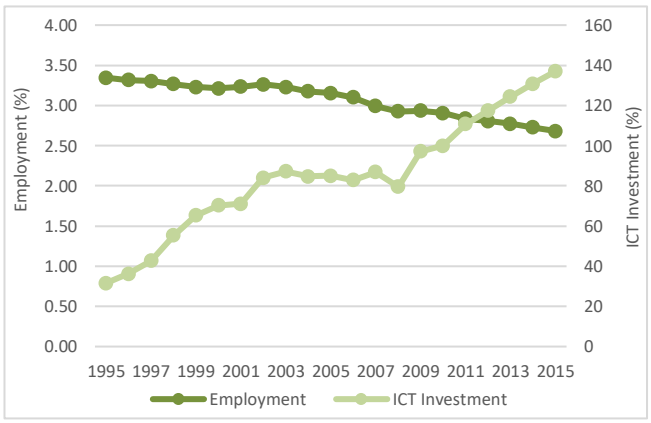

Figure 67 Finance and insurance. Employment & ICT Investment. Germany

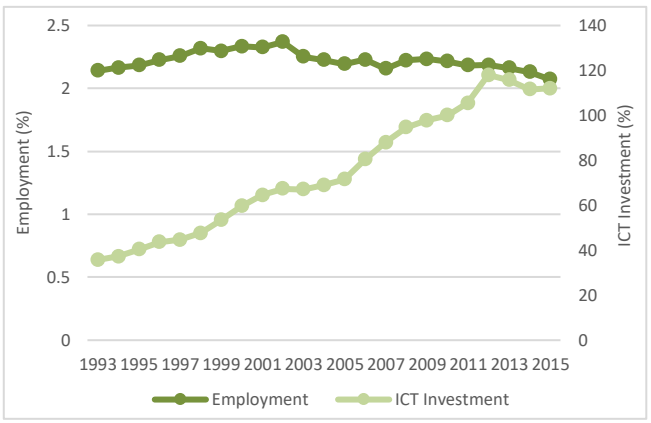

Figure 68 Finance and insurance. Employment & ICT Investment. Sweden

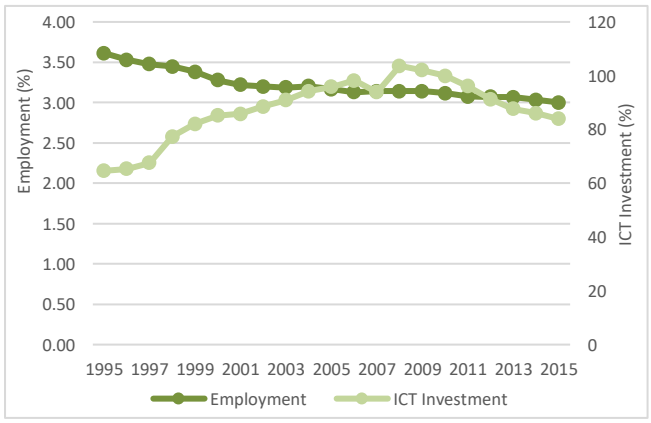

Figure 69 Finance and insurance. Employment & ICT Investment. Italy

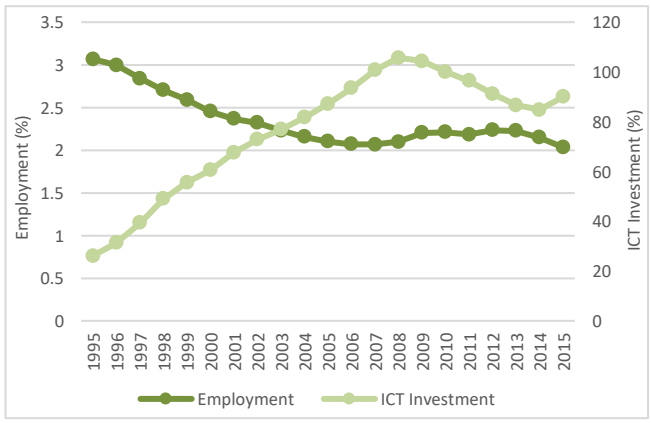

Figure 70 Finance and insurance. Employment & ICT Investment. Spain

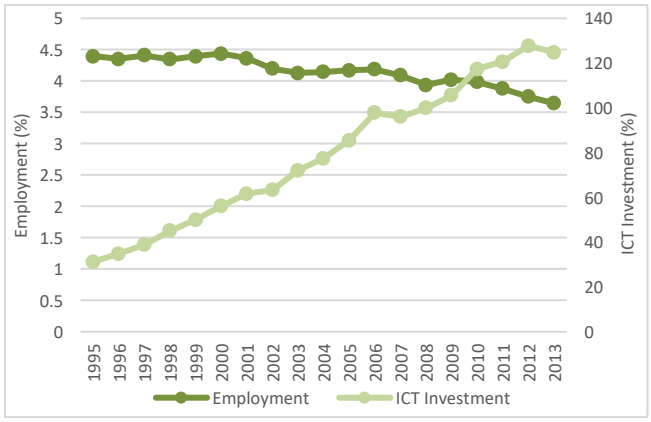

Figure 71 Finance and insurance. Employment & ICT Investment. UK

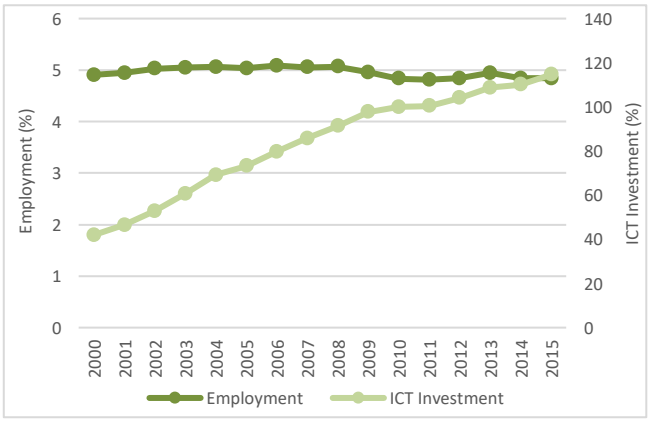

Figure 72 Finance and insurance. Employment & ICT Investment. USA

Financial and insurance activities are defined as those activities that involve financial intermediation, such as credits, loans, derivatives, financial leasing, funds, insurances (home, wealth, death, goods…) and pensions; and also brokers and other activities related to managing money.

This sector has experienced a decreased in employment rates, but its decline is not as clear as other activities or sectors because of the fact that people employed only represents around two or three percent of the working population.

On the other hand, ICT investment has maintained a positive trend during the years recorded by OECD data, except those countries such as Spain or Italy where investment decreases due to the financial crisis that started in 2007.

It is clear then, that these different activities have a very weak negative relationship between employment and ICT investment, as *The World Bank Group* declared on an article (The World Bank Group, 2015), even though these jobs are extremely important, the creation of new jobs is very slow and low. A clear example can be found in insurance activities': aggregators of insurances and other financial services have allowed people to search for different insurances without moving from their homes or asking anyone by telephone. The same scenario can be found on financial activities, *fintechs*, online banks, have appeared and have attracted young people that want to be able to manage all their accounts and money through their smartphone.

So, as more investment is done in this sector, more traditional businesses will disappear, and technology will replace some jobs that can be automatized, while creating some new ones.

5.10 Finance and insurance. Average wages and ICT investment

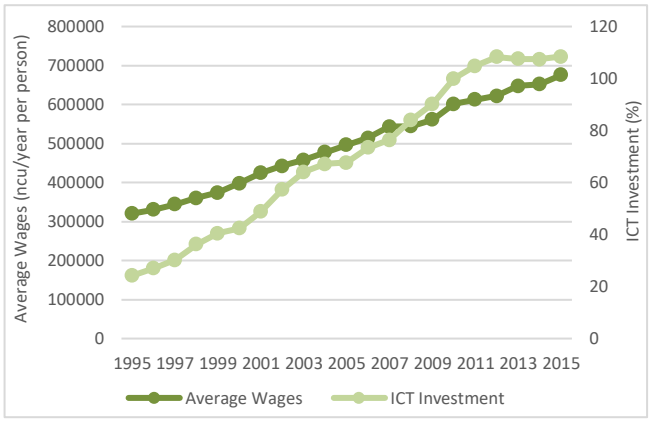

Figure 73 Finance and insurance. Average wages & ICT Investment. Denmark

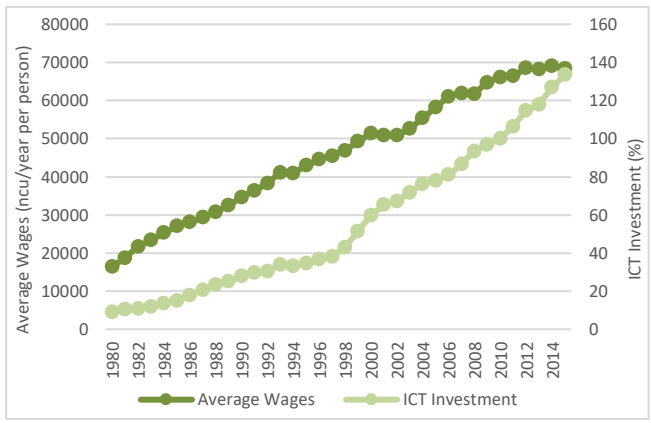

Figure 74 Finance and insurance. Average wages & ICT Investment. France

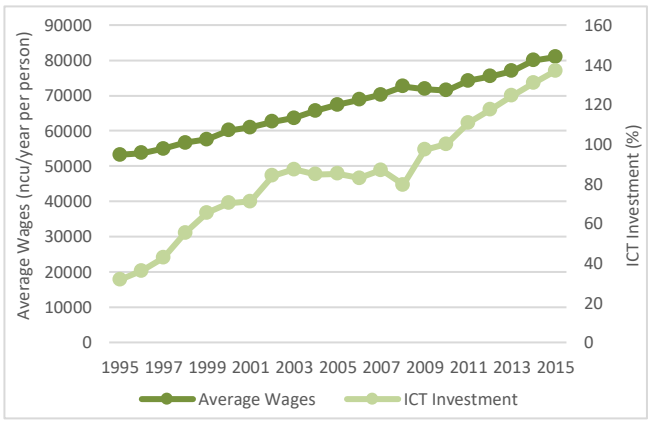

Figure 75 Finance and insurance. Average wages & ICT Investment. Germany

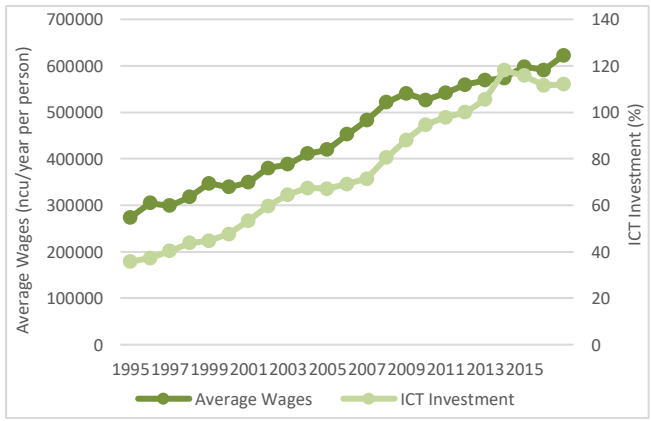

Figure 76 Finance and insurance. Average wages & ICT Investment. Sweden

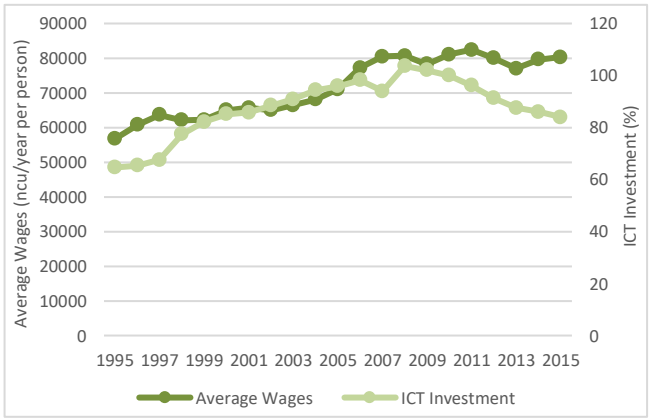

Figure 77 Finance and insurance. Average wages & ICT Investment. Italy

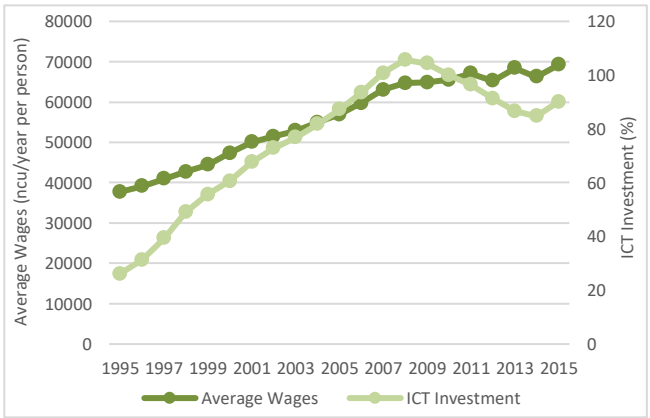

Figure 78 Finance and insurance. Average wages & ICT Investment. Spain

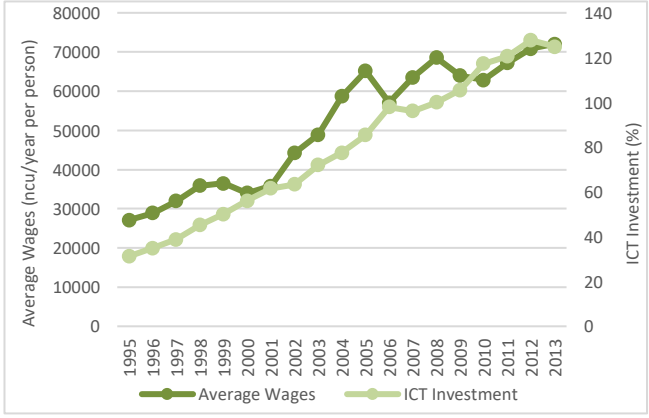

Figure 79 Finance and insurance. Average wages & ICT Investment. UK

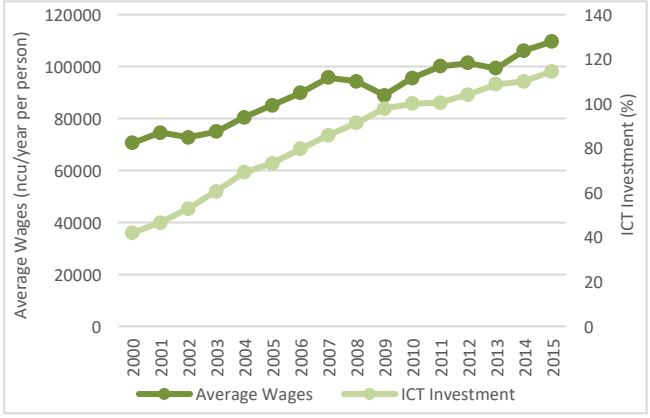

Figure 80 Finance and insurance. Average wages & ICT Investment. USA

Even though employment rates have been falling in a slow trend, average wages have doubled, or almost doubled themselves on most countries. Average retribution has followed the positive trend as ICT investment has had. Average wages do follow the same trend as ICT expenditures.

If most processes can be automatized or digitalized so that people are no longer needed, less people will be employed, and some will lose their jobs. Those who are able to maintain it will dedicate more time to more complex functions, more non-manual non-repetitive tasks. Therefore, it is supposed that these employees should have better salaries that reflect this more complex and high-skilled work.

It is also important, as with other sectors, to look at the global image of how much money is people earning in these activities in comparison with all the other sectors, so that it is possible to know how this sector is improving or how it is degrading.

5.11 ICT Investment per country

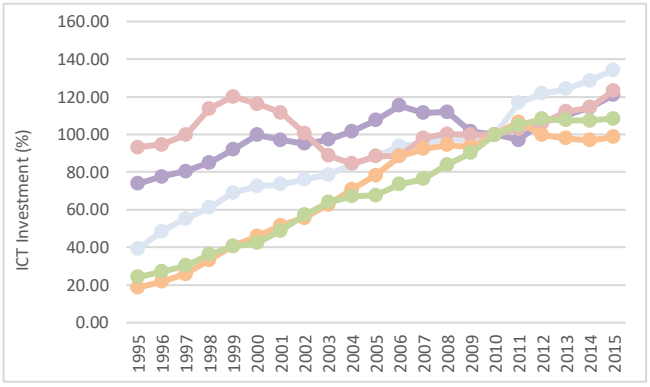

Figure 81 ICT Investment in Denmark

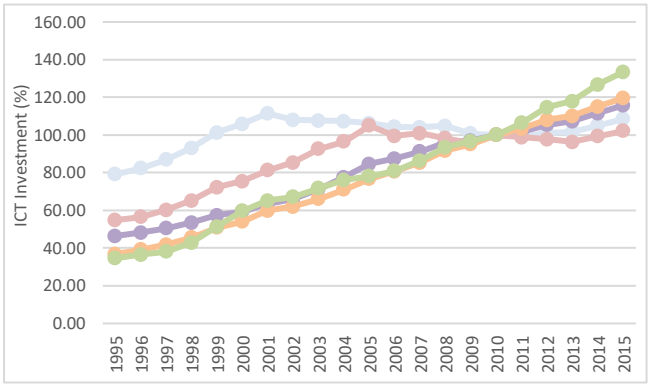

Figure 82 ICT Investment in France

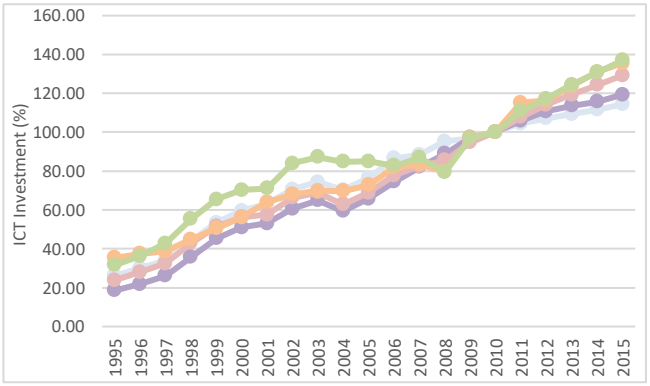

Figure 83 ICT Investment in Germany

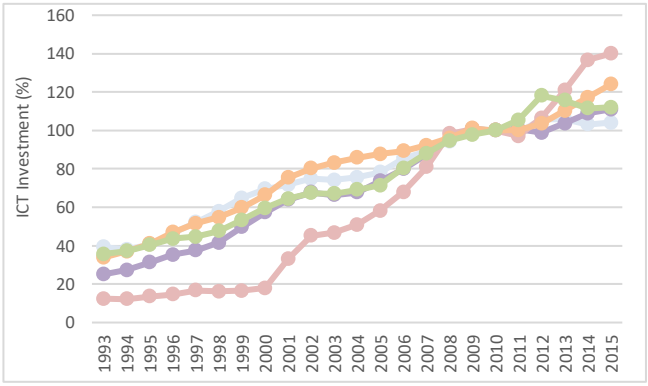

Figure 84 ICT Investment in Sweden

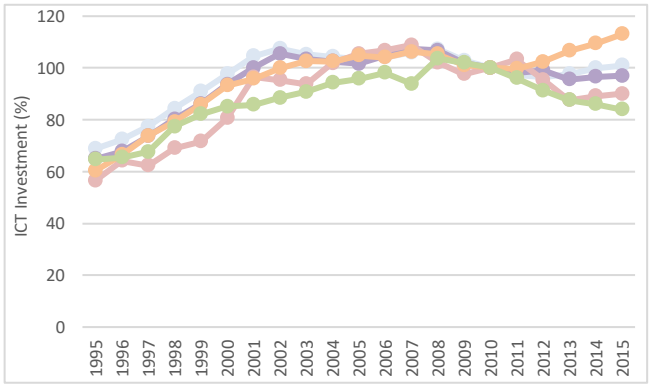

Figure 85 ICT Investment in Italy

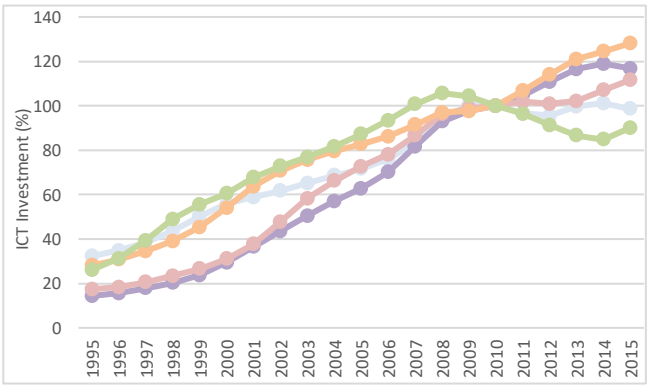

Figure 86 ICT Investment in Spain

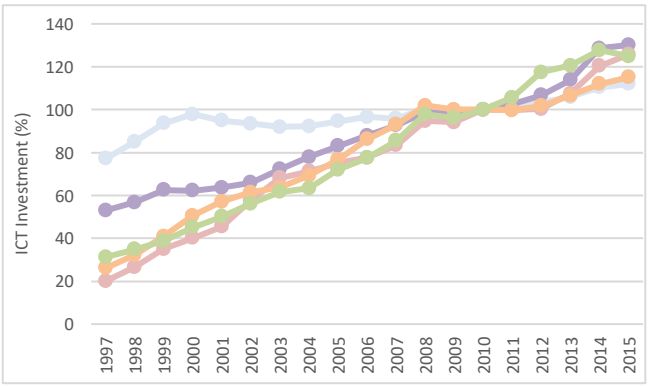

Figure 87 ICT Investment in UK

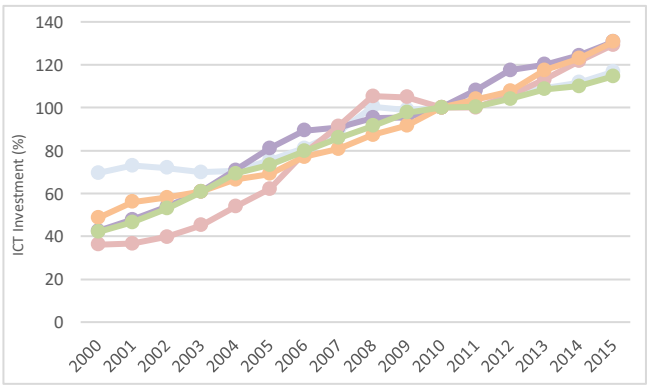

Figure 88 ICT Investment in USA

ICT investment has been rising in all countries, following some patterns in all developed economies.

All these countries do show positive levels in investment of information and communication technologies. Only those highly affected by the financial crisis present some negative rates in comparison with 2010 numbers. Through these graphs it is possible to perceive that all sectors of activities are investing heavily on computers, software and technology in general.

The growth level at which ICT investment increases or decreases depends a bit on the country, its priorities and its economy. Nevertheless, there are some insights that are common in all developed countries that have been analysed.

- On manufacturing activities, it is clear that this sector has lost its important position. It shows how ICT investment has stagnate and falls short behind all the other sectors. This fact manifests the shifted from industry activities to service activities in developed economies.
- Wholesale and accommodation & food service activities', tourism sectors, have become one of the most invested in all countries, even though accommodation levels exhibit ups and downs due to the way the sector work.
- Finance and information & communication activities present high levels of investment since the first year of data, also showing how economies have become dependent on technology in finance and communication sectors.

5.12 Average wages per country

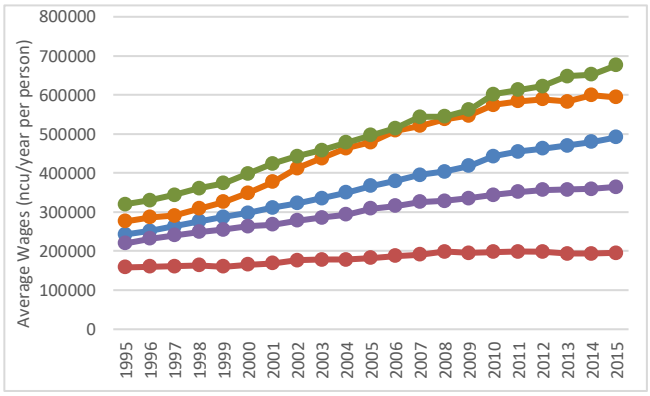

Figure 89 Average Wages in Denmark

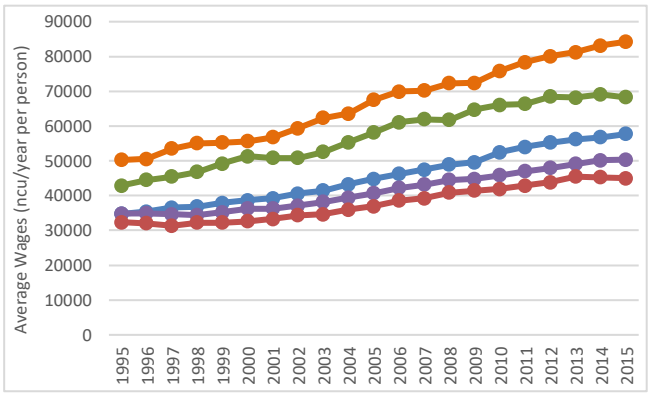

Figure 90 Average Wages in France

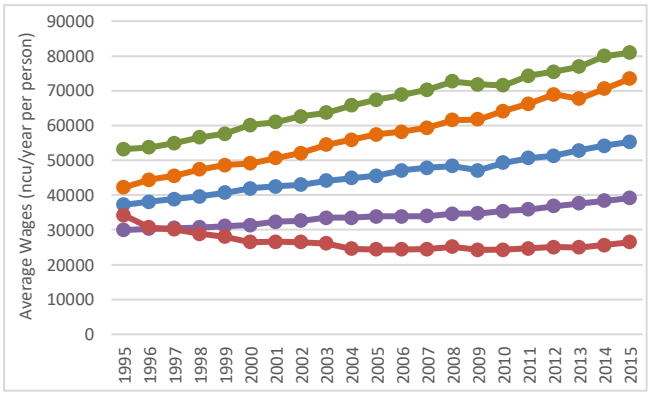

Figure 91 Average Wages in Germany

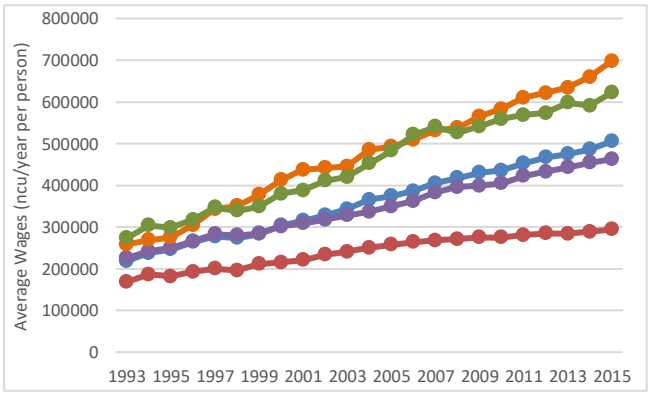

Figure 92 Average Wages in Sweden

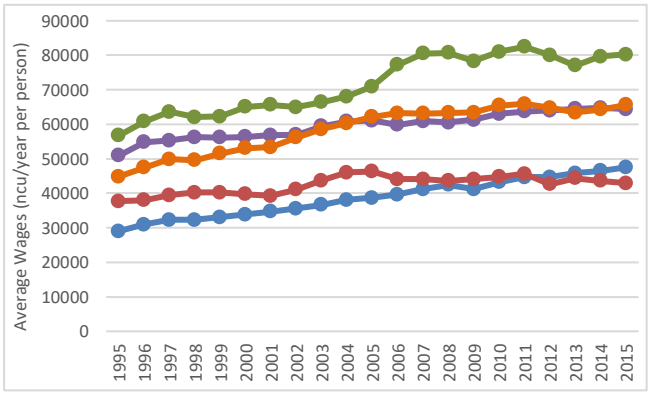

Figure 93 Average Wages in Italy

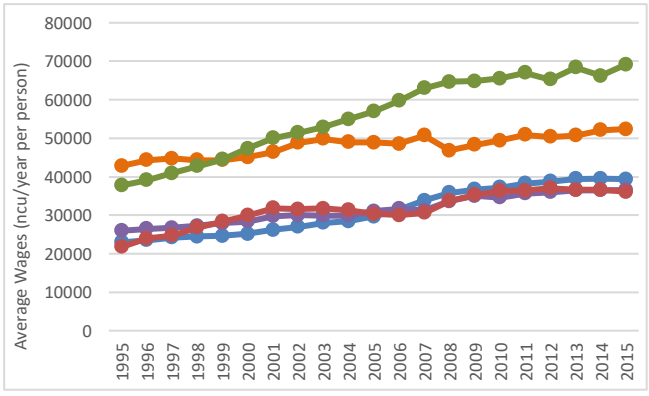

Figure 94 Average Wages in Spain

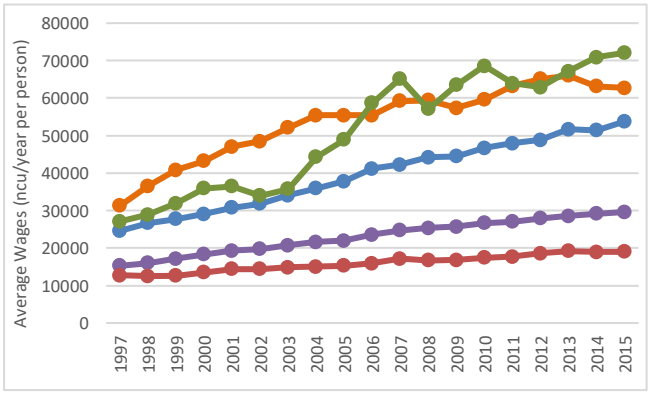

Figure 95 Average Wages in the UK

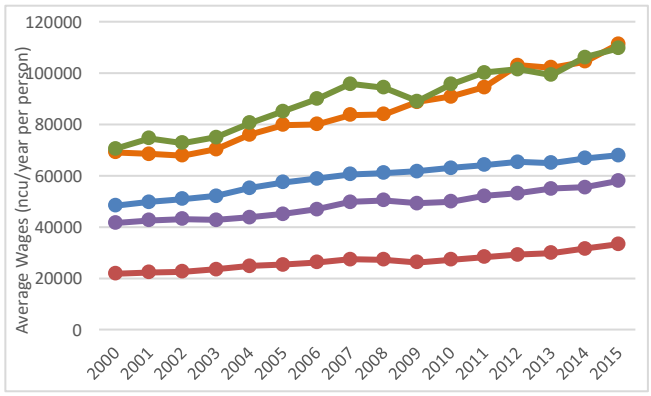

Figure 96 Average Wages in the USA

Average wages levels clearly show the same trend on all eight analysed countries. Those sectors that are surrounded by technology and software, such as Information & Communication, Finance & Insurances, and Manufacturing; present high increases on salaries. Especially those sectors surrounded by software, Finance and Information activities, show the highest remuneration levels in all countries (Italy and Spain show differences because of the importance of the financial sector on the countries and how the financial crisis impacted in them).

The most important fact if we examine the data is that the gap between the best salaries and the worst ones is increasing year in, year out. The worst sector of activities affected by this trend is the one that has been absorbing the loss of jobs from manufacturing: accommodation and food services. This activity is, almost in all countries, the worst paid, and the gap with the better ones is at least twice the difference, or even triple, than it was on the mid-nineties. The increasing employment rates and this existing gap thus evidence the precarisation of this sector. Wholesale and retail activities is the second worst sector, only above accommodation and food services.

Manufacturing has been keeping a half-way position, it has increased the gap with both groups: the best and the worst paid; showing little variations depending on the country which is analysed.

6. Descriptive analysis results: Summary

6.1 Countries

- **Denmark:**

As a general ICT investment have shown high rates of expenditure in most sectors, except accommodation and wholesale that have been around 2010 levels since late nineties.

Employment rates follow a trend seen in other countries: manufacture jobs decrease while service sectors increase or remain at the same levels. Wages at the contrary have increase in all sectors, but the gap between all of them is increasing, that is to say, the difference between the highest and lowest is increasing very quickly, but also the difference between the worst and the second worst is also increasing. The major lag that exists in wages can be found on accommodation sector, where salaries have almost remained the same since 1980.

- **France**:

Non-ICT investment started to slow down its rates, while ICT investment experienced growth rates equivalent to 20% every 5 years. Manufacturing is the sector with steadier ICT, that explains why it is the one that has lost more jobs, almost half of them, salaries at the contrary have improved: from being one of the lowest to being above accommodation and wholesale sectors. As seen in other countries manufacturing jobs have remained with higher salaries, so it is possible to conclude that jobs remained ask for employees with higher qualifications.

IT and finance are the sectors with higher salaries and higher ICT. Wholesale and accommodation activities have more employees, but their wealth levels have decreased, with salaries starting to lag behind most of the other industries.

- **Germany:**

ICT investment experienced an aggressive growth from 1995 to 2015, approximately 15% - 20% every three years. Economic sectors with higher computer rates have seen a slightly decline in employment rates, even though salaries are the highest, increasing the gap with all the other sectors.

It is possible that those who invest heavily in computers require more complex tasks that create high qualified jobs with better wages. This fact could explain why Finance and IT, and even manufacturing, have higher salaries than accommodation and wholesale: maybe in financial and IT activities is more difficult to substitute tasks that require analysis with computers, they help those tasks, without substitute them.

- **Italy:**

Employment rates on Italy show that jobs have shifted from manufacturing to accommodation and wholesale sector. ICT levels showed slowly growth rates until 2010, due to the economic crisis both investments started to contract and experimented negative growth. Salary levels are different in comparison with other countries. Even though finance and IT are the best paid, wholesale show the same levels of wages as finance and IT, instead of lagging behind of them as in other countries.

- **Spain:**

ICT expenditures had seen, since 1995, a rapid growth until the 2007 financial crisis, and these expenditures levels recovered in 2013. The only exception are finance activities, this fact is due to the injection of European capital that occurred in 2012 to rescue loans and avoid the failure of major capital institutions.

Employment rates, omitting financial crisis years', shows the same tendency as other countries: accommodation and wholesale jobs are created at the expanse of manufacturing jobs, while wages of the last one improves over the other two. This fact reflects how the economy works in Spain: tourism and service sectors are the main cause of growth, but temporality of jobs cause that remuneration is very low due to seasonality.

- **Sweden:**

All sectors in Sweden have experienced major capital investments in ICT investment. Accommodation and wholesale jobs have been growing at the expense of manufacture, while these wages have increase their levels and the gap between manufacture and accommodation and wholesale is increasing. IT employment is twice what it used to be and salaries have raised up, being the sector best paid along with finance.

- **USA:**

It is important to mention that USA data starts at 2000, while all other countries have data since, at least, 1995. All sectors, except manufacturing, have seen important growths on ICT investment. Employment rates illustrates the shift from manufacture to service jobs experienced in European economies. Although USA economy follows the same patrons as other European countries, the gap between salaries is increasing at a much lower rhythm than the EU economies.

- **UK:**

ICT investment has increased a lot during the las eighteen years, except for manufacturing, where levels of investment have had approximately the same levels as 2010. As seen in other economies, wholesale and accommodation jobs have gone up while manufacture has lost almost half of their workplaces and salaries have been stable, lagging behind manufacture and far behind finance and IT.

6.2 Sectors

- **Manufacturing**

Even though investment on computers had high levels in this sector, it quickly fell into last position with almost no growth. This fact, along with the decreased of people employed, almost half of the jobs have been lost, do show the shift from developed economies to other sectors away from manufacturing.

On the other hand, retribution per year per person has increase, so even though less people are working on these activities, the average salary that workers receive annually has increased. Once automation was done investment in this sector was no longer profitable, so it stopped.

- **Accommodation and Food Services**

In accommodation activities, ICT investment shows some up and downs. This trend is due to how these activities work: businesses tend to watch out new technologies before they implement it. This data also shows that, while investment is taking place, salaries do

not increase.

Employment rates have increased, as said, low-skill workers have shifted from industry to service activities, and these activities cannot be off-shored, so people are still being hired. These activities though, shift from season to season, they are subjected to high seasonality effects: employment do increase on holiday periods and decreases on working months. This fact could explain why remuneration is stagnate if you look the picture with all the other sectors in mind. The gap that these activities suffer with the best salaries is increasing abruptly. Job creation do not carry out high salaries in comparison with other sectors, so they are unstable (due to seasonality) and precarious.

- **Wholesale and Retail**

Even though people are buying more things than ever before, and economic growth is driven by consume, employment rates have almost not grown due to, in most part, online shops. E-commerce trends show that 80% of people buy online, and the profits of this distribution channel increases around 10% every year. This fact explains why ICT investment has increased so much and why employment has not grown along with it. People buy more but more physical shops with retailers are no longer a requirement.

Retribution on this sector follow similar trends as accommodation and food service activities: the gap with the highest salaries has increased a lot during the last decade, but due to the stagnant employment rates salaries have been able to distance a bit from tourism activities, being the second worst paid sector, but better in comparison with accommodation activities.

- **Information and Communication**

Information and communication activities have experienced one of the most important rates of ICT investment, a trend that continues nowadays. As it can be seen though, this positive trend on investment has not carried out the creation of new jobs, as employment rates have been almost steady for 20 years. These activities are surrounded by technology, so this investment in technology, apart from pull forward what they can do, may have been used to automatize processes, so that people can focus on more difficult tasks, without the need to hire more people to do those "basic" tasks. This could explain why salaries have such a positive trend.

- **Finance and Insurance**

Finance and insurance activities are very similar to IT sector. ICT investment has been positive and constant until nowadays. The same fact that explains why IT employment has not increased could explain finance too. As technology has been able to develop routine tasks automatically, employees have been able to do more complex tasks. This explains why, even the importance of this sector, average employment has decreased a little bit. One example of technology substituting workers would be *fintechs* or search aggregators of insurances, where you almost no longer need human contact. So, more difficult tasks mean higher remuneration.

7. Regression Analysis of economies

The main purpose of this analysis is to check if the results obtained through the sector comparison are also found through a regression analysis.

The results are that, the economy in its whole is affected by last year's ICT investment in employment depending on the country. On Denmark, France, Germany, Sweden, Spain, and UK it has negative effects on the total economy, decreasing the number of people employed by every tan per cent that ICT investment increases. On the rents and value-added side, the results are as expected: if value added increases so do jobs, and if rents increases the number of jobs of the economy decreases.

On the other hand, salaries are affected negatively by last year's ICT investment, but this variable is not relevant because its p-value is almost always less that 10%, so it is not important in the analysis. ICT investment of the same year has a positive effect, so more investment translates into more salaries, even though its p-value is also under 10% in some cases. The variables that matter are rents, value added and employment levels.

	Denmark		**France**		**Germany**		**Sweden**	
	(1) Employment	(3) Salaries	(1) Employment	(3) Salaries	(1) Employment	(3) Salaries	(1) Employment	(3) Salaries
ICT investment (t-1)	-0.892***	-43.13	-2.357***	-105.6**	-3.458***	2.336	-0.423**	-45.74
	(-5.05)	(-0.99)	(-2.63)	(-2.18)	(-3.60)	(0.03)	(-2.13)	(-0.45)
ICT investment (t)		43.20		104.6**		11.19		40.95
		(0.98)		(2.19)		(0.16)		(0.42)
Value added (t)	0.00118***	0.964***	0.0104***	0.977***	0.0187***	1.067***	0.000819***	1.011***
	(7.76)	(126.96)	(15.10)	(261.76)	(19.89)	(94.84)	(5.25)	(122.26)
Rents(t)	-0.000987**	-0.953***	-0.0118***	-0.973***	-0.0255***	-1.064***	-0.000693*	-1.004***
	(-2.27)	(-78.87)	(-6.74)	(-131.87)	(-11.81)	(-70.37)	(-1.96)	(-76.22)
Employment(t)		21.02***		2.039***		-1.757***		7.947***
		(9.34)		(18.26)		(-4.50)		(3.97)
Const.	285.9***	-129.9	2236.1***	-178.4	2436.9***	-1071.3	449.6***	264.8
	(8.74)	(-0.14)	(10.45)	(-0.46)	(7.22)	(-1.07)	(8.63)	(0.21)
N	280	280	488	488	279	279	293	293

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 1: Regression Analysis' results

	Italy		Spain		UK		USA	
	(1) Employment	(3) Salaries	(1) Employment	(3) Salaries	(1) Employment	(3) Salaries	(1) Employment	(3) Salaries
ICT investment (t-1)	-1.201	-75.19	-6.937***	-8.536	-1.911*	-82.74	-1.580	-1359.3***
	(-1.05)	(-1.64)	(-6.50)	(-0.37)	(-1.90)	(-1.49)	(-0.60)	(-3.38)
ICT investment (t)		118.3**		10.20		65.45		1323.3***
		(2.34)		(0.61)		(1.15)		(3.29)
Value added (t)	0.00745***	0.919***	0.0303***	0.772***	0.00429***	0.950***	0.00553***	1.012***
	(11.42)	(94.16)	(20.65)	(39.23)	(4.00)	(91.22)	(18.44)	(83.28)
Rents (t)	-0.00390**	-0.899***	-0.0324***	-0.756***	0.00431	-0.957***	-0.00711***	-1.014***
	(-2.45)	(-68.36)	(-8.52)	(-26.60)	(1.20)	(-59.54)	(-11.98)	(-70.92)
Employment (t)		3.976***		7.865***		2.863***		1.466*
		(10.37)		(14.50)		(8.92)		(1.92)
Const.	1562.1***	-3872.5**	702.9***	-78.02	2745.7***	1142.7	8133.0***	-3726.8
	(7.00)	(-2.14)	(7.00)	(-0.11)	(7.39)	(0.85)	(7.23)	(-0.46)
N	279	279	279	279	251	251	195	195

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 2: Regression Analysis' results

8. Results

At least in some sectors, computers have had an impact on both, employment rates, and retribution levels. Those sectors with high levels of investment in computers (Finance activities and information & communication) have experienced an incredible growth on wages, with an enormous gap with the lowest salary. These jobs are supposed to need more advanced skills than the others from other sectors, so it could be argued that it is not the investment that causes major wages, but the kind of tasks you develop (Michaels, Natraj and Reenen, 2014).

This same fact is seen in other sectors, as accommodation and wholesale, where even though they have good or great levels of ICT investment, retributions have not grown almost, technology has substituted some tasks, except those tasks which cannot be offshored, which have been embraced by those low-skilled workers who lost their jobs on manufacture and industry activities (Goos, Manning and Salomons, 2014). Therefore, three events impact these activities: a large number of people searching for jobs, a limited demand and the seasonality of the sector and its temporality, do provoke low salaries.

Regarding manufacturing, maybe it is one of the sectors where it is easier to check that, at first sight, Levy was right (Murnane, Willett and Levy, 2016): low skilled jobs have been eliminated by computers and that those non-routine manual tasks have remained with better salaries than before, because there is no chance of offshoring them.

These conclusions are also backed up by the regression analysis, that confirms us, that, at least, the total economy of a country is affected by ICT investment, that causes employment to decrease if this investment is done.

9. Artificial Intelligence and the future labour market

The effects that technology has had on labour market has been studied since the First Industrial Revolution. From the eighties on, a lot of papers have focused on the Third Industrial Revolution that the world is facing nowadays, studying the effects of computers and machines on wages and employment levels.

This study has found that computers and electronic devices and software have changed labour market, adjusting employment rates and retribution levels depending on the sector of activity and the type of task that was being developed by employees.

Artificial Intelligence and other types of advanced software (deep learning, machine learning, big data, etc.) are making their way into everyday jobs, and the debate of how these algorithms will change labour market and the economy is starting to surface.

Bessen, (Bessen, 2018), links the future effects of AI to demand. If demand is elastic enough to adapt to the new circumstances, new jobs will be created. There is the concern but, that AI and other algorithms will outpace humans in most tasks because of the Moore's Law. The distances between industrial revolutions are shortening, and technological advances are evolving faster than ever. For example, in their 2003 article, (Murnane, Autor and Levy, 2003), Levy, Murnane and Autor's conclusion was that some tasks, as driving a car, were not possible to define through algorithms. Not more than 7 years later, Google announced that it had modified some Toyota cars so that they had been able to drive autonomously more than 140.000 miles of North-American roads without the need of human responses.

The research about how technology has affected labour market covers from the first industrial revolution to the third industrial revolution (computers and internet), and nowadays new papers are appearing about the fourth industrial revolution (artificial intelligence, deep learning, big data…).

This same fact worried Martin Ford, who in his book *The Lights in the Tunnel* (Ford, 2009) described how the rapid evolution that was happening with electronic devices and software could outpace the creation of new jobs and create important unemployment levels.

Through this analysis it is possible to conclude that Artificial Intelligence will accelerate the changes that have been introduced with computers since the late nineties. The fourth revolution is based on the third. Deep learning, big data, etc. wouldn't be possible if computers did not exist. If artificial intelligence evolves only at the same rhythm that computers do, the consequences observed on this analysis will accelerate too. Employment levels will decrease in some sectors of activities and wages will decrease or increase depending on the tasks done. New high-skilled jobs will be created to maintain and create the algorithms and to teach them, but it is possible that the creation of this new jobs, as Martin Ford concluded, will not be as fast as the advances of the technology.

For example, ten years ago, to maintain a big 24-7 warehouse, it was necessary to have workers, for example three turns of four workers, to receive the materials, organize them and deliver them; nowadays, all these tasks can be performed by robots controlled by software, and maybe a team of five persons to control that everything is up and running correctly. Five new jobs have been created, but they require high skills on computer engineering, and twelve jobs have been lost.

These changes will go on, and industries that seemed untouchable will begin to see how some tasks are substituted by software and devices, such as manufacturing sector started to experience with the first industrial revolution.

10. Descriptive statistics Tables

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	294	3.728.605	6.588.871	3	2752
Employment (t-1)	280	3.723.357	6.580.655	3	2752
Salaries (t)	294	126018.9	226474	1.428.927	1130828
ICT Investment (t)	294	8.172.292	3.042.771	1.869.471	1.384.378
ICT Investment (t-1)	280	7.977.589	2.975.108	1.869.471	1.349.784
Value Added (t-1)	280	189902.1	332963	7933	1715195
Rents (t-1)	280	65743.56	115769.5	2.489.848	616747.9

Table 3: Descriptive statistic table of Denmark

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	504	3.192.263	5.637.667	17.78	24757
Employment (t-1)	488	3.148.863	5.584.066	18	24757
Salaries (t)	504	117289.1	222592.7	614.35	1310435
ICT Investment (t)	504	6.622.355	4.083.796	9.14	208.99
ICT Investment (t-1)	488	6.468.779	4.034.555	9.14	208.99
Value Added (t-1)	488	173031.9	326287	1782	1917675
Rents (t-1)	488	58260.54	113530.1	-964.73	648027.5

Table 4: Descriptive statistic table of France

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	294	5.216.956	9.055.655	57	38721
Employment (t-1)	279	5.196.344	9.035.563	60	38260
Salaries (t)	294	203294.9	354722.1	3850.2	1766748
ICT Investment (t)	294	715.515	3.325.007	9.3	136.92
ICT Investment (t-1)	279	688.862	3.197.059	9.3	130.89
Value Added (t-1)	279	306882.1	528166	3811	2631268
Rents (t-1)	279	106241.1	187441.2	-3018.51	922644.6

Table 5: Descriptive statistic table of Germany

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	294	2513.65	4.485.308	21.5	18769.7
Employment (t-1)	279	2.514.972	4.483.941	22.1	18769.7
Salaries (t)	294	111016.5	197303.4	908.94	918735.1
ICT Investment (t)	294	8.922.085	1.516.993	41.73	126.94
ICT Investment (t-1)	279	8.899.434	1.536.429	41.73	126.94
Value Added (t-1)	279	181203.9	314903	4389.8	1473045
Rents (t-1)	279	70884.95	124535.7	3172.04	577624.8

Table 6: Descriptive statistic table of Italy

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	294	2.184.393	3.869.598	29.79	18451.1
Employment (t-1)	279	2.183.696	3867.84	29.79	18451.1
Salaries (t)	294	69180.19	124588.5	729.83	640984.6
ICT Investment (t)	294	7.249.095	5.083.091	11.02	635.25
ICT Investment (t-1)	279	6.827.556	3.781.688	11.02	351.5
Value Added (t-1)	279	109837.2	196691.5	1707	1025672
Rents (t-1)	279	41299.83	75780.64	498.01	384687.4

Table 7: Descriptive statistic table of Spain

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	308	5.954.838	1.053.921	8	4506
Employment (t-1)	293	5.940.751	1050.79	8	4440
Salaries (t)	308	195275.9	356088.7	2135.73	1979551
ICT Investment (t)	308	6.825.071	3.088.695	12.12	182.74
ICT Investment (t-1)	293	6.567.433	2.909.803	12.12	159.46
Value Added (t-1)	293	344375.1	615531.2	4376	3333436
Rents (t-1)	293	153024.3	274257.2	2240.27	1431567

Table 8: Descriptive statistic table of Sweden

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	266	3.616.727	6.244.964	53.58	26604.21
Employment (t-1)	251	3.612.767	6.231.017	53.58	26079
Salaries (t)	266	118267.4	208877.1	3059.89	1066084
ICT Investment (t)	266	7.977.169	3.199.079	5.05	177.33
ICT Investment (t-1)	251	7.734.952	3.112.671	5.05	177.33
Value Added (t-1)	251	179142.8	308993.2	15464	1624276
Rents (t-1)	251	62378.43	109674.9	1000.17	558192

Table 9: Descriptive statistic table of UK

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment (t)	208	10836.87	11577.02	466	50725
Employment (t-1)	195	10795.58	11514.68	466	49510
Salaries (t)	208	653113.4	722536.5	36588.1	3596638
ICT Investment (t)	208	8.737.827	2.591.423	28.39	162.65
ICT Investment (t-1)	195	85.036	2.481.498	28.39	151.52
Value Added (t-1)	195	1069767	866646.8	110473	4200711
Rents (t-1)	195	428088.5	406543.7	71961.21	1931886

Table 10: Descriptive statistic table of USA

11.Figures' table of contents

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